ICICTE 2018

International Conference on Information Communication Technologies in Education

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The International Conference on Information Communication Technologies in Education (ICICTE 2018) Proceedings

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PREFACE TO THE PROCEEDINGS

Ġorġ Mallia
Chair, ICICTE 2018 Communications Committee

This is the eighteenth edition of the International Conference on Information, Communications Technologies in Education (ICICTE), and that number signifies that this conference has staying power... that its scientific excellence, its great networking capabilities, its (dare I say) legendary social calendar, all contribute towards it having been around for this long. Along the years ICICTE has gathered a core group of dedicated participants... the conference family... that have spurred it on into ever more excellent directions. And each new participant that it adds to its roll call quickly falls into place as one of the family – because it is one based on the need to explore, to know, to understand and, ultimately, to provide solutions.

And this is absolutely necessary in a day and age when technology has taken over so much of our daily existence. We eat, breathe and dream technology. It is no longer a peripheral part of society, but it has ingrained itself into the very foundations of existence. We cannot conceptualise a world without the dominating presence of technology, and therefore, how is it even remotely possible that technology not govern that most influential of all places: the hall of learning?

Though, let's admit it, "hall" has become very much a symbolic word, because the hall of learning can be online through distance education, potentially even as part of a MOOCs involving thousands of participants, or, on the other hand, that hall can be individual, a person alone with a mobile phone, absorbing information that interests him and that is accessed on the go... just as the whim strikes.

The second decade of the twenty-first century has been dominated by mobile technologies that make learning on the go a way of life for many, creating the classroom in someone's pocket, fuelling individual-independent learning, extending the educator's reach infinitesimally. Even though this particular educator might have been an unwitting one. Not a professional educator at all, but an individual who, nonetheless, educates through the facilities provided by omnipresent technology.

And where does this leave the physical "hall" of learning? Schools and brick and mortar universities have also embraced technology, though to varying degrees, as they cater for students shaped by the equipment with which they co-exist and from which they draw even procedural skills.

That is why conferences like ICICTE are so important, because they bring together scholars on the cutting edge of the technological advances that are ever present across education. They are the ones who innovate, who examine, who understand and who, yes, solve the problems that such a complex new society and the way it has transformed cognition brings with it.

These *Proceedings* clearly show the variety of experimentation and depth of understanding that our participants have undertaken. This collection of papers should prove to be stimulating reading for all education professionals who go beyond the curricular routine and are willing to push the envelope in favour of innovation.

On behalf of the Steering Committee, it is my great pleasure to welcome all those attending this annual conference, be they presenters, workshop leaders, or participants. I would like to say that you are now part of the ICICTE tradition. This "family" conference contains a mixture of the scientific and social and this has proved to be a very successful base on which to build a friendship-based scholarship. It is also wonderful to be back in Chania, where we had a very successful conference in 2013. The conference had previously been in Crete in 2007, but that time it was held in Heraklion. The backdrop provided by wonderful Greek islands like Crete create the atmosphere necessary for disseminating knowledge in both plenary and social settings, creating a real community spirit that is at the heart of what this conference is to all its participants past and present. This is a "Greek" conference in that sense, though the community in it is vastly international, both on the organisational and on the participant sides.

ICICTE would not be even remotely feasible without the tireless work of the Conference Director, Nancy Pyrini, who deals not only with the indispensable logistics, but also is the face of the conference to our many delegates. Nancy is both the mind and heart of ICICTE. There would not be this annual get-together of friends without her.

These *Proceedings* are the result of a symbiotic process which involves the members of the Scientific Committee, ably led for many years by Dr Greg Anderson, and the editing work of Dr Linda Morris. The members of the Scientific Committee two-way blind review papers (though there are times when the review process goes through multiple phases), and Dr Morris scrupulously edits and formats the papers that are then produced by myself to form this assembled volume.

But there are a lot of people involved in the success story that ICICTE has become. Once again, this conference has been successfully organised by Solent University of the United Kingdom, represented by Dr Chris Barlow, who chairs the Steering Committee. This is done in collaboration with the Justice Institute of British Columbia, Canada, represented by Dr Anderson. We are also aided greatly by Dr Costas Tsolakidis of the University of the Aegean, George Sarrigeorgiou, and Marie Louise Kold, among others.

We sincerely hope you find these *Proceedings* illuminating, and if they are of use to you in ways that make you utilise what you read here in your own professional capacity, then we have succeeded. Please do contact any of the authors with whose work you find you share an affinity and make sure that you join us in the annual sojourn of creative, innovative scholarship that is ICICTE.

BACK TO CONTENTS

COOPERATIVE INTERNATIONAL VIRTUAL CLASS TO TEACH INTERCULTURAL SKILLS IN GLOBAL SOFTWARE ENGINEERING

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Germany

Abstract

For today's IT graduates, programming skills alone are not enough. In addition to knowledge of technical skills, intercultural understanding is vital in order to work together in geographically distributed, international teams. Unfortunately, few students have the opportunity to travel abroad to acquire first-hand the international experience necessary to learn how to work together with software developers from different cultural backgrounds. In order to teach students these intercultural skills, a *project-based learning* approach was applied to teach virtual, international courses in global software engineering. Experiences, difficulties and lessons learned from a number of team-teaching co-operations involving Germany, Japan, Mexico, and Mongolia are described.

Keywords: distance learning, international, intercultural, project-based

Introduction

Information and communication technology help people worldwide to learn and work cooperatively. Globally distributed, multi-national teams often develop the software that this technology runs on. The team members working together on one software project may live in different countries, work in different time zones and speak different native languages.

As a result, global software development presents a number of new challenges: geographic distance, different time zones, different languages, a lack of trust and cultural differences. For example, a team made up of members in different countries can take more than twice as long to complete the same task than if all of them were sitting in the same room (Herbsleb, & Mockus, 2003).

Originally, different time zones were seen as a potential driver for increased productivity. A "Follow-the-Sun" time zone model means that three teams distributed around the planet could work around the clock in eight hour shifts (Carmel, Espinosa, & Dubinsky, 2010). Although this theoretically should lead to increased productivity, many projects experience lower productivity. Different work schedules make it very difficult to communicate real-time with team members at different locations (Sosa, Eppinger, Pich, McKendrick, & Stout, 2002).

Team members who speak different languages often have difficulty communicating in real-time. A third common language, such as English, is often used. This third filter language may require extra time and effort. Team members first need to translate their thoughts from their native language to English. Then they need to translate the English answers from the other group back into their own native language. Some non-native speakers may feel anxious about telephone or video conferences (Sangwan, Bass, Mullick, Paulish, & Kazmeier, 2007).

Teams in different countries, who have never actually met, often experience difficulty in establishing trust. Familiarity often grows naturally during informal communication about non-project related matters, such as sports or hobbies. This important team-building activity is often missing in distributed teams (Nguyen, Babar, & Verner, 2006).

Misunderstandings due to cultural differences have repeatedly proved to be one of the most difficult challenges to overcome in successful global software engineering (MacGregor, Hsieh, & Kruchten, 2005). Increasing awareness of cultural differences to work more effectively in international teams is one of the main goals of this project.

These new challenges emphasize the need for additional skills in IT graduates. The stereotype of the isolated computer programmer working alone is no longer adequate. Today's IT graduates need to learn both international project management methods and the intercultural skills necessary to collaborate with team members in other countries. A wide variety of soft skills are necessary for success in global software engineering, such as communication, teamwork and conflict resolution skills. In addition, self-criticism, dealing with uncertainty and ambiguity, appreciating diversity and multi-culturalism, understanding cultures and customs of other countries are vital for the success of international projects. Due to time and budgetary constraints, few students have the opportunity to go abroad for an entire semester in order to gain international experience first-hand.

This research attempts to find answers to the follow questions:

1. Can virtual, team-teaching courses help students learn intercultural skills as part of their regular curriculum at their home universities?
2. Can project-based learning help students discover their own solutions to intercultural misunderstandings?

To answer these questions, virtual, team-teaching courses between the Nuremberg Institute of Technology, Germany and three international partners are presented:

1. Mongolian University of Science and Technology (2012, 2013)
2. National Polytechnic Institute in Mexico (2014, 2015, 2016)
3. Ritsumeikan University in Japan (2017).

Challenges, experience gained and lessons learned are discussed.

Context

One of the first researchers to use empirical methods to investigate the cultural differences in the software industry was Hofstede (Hofstede, Hofstede, & Minkov, 2010), who applied multivariate statistical methods to analyze data collected from thousands of IBM employees worldwide. Hofstede classified differences in cultural perspectives according to six dimensions:

1. Power distance: The attitude of a society to inequalities among individuals in a society (PDI)
2. Collectivism vs. individualism: The degree of interdependence among members in a society (IDV)
3. Masculine vs. feminine: Success vs. harmony and caring (MAS)
4. Uncertainty avoidance, ambivalence: Feeling threatened by unknown situations (UAI)
5. Long-term vs. short-term orientation: Planning for the future vs. living in the present (LTO)
6. Indulgence vs. restraint: The extent to which life is to be enjoyed vs. showing restraint (IND)

These dimensions can be used as a framework to make international project teams more aware of country-specific differences. In addition to these six cultural dimensions, Hall (1990) differentiated between two ways of how different cultures perceive time: M-time (monochromatic) and P-time (polychromatic). Monochromatic cultures, such as Germany, tend to start and end a meeting at a precisely scheduled time. Polychromatic cultures, such as Mexico, may feel that such a meeting is being rushed through and then cut off abruptly, before they have a chance to adequately express their views.

Hall (1990) also differentiated between high and low context cultures Collectivist societies such as Asian countries also tend to be classified as high context cultures. The personal relationships between people are often an intrinsic part of communication. Facial expressions, gestures and pauses can convey more meaning than the actual words spoken. Western countries such as Germany tend to be more individualistic and lower context cultures. Because written and spoken words convey meaning, communication can be verbose.

Teaching Global Software Engineering

Beecham et al. (2017) and Clear et al. (2015) conducted systematic reviews of papers to define the challenges facing global software engineering education, including: global distance, teamwork, soft skills, stakeholders, infrastructure, development process, and curriculum. Hoda, Babar, and Shastri (2016) discuss socio-cultural challenges in global software engineering education. They conducted a case study of 14 participants from 10 different universities in 8 countries. They identified six dimensions that caused significant challenges: language, concept of time, attitude towards grades, assumptions about national culture, autonomy, and influence of the lecturer.

Methodology

The global software engineering classes analysed in this research were all taught at the graduate level. Class sizes were relatively small, with 20 students or less. As a result, sample sizes are not large enough for statistically significant quantitative analysis. This study implements a qualitative approach based on questionnaires and group retrospectives to gather data.

Students were asked about their opinions at the beginning and at the end of each course. Students filled out questionnaires ranking which factors they felt were most important for global software engineering, such as geographical distance, time zones, language or cultural differences. They rated their expectations of differences between themselves and the students at the partner university, according to the cultural dimensions (Hofstede et al., 2010) (Hall, 1990) discussed in the previous Section Context.

At the end of each course, a project review and retrospective based on the moderation method "4Ls" (Gottesdiener, 2010) was conducted. Each student was asked to fill out four sticky notes, one in each color:

1. **Like** (green): What did you like about this project?
2. **Lack** (red): What did you miss? What went wrong?
3. **Learn** (blue): What did you learn during this project?
4. **Long for** (yellow): What would you do differently next time?

Students placed their notes on the board and explained their experiences in each category. These discussions are summarized in the Section Results.

Project-Based Learning

Although the teaching method *project-based learning* is often used interchangeably with the term *problem-based learning*, each method has a slightly different focus. Problem-based learning was first introduced to teach medicine at the McMaster University in Canada (Barrows, 1996). The idea is to replace instructor-centered, frontal lectures, which emphasize the passive consumption of material and the rote memorization of facts. Instead, students work in small, autonomous groups, and the instructor plays the role of a facilitator. An authentic problem is presented, without any introductory lectures. Students actively self-organize to investigate and construct their own solutions in a case study. The central hypothesis is that students learn more effectively when the learning process is centered on a concrete problem. Because the learning is self-directed, students develop problem-solving skills.

Project-based learning (Savery, 2006) is quite similar to problem-based learning. Students work together to complete a project and thereby encounter a number of problems. Each of these problems can be expanded on as "teachable moments." The major difference to problem-based learning is that the project is defined as an external outcome, determined by a product owner or customer. The students' role in defining the problem goals and in evaluating the success of the results is limited. As in real-world projects, external stakeholders have a say.

Rodrigues and dos Santos (2016) discuss a framework for applying problem-based learning to computing education. They emphasize the need to adhere rigorously to the pre-defined processes of the problem-based learning method. In contrast, other researchers found versions adapted to software engineering were more effective. Richardson and Delaney (2009) successfully applied a hybrid project-based learning approach in an undergraduate software engineering class. They found the approach especially effective in teaching soft skills. Mendes Silva, Goes dos Santos, Ribeiro da Silva, Viera Dias, & Marques da Cunha (2011) found that an adapted version of problem-based learning gave more realism to teaching software engineering.

Perrenet, Bouhuijs, & Smits (2000) noted that while problem-based learning is more directed toward the acquisition of knowledge, Project-based learning is more suited to the application of knowledge. They also found that project tasks more closely mirror professional reality, because a single project often lasts several weeks or months, whereas single problems in problem-based learning are often limited to one week. Woodward, Sendall, & Ceccucci (2010) developed instructional modules based on project-based learning to teach information systems. A combination of experiential learning, cooperative learning strategies and dialog-based analysis of cases were shown to have a positive effect on the development of students' soft skills. The experiments presented here implement project-based learning because the goals in software engineering almost always involve external stakeholders.

Description of the Cooperative Virtual, International Courses

Over the last six years, a number of virtual, international global software engineering courses have been conducted at the Nuremberg Institute of Technology in Germany. Each course was conducted together cooperatively with a partner university in a different country: Mongolia, Mexico and Japan.

Before starting the project phase, students were given introductory lectures about different aspects of global software engineering, such as "international project management," "agile software development," "distributed collaboration tools," and "intercultural communication." After this initial orientation lecture period, students from each group attempted to collaborate on an international group project. A realistic, international software development project was simulated as part of a project-based learning approach. Students participated either in an intensive, all-day block seminar, which ran for seven consecutive days, or a course that ran for 12 weeks during most of one semester. Students were assigned a messy, real-world project, without detailed instructions on how to solve it.

During the first five courses (2012 – 2016), students formed homogenous sub-teams at each site. For example, 20 students in Germany were responsible for the requirements engineering, 20 students in Mexico for the programming. The two teams together developed one software project. Each site selected one person as a communication manager. In 2017, for the first time, heterogeneous teams were formed. Each team was made up of four students in Japan and four students in Germany. These mixed teams then competed against each other to see who could develop the best project.

Communication between the two groups was limited to electronic means: video conferences, chat and e-mail. The teams exchanged documents and computer code using cloud-based project management and collaboration software. Due to the relatively large time differences between Germany and

Mexico (7 hours), Mongolia (7 hours) and Japan (8 hours) students only had about a one hour time window each day when they could communicate in real-time via video conference. All other communication was conducted asynchronously via cloud platforms, messaging and e-mail.

Results

This section describes the results of the cooperative classes taught with Mongolia, Mexico and Japan, in chronological order.

Results from the Mongolia – Germany Experiments

A virtual, team-teaching cooperation between two universities in Germany and Mongolia is described in detail by Beier, Bickel, Brockmann, & Choinzon (2012) and Ende, Lämmermann, Brockmann, & Ayurzana (2013). During the first course, four professors from the Mongolian University of Science and Technology flew to Germany for one week. This initial meeting greatly helped to establish a sense of trust between the cooperating professors. To further aid in communication, a student originally from Mongolia who was currently studying in Germany served as an intercultural coordinator. Without this "intercultural bridge builder," communication would have been difficult, even between the professors.

In addition to the expected geographical and temporal differences, enormous barriers in language and culture presented huge obstacles for the students. Solutions to anticipated problems, such as geographical distance and the eight-hour time difference could be taken into account by scheduling video conferences at a time when it was afternoon in Mongolia and morning in Germany. Unstable internet connections slowed down asynchronous communication via e-mail.

Although the language barrier could be somewhat alleviated by translation software, the cultural barrier proved to be almost insurmountable. The Mongolian students were used to a traditional lecture format, where the professor is seen as a person of authority. German students felt comfortable asking questions and participating in lively, heated discussions. The Mongolian students sometimes viewed this behavior as rude. Although the students on both sides appreciated the opportunity to work together with other students from a very different culture, they felt this proved to be too much of a challenge, even for master's degree students.

Results from the Mexico – Germany Experiments

The next cooperative course with the National Polytechnic Institute in Mexico was conducted for three years in a row, from 2014-2016 (Harrer, Brockmann, & Olivares-Ceja, 2014; Olivares-Ceja, Gutierrez-Sanchez, Brockmann, Kress, & Staufer, 2017). Although Mexico and Germany have two very different cultures, it was hoped that there would be enough common overlap to enable a successful cooperation.

According to Hofstede et al. (2010), Germans have a high value for uncertainty avoidance and feel uncomfortable in ambiguous situations. German students usually expect detailed specifications and clear instructions of what is expected of them. To test this hypothesis, students were intentionally assigned a vague, messy project. This intentional ambiguity proved unsettling for the German students. In contrast, the Mexican students looked forward to taking part in a novel experience. The German students immediately tried to establish clarity. During the first video-call with the Mexican students, the German students concentrated on task-oriented organization. This “business first” approach intimidated the Mexican students, who expected an informal phase of social contact to ease team building.

As the project progressed, the two teams identified what the difficulties in this intercultural collaboration were and tried different approaches to alleviate these problems. Meetings were conducted based on a written discussion agenda, which each group received ahead of time. Because e-mail was often not read or answered, the students agreed that any binding agreements had to be made during video conferences. In contrast to typical German inflexibility, the Mexican students improvised ideas and goals quite agilely. The German students were alarmed by requests for new requirements during the project, which they saw as a violation of the initial project specifications. They had to learn to abandon their strict plans and adapt to the agility of their Mexican group members, whose new ideas were often better.

Not until the end of the semester, after the pressure of grades abated, did the German students finally relax enough to communicate informally with the Mexican students. They asked themselves why they didn’t even know the names of most of their Mexican partners. They realized that they could have saved a lot of time and prevented misunderstandings by first building trust.

Results from the Japan-Germany Experiment

During the winter semester of 2017/2018, the students were first introduced to the topic of Global Software Engineering during an initial orientation lecture. The lecture topics presented the theory and methods central to global software engineering, adaptation of agile software project management methods to distributed teams, intercultural aspects of global software engineering, as well as team-building and conflict management.

One goal in this class was to prevent students from clustering together with other students from their own country. Students were assigned to heterogeneous groups, made up of 3-4 students from Japan and 3-4 students from Germany. The intention was to test whether mixed teams could lessen “in-group” vs. “out-group” conflicts. Students found these mixed, cross-site teams much more challenging. They were also quite surprised that the students from the Japanese university were not originally from Japan. As part of an English language master’s degree program, students were from a number of East Asian countries, such as China, Korea and Vietnam. Having to adapt to a number of different Asian cultures proved even more difficult than planned.

The fact that clear requirements were not delivered at the beginning of the project was unsettling to the students in Germany, who feared the ambiguity and were intent on getting good grades. Students from both countries reported extreme difficulty in communicating with the remote half of their teams. Some team members reported a lack of trust in team members in the other country, since they had never met them before. They also learned to takes minutes of every meeting and to set deadlines for each individual activity and to assign one person as responsible for each task. Next time, they vowed to spend more time getting to know each other at the beginning of the project.

Observed Intercultural Differences

After the project reviews and retrospectives with the 4Ls Method (Gottesdiener, 2010), the team members' behaviour was rated according to Hofstede et al.'s (2010) and Hall's (1990) cultural dimensions. See Table 1.

Table 1

Comparison of Cultural Dimensions in Five Countries, based on Hofstede et al. (2010) and Hall (1990)

Cultural Dimensions	Germany	Japan	Mexico	Mongolia
Power Distance (PD)	low	high	high	high
Individualism (IND)	high	low	low	low
Masculinity (MAS)	high	high	high	high
Uncertainty Avoidance (UA)	high	high	high	high
Long-Term Orientation (LTO)	high	high	low	low
Indulgence (IND)	low	low	high	high
Monochromatic/Polychromatic	mono	mono	poly	poly
High Context / Low Context	low	high	high	high

As evident from Table 1, Germany, Japan, Mexico and Mongolia differ considerably on the cultural dimensions of power distance, individualism, long-term orientation, indulgence and time perception. Masculinity and uncertainty avoidance score high for all four countries. Team members from Germany were the only ones who valued a low power distance, high individualism and low context communication.

The teams of students noticed quite rapidly that they had different views on the power distance between students and professors. Although German students were used to self-organizing and asking professors direct questions, this behavior was considered rude in the other three countries. German students needed to recognize that their ambition to maximize their individual grades might not have been as important as the success of the entire group. The dynamic, short-term flexibility of the Mexican and Mongolian teams was unsettling for the Germans, who are used to long-term planning to minimize uncertainty. The polychromatic time perception of some teams conflicted with the monochromatic German view of time. As the only low context culture, German students were often confused by what they perceived as vague answers from the East Asian students, while the East Asian students sometimes found the directness of the Germans rather rude. Mexican students were disappointed that the German students did not seem interested in interacting with them informally on social media. From a high indulgence and collective culture, Mexican students thought the German students focused solely on the tasks, neglecting the social aspects of the group. At the beginning of the courses, students ranked differences in time zones and languages as the most important factors for global software engineering. At the end of the courses, students ranked cultural differences and trust between teams as the most important factors.

Conclusions

After six years of team-teaching experiments in global software engineering, we can report a number of conclusions. First, students reported that project-based learning was much more challenging than a traditional, instructor-based lecture. German students experienced anxiety due to the ambiguity inherent in the lack of detailed specifications. At the end of the class, a number of students complained of exhaustion. These experiments were conducted with students at the master's level. Although project-based learning could theoretically be used with less experienced participants, the danger of cognitive overload (Kirschner, Sweller, & Clark, 2006) should not be ignored.

Project-based learning had quite a positive effect on students' performance and on their learning success. The virtual course conducted in cooperation with another university in a foreign country allowed students to participate in a realistic simulation of an international project. Students had to deal with real-world problems, such as a seven or eight hour time difference. Project-based learning was especially effective in helping students learn to understand and to communicate better with people from different cultures. The review and retrospectives at the end of each course demonstrated that the students felt they had learned more by taking part in real-world experiences than they would have learned by listening to theoretical lectures.

When students were allowed to form homogeneous, same-site sub-teams in the previous courses, the development of an "in-group vs. out-group" mentality was observed. Forcing students to work in heterogeneous, cross-site teams increased the amount of communication necessary. Although potential for conflicts increased, students felt that they learned more.

Finally, from the point of view of the instructors, organization, informal communication and trust were judged to be the most important factors for conducting a virtual, distributed course. Although the students never got the chance to meet each other "in real life," the instructors were able to meet personally for one week before each course. These personal meetings were essential, not only to discuss class organization. More importantly, these meetings gave instructors the opportunity to get to know each other on an informal basis. This informal communication formed the basis for a level of trust, which is vital for the success of a virtual, cooperative course. Other researchers also confirm that trust and a good relationship are vital for collaborations (Hussain & Blincoe, 2016).

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OPEN SOURCE SOCIAL TECHNOLOGIES FOR TEACHING HEALTH INFORMATICS

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Abstract

An estimated 87% of university students rely on social networking sites (SNS) in their daily social activities. Some universities have adopted open source SNS in teaching. This paper discusses the benefits of using open source SNS, especially Elgg, in teaching health informatics. It is organized as follows: (a) A literature review to define open education, (b) a review of open source SNS and their effects on education systems, (c) an overview of Elgg pointing out its features, (d) a case study of implementing Elgg in teaching Health Informatics course, including a discussion of results and recommendation, and finally (e) the conclusion.

Introduction

People use social networking sites (SNS) as tools to connect with others around the world. Institutions and organizations that provide teachers and students with community building capabilities can use such tools. Specifically, open source SNS include a lot of features that provide institutions with a way to enhance learning capabilities. Institutions have adopted open source SNS as an effective approach to improve students' academic performance where teachers and students can benefit from online services to achieve high level of cooperative learning platform.

The aim of this paper is to show the importance of using open source SNS, especially Elgg, in teaching the Health Informatics course at the department of Computer Science at the University of Balamand. The paper starts with an overview on open source social networking and its effects on educational systems. It highlights the most included features offered by Elgg that makes it the correct choice to be a used as a social learning tool in institutions. In order to properly assess the effectiveness of adopting Elgg as an open source learning platform, a questionnaire survey was conducted with teachers and students who are teaching or taking the Health Informatics course. Results clearly show a good satisfaction from all participants of using Elgg, promising to be adopted as a learning management system offering all the needed and important features.

Open Source Social Technologies and Their Effects

According to the GNU's Not Unix (GNU) project, free software can be defined as "a matter of the users' freedom to run, copy, distribute, study, change and improve the software" (Stallman, 2018, para. 3). The benefits of using open source are: less expensive, more secure, and easier to fix code bugs (Van Rooij, 2009; Weber, 2004). Subsequently, the world is adopting online teaching by moving towards open education-- a new social process that can substitute traditional face-to-face class where knowledge and learning materials should be free and open to use by students (Hiltz & Turoff, 2005). Through open education, the following advantages can benefit institutions: cost-saving, evolving educational performance and strategies, increasing communications and collaborations among teachers and students, increasing learning quality, and improving teaching functionalities (Siemens, 2003).

By definition, an open source social networking tool is an online platform providing a primary role of building social relations among people. People use SNS for a number of purposes: connecting with friends, sharing photos, discussions, activities, ideas, events and interests (Srivastava, 2012). SNS will meet the changing needs of higher education (Jalal & Zaidieh, 2012) where they help in adding an interactive side with students and make their participation in the educational process more important. Many universities have adopted open source SNS as an online tool to deliver real-time education for many reasons, including software licenses' cost reducing and rapid fixing of open source software bugs and problems. Students rely and use SNS in their daily social communication life. Students want systems that place them at the epicenter, rather than being course-focused (Garrett, Thoms, Soffer, & Ryan, 2007). According to some academic researchers, the greatest benefits of using open source SNS are in their ability to promote student reflection, engagement, portfolio, and high-level synthesizing activities (Berscia & Miller, 2006). SNS can be used as a source of knowledge. Blogging can be used to post research topics as a way of increasing students' learning by reading recent topics in areas that they are studying.

Open source social networking platforms provide an abundant number of positive effects on improving the learning process:

- Improved collaboration: Advanced collaboration between local students and others from different communities and advanced collaboration between teachers and other teachers and researchers.
- Customization: Customization where educational institutions can customize open source technologies to meet their needs.
- Motivation: Students' motivation in which students can build online collaboration to enhance their learning capabilities.
- Creative teaching atmosphere: Teachers use social networking sites to go beyond the institution walls and track their students in an effective learning system.
- Fruitful conversations: Online conversations between teachers and students that allow teachers to keep track of their students' activities and comments, interact and give proper help.

Elgg

Elgg is an open source, award-winning social networking tool, that enables businesses, schools, universities and associations to create their own fully-featured social networks and applications (Elgg, 2014). Elgg has a lot of social features including: social networking, weblog, bookmark, instant messaging, files repository, access control, tagging, customization, and community building. These features provide an attractive environment that allows students to collaborate in an online learning community.

Elgg offers students the possibility to fully control their own online profiles where they can maintain their personal file gallery, blog, and individual customized templates. Furthermore, Elgg users have full control over other users in the community who can view their content. Elgg users can maintain their own blog, gallery, files, and private personalized templates. Through a Wiki add-in component, Elgg can be more practical for an academic course community where several students can have their own pages with the same name. Table 1 summarizes the most important features that Elgg includes and is characterized by.

Table 1

Elgg Most Important Features

Important Features	Description
Community Building	Shared interests communities can be created by students
Weblog	Personal and friends weblogging can be created and can be shared with others
Instant Messaging	Provides students with instant conversations and messaging
Multiple Institutions Support	Link specific account to multiple institutions
Full Students Track	Can monitor and track all students activities
Full Course Management and Delivery Tools	Elgg can be integrated with an API to provide a complete learning management system
Create Pages and Groups	Students and Teachers can create groups for classes or own pages. They have full control over created pages/groups
Real-Time Notifications	Students/Teachers can send Real-Time messages

Based on the most important features that Elgg offers, Elgg could be considered as a powerful social network component for higher education institutions to improve students' interaction and flexibility in learning.

Case Study

Implementation

In this paper, we describe using Elgg as a social networking platform to create an online community, for teaching the Health Informatics course in the Department of Computer Science at the University of Balamand, Lebanon. The main goal of adopting Elgg as a social networking platform was to provide teachers and students with all needed features that are considered as an enhancement for the educational process. Also, this platform enhanced a learning community among students and teachers through a collaborative online framework. Such a framework emphasized the significance of the academic activities and the perceived learning of students in a cooperative learning community. Teachers and students used Elgg as a learning tool to post class materials, projects, etc. They got engaged in class discussions and project coordination.

Survey Questionnaire
Being used as a social networking platform, Elgg has been implemented to provide Health Informatics students with an effective tool for the creation of a cooperative learning community. Teachers used Elgg to communicate with their students, post course information, and follow their students' online activities. Students used this platform for social learning and communication, to build collaboration among others, work on projects and assignments with their colleagues, link to resources, and share their personal files.

A questionnaire survey was conducted to evaluate the effectiveness of using Elgg in higher educational institutions as an open source learning platform. The total number of survey participants was 177 (5 teachers and 172 students). Teachers and students had given or taken the Health Informatics course using Elgg as a social learning tool over two sequential semesters in the year 2017. Selected teachers and students have good know-how in using social networking sites (e.g., Facebook, Moodle, etc.).

The survey was comprised of 10 questions on the usefulness of Elgg with its offered features. A five-point rating scale ranging from 1 (strongly disagree) to 5 (strongly agree) was used for each question in the survey. The survey included questions about features related to communication between users, blogs, file repository, instant messaging, customizability, resource publishing, group discussions and collaboration, class interaction, and course management.

Discussion of Results
Table 2 highlights the number of participants in the corresponding scaling rate for each Elgg's feature.

Table 2

Elgg's Features Rating-Points Survey

Features	1	2	3	4	5
Communication between users	0	0	15	46	116
Blogs	0	0	11	51	115
File repository	0	0	31	54	92
Instant messaging	0	0	13	48	116
Customizability	0	0	9	23	145
Resource publishing	0	0	25	31	121
Group discussions	0	0	16	29	132
Group Collaboration	0	0	24	56	97
Class interaction	0	0	12	25	140
Course Management	0	0	16	19	142

Based on the above table, the total results clearly show that most teachers and students were very positive about using Elgg as a powerful open source tool for social learning. These high good numbers reflect the facts that students can use Elgg as a social learning platform and as a social networking site in their daily communication. Such communication can offer, and are not limited to, communicating with their colleagues, sharing news and personal files, exchanging interests, and meeting new friends from other communities. In addition, students can use such a tool to collaborate in their classes, get involved in class discussions, coordinate projects, share ideas, and solve assignments. Overall, students can benefit from such an interactive environment to improve themselves and communicate with their teachers and remaining colleagues in their daily life and classrooms. Such adoption shows that students have more interest in learning and have achieved better results in their learning progression.

From another perspective, using Elgg teachers can reach a high level of collaborative research with other colleagues. Teachers can post materials and information related to their courses and keep track of their students. They can collaborate with their students and assist them in their assignments and projects. Generally, teachers can participate in an excited and interactive learning system with students.

Accordingly, this platform will provide better collaboration and offer high level of knowledge achievement in an improved learning educational system. Most participants showed satisfaction in using Elgg as a social networking and learning tool in the educational system. Based on the above results and satisfaction, Elgg is recommended to be adopted by the remaining departments in the university as an online social learning tool that empowers the educational process with a numerous number of effective features.

Conclusion

Many educational institutions and organizations have started the initiative of adopting open source social networking platforms. Elgg can be used as an efficient class social networking tool that empowers learning with effective features and simplifies real-time communications in classrooms. In this paper, a case study of implementing Elgg in teaching the Health Informatics course at the University of Balamand was presented. The results promise that Elgg can be considered as an efficient tool that can be adopted as an open source fully featured social networking platform to enhance education in classrooms. In conclusion, Elgg can be considered as a substitute for learning management systems.

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SUPPORTING STUDENT LEARNING THROUGH INNOVATIVE TECHNOLOGY IN THE AVIATION CLASSROOM

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Abstract

This paper reports on the implementation of the new Flight Procedures Laboratory at Griffith University, Brisbane, Australia. This computer lab has been outfitted with hardware and software to support the student learning of flight procedures in a practical, task-oriented way. Data has been collected from the first cohort of students using this computer lab with a pre- and post-survey conducted. Student interviews were also conducted. Results from the survey as well as a description of the lab setup are included in this paper along with information about how this type of teaching facility may help our future pilots.

Introduction

Commercial pilots worldwide, and in Australia, have to pass several theory based examinations administered by the Civil Aviation Safety Authority (CASA) before receiving a flight licence. Griffith University offers related courses as part of its three year Bachelor of Aviation program, which can be accelerated and completed in two years. The volume of the content to be mastered is sizable though. In addition, the information varies in its degree of relevance to a particular flight and adds to the complexity of practical flight training.

For these reasons, Griffith University has introduced a three part core course series called Flight Procedures, which is recognised towards its Bachelor of Aviation degree. The content is a selection of all the highly relevant parts of information taken from the various theory examination syllabi, and it spans the entire spectrum from *ab initio* to advanced flight training information. It aims to focus the attention of the aspirant pilot on that information which is highly important and relevant for most flying, and to prepare the student for his/her forthcoming practical flight training.

This study focused on the first Flight Procedures course taught in Trimester 3, at the end of 2017 and the beginning of 2018. The course was taught as an intensive course over a period of four weeks. The nature of the class activities is what is unique in Flight Procedures as well as the laboratory component. This paper will describe the implementation of flight procedures training in the Bachelor of Aviation program and the setup of the unique laboratory that contains computers with everyday flying software as well as PebblePad, an ePortfolio system that allowed the students to complete tasks and reflect on their flying. Students were taught the theory of aviation in this lab, assisting them in having better command of flight theory to support improved or accelerated flight training in the future when they are completing the practical flight training course, or Graduate Diploma of Flight Management (GDFM).

Literature Review

This literature review will comment on the history of flight training as well as aviation education in a global context. Research around software used for teaching flight training will also be reported.

Flight Training History: Brief Overview

Flight training commenced in 1909, when Wilbur Wright started training United States Air Force (USAF) officers to become pilots (Barata & Neves, 2017). The completion of the training syllabus prior to solo flight lasted about three hours. The first standardisation of flight training was in 1916 when the Royal Flight Corps (predecessor to the Royal Air Force) established a flight training establishment at Cranwell in the United Kingdom. In the same year, both Portugal and France also commenced with flight training.

A century later, the boundaries of aviation training and education have expanded to include aviation education at the tertiary and postgraduate levels. Included in this aviation education are many secondary schools, colleges, flight training schools, universities and other institutions from across the globe. Importantly, the training and education presented is no longer limited to flight training, but it typically contains the underlying theory from subjects such as aerodynamics, meteorology, human factors and air law, as prescribed by a regulatory authority.

Current State of Aviation Globally

An abundance of commercial information has been published over the past few years to discuss the present and expected high growth in the aviation sector. The annual 20-year forecasts by both Airbus and Boeing are leading examples (Airbus, 2017; Boeing, 2017) with both companies forecasting high growth in the next few years. Of particular relevance is the expectation that 534,000 new pilots should be trained by 2036 (Airbus, 2017).

Both the aviation industry and academia are concerned, and many plans are presently being put into action to address the shortage. For example, Qantas launched the "Qantas Future Pilot Program" in December 2017, partnering with five major Australian universities to mentor aspirant commercial pilots from an earlier stage in their careers and secure talent for the future (Qantas Airways Limited, 2018).

Despite these efforts, a main obstacle to increase the production of pilots remains the enormous cost of training a pilot to fulfil all the requirements. For example, to study a Graduate Diploma in Flight Management at Griffith University, resulting in a Commercial Pilot Licence (CPL), will cost approximately $122,000. This figure excludes the cost of a type rating, which can be an even bigger figure depending on the type of aircraft for which the type rating is sought. Any successful initiative to reduce the cost of flight training could have a substantial overall impact on the global pilot shortage.

Previous Flight Training Research

There is a dearth of literature pertaining to flight training setup in computer labs although the use of computer labs as an aviation training device has been available for years, with previous research suggesting that these labs can be effective in both maintaining instrument rating currency and enhancing proficiency (Talleur, Taylor, Emanual, Rantanen, & Bradshaw, 2003). The Federal Aviation Authority (FAA) acknowledged its value in the regulation in 1997 to allow partial recognition of flight hours on these devices (McDermott, 2005). Thus, the setting up of a computer lab for students to receive some training at university has some benefit, although with limited research reported in the literature.

EPortfolio use for flight training also has had minimal research conducted in this area. Often the research reports on aviation as a small section in a larger project. This type of research is reported in Cameron (2012), where the project mentions aviation as part of a larger university-wide implementation, but not how it was used specifically. Another article (Botterill, White, & Steiner, 2010), reports how ePortfolios are used as part of a larger graduate attribute project, but not for aviation students specifically.

The Griffith University Solution

To assist in graduating high quality candidates for programs such as Qantas' Future Pilot Program, Griffith University has introduced a new "Flight Procedures" course series in 2017 to improve the quality of pilot education. The content is a selection of all the highly relevant information with sections taken from the various theory examination syllabi that spans the entire spectrum from *ab initio* to advanced flight training information. It aims to focus the attention of the aspirant pilot on that information that is highly important and relevant for most flying and to prepare the student for his/her forthcoming practical flight training.

The three important components embedded in the course are the course content, the teaching style and student assessment. Thus, a constructive alignment approach has been used for this course (Biggs, 1996; Biggs & Tang, 2011) as well as a backward design approach to the curriculum development (Wiggins & McTighe, 2005).

This initial course implementation of Flight Procedures taught students the process of conducting a flight and has been developed from the theory curriculum as prescribed by Australia's CASA, which is mandated with regulating aviation in Australia. This included aerodynamics, flight planning and performance, meteorology and air law (Griffith University, 2018). The single pilot flight exercises covered encompassed Visual and Instrument Flight Rules, in both day time and night time. A basic single engine aircraft and a complex single engine aircraft were used as the training platforms. Various practical components were embedded in the course, such as the use of checklists, the pilot operating handbook, and navigational charts. This Flight Procedures course consisted of 12 x two-hour laboratory sessions, in a computer lab, under the guidance of a suitably qualified instructor, who was a retired airline pilot. The aim of the Flight Procedures lab is to use the lab as a teaching tool to enhance the understanding and internalisation of critical operational procedures and theory. It aims to improve students' cognitive preparation for their forthcoming flight training, resulting in more efficient learning experiences in the air.

The following research questions were developed:

- What should be included in a flight procedures laboratory to assist aviation students?
- In what ways can PebblePad be used to support student learning in the flight procedures laboratory?

Methodology

The project used design based research as it provides a "systematic, but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation" (Wang & Hannafin, 2005, p. 6). This iterative process allows for the design, redesign and development of both the teaching and data collection methods for the Flight Procedures series of courses. Thus, this paper reports on just the first iteration with the one course.

There were several methods of data collection including an anonymous pre- and post-survey that was conducted in class to assist with responses, although participation was completely voluntary. From the 142 students enrolled in the course, 49.3% (n=70) completed the pre-survey, which was mostly about student background knowledge. The post-survey was completed by 57.7% (n=82) of the cohort and asked the students how many times they practiced flying the circuit tasks, what they found improved and how it assisted their improvement. It is important to note that not all students answered every question, so some of the percentages pertain only to the number of students who responded. Students were also asked if they uploaded the optional first video, and how this may have helped with their learning and about using online technologies as well as PebblePad and how it worked as a tool.

Seven short interviews were also conducted with students who gave permission. This allowed for in depth data to be collected and has given greater perspectives on the lab and the tasks students were given in class and for the assessment. These interviews were audio recorded and transcribed. The two tutors who taught in the course were also interviewed prior to the course beginning and then at the end of the course. These interviews consisted of asking about their background, and how they thought the course would be beneficial to students as well as how it was received throughout the course. These interviews were also audio recorded, then transcribed and finally coded for themes.

Students were also able to give permission for their individual work to be analysed for research purposes with 50 students giving permission who also completed the initial reflection section of the assignment. Ethics approval was gained for this study and all data collection methods prior to the commencement of the project.

Results

These results are based around the two research questions and have been presented in a way as to answer them.

Development of the Flight Procedures Lab

A lab was developed in 2017 to provide a facility where Flight Procedures could be taught. This lab was fitted with 25 desktop computer workstations, each with their own flight controls (Figure 1), called a Personal Computer Aviation Training Device. The computers were also configured with a commercial flight simulator programme called Microsoft Flight Simulator X loaded onto the computers, as well as software to record the screen. All classes were taught in this computer laboratory, and students had access to go in and practice when there were no scheduled classes.

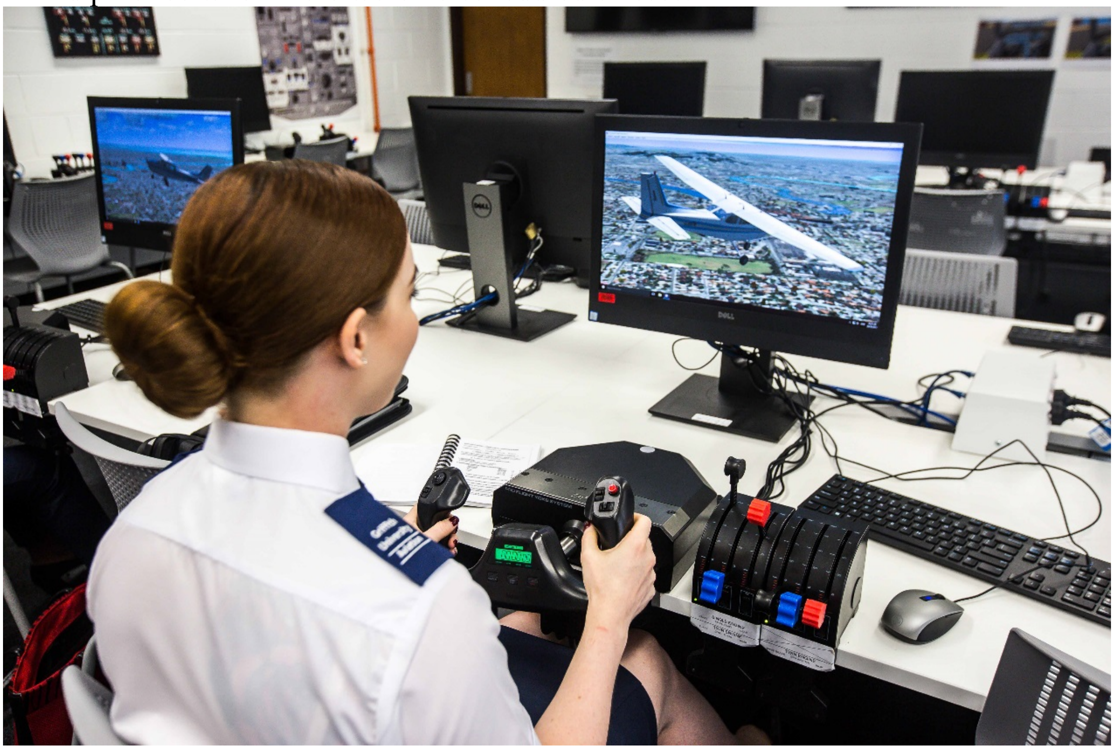
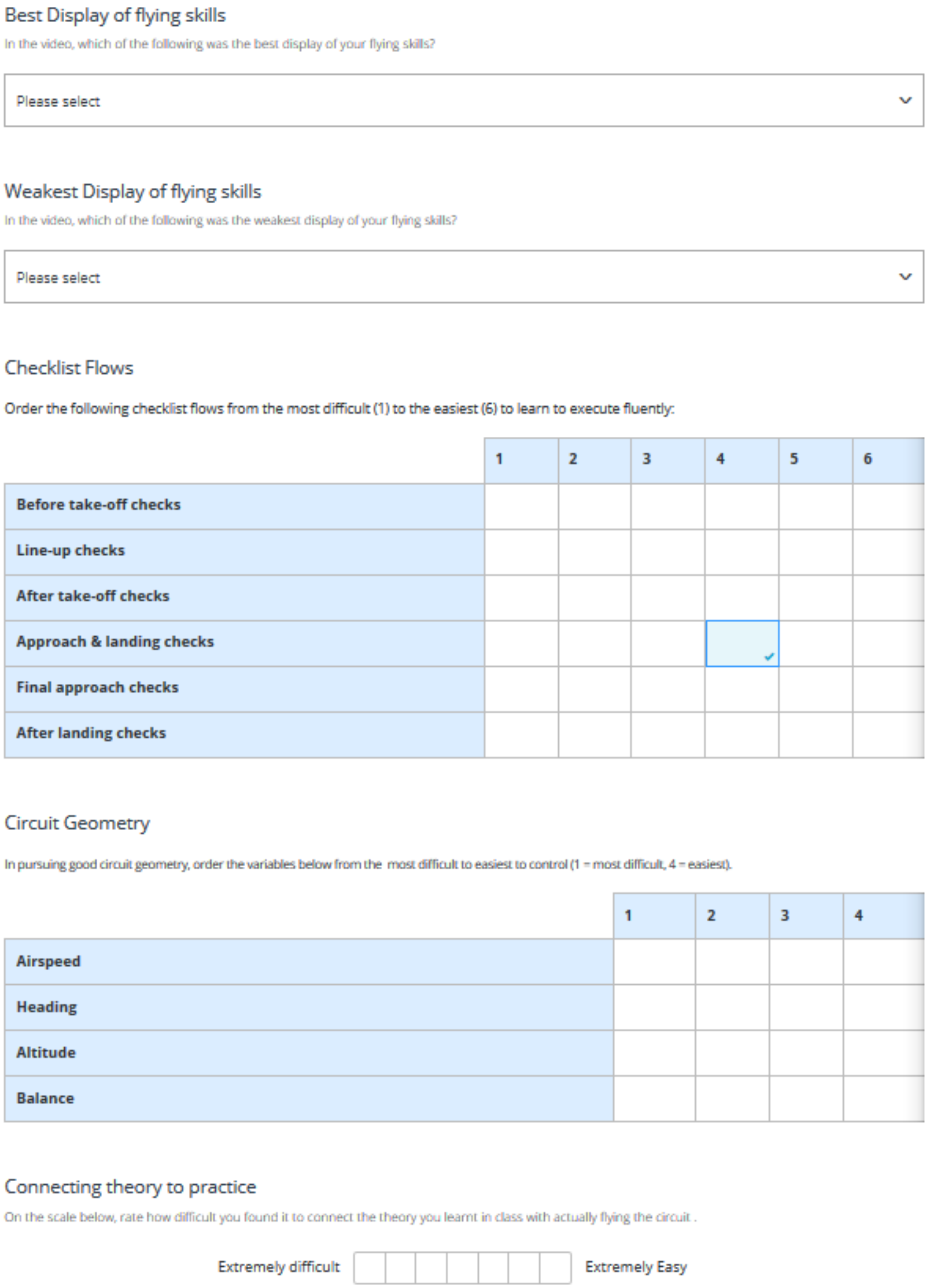


Figure 1. Using the simulator software in the Flight Procedures Lab.

As part of this Flight Procedures course the students were given specific tasks to complete using the software. Some of these tasks formed part of the assessment. However, there were other associated tasks that were not assessed. One such task was worth 30% of the final course mark and involved a Basic Visual Flight Rules (VFR) Circuit. After receiving a briefing on the flight circuit and having watched a demonstration video, students then had the opportunity to "fly" their first circuit during a laboratory session. They recorded their first attempt and then uploaded it into PebblePad. They answered seven reflective questions (see Figure 2). These questions have been designed to assist the students to focus on the critical thought patterns needed to fly quality circuits. This recording is not formally assessed, as it is meant to be used as preparation to assist the students to better understand the expectation for the formal assignment.

Following this session, students were able to complete four hours of supervised practise, and they were then able to practice as little or as much as they wished. Once ready, they were required to record and upload a final video that was assessed. PebblePad was used to upload the video both times and also had several reflective questions that students were able to answer in the final submission. Students were able to check their best display of flying skills and weakest display, which included items such as take-off, crosswind leg, downwind leg, base leg and final approach (Figure 2).



Best Display of flying skills

In the video, which of the following was the best display of your flying skills?

Please select

Weakest Display of flying skills

In the video, which of the following was the weakest display of your flying skills?

Please select

Checklist Flows

Order the following checklist flows from the most difficult (1) to the easiest (6) to learn to execute fluently:

	1	2	3	4	5	6
Before take-off checks						
Line-up checks						
After take-off checks						
Approach & landing checks						
Final approach checks						
After landing checks						

Circuit Geometry

In pursuing good circuit geometry, order the variables below from the most difficult to easiest to control (1 = most difficult, 4 = easiest).

	1	2	3	4
Airspeed				
Heading				
Altitude				
Balance				

Connecting theory to practice

On the scale below, rate how difficult you found it to connect the theory you learnt in class with actually flying the circuit .

Extremely difficult Extremely Easy

Figure 2. Student reflection in PebblePad after initial video upload.

Students were also required to reflect on their flying after the final (assessable) video upload on topics such as describing air speed control throughout the different stages of the circuit, adjusting speed to maintain planned circuit geometry as well as which aerodynamic, regulatory or meteorological understandings informed speed control decisions. PebblePad allowed the process of uploading the video for submission as well as reflecting on the required questions easy to complete.

From the 70 responses to the pre-survey, 73% (n=51) were male and 27% (n=19) were female. The survey responses by sex were similar for the post survey. Of the 82 respondents, there were 73.2% (n=60) male and 26.8% (n=22) female. The results reported here are from the post-survey.

Students were asked if they were comfortable using online technologies for educational purposes with 92% (n=69) of the 75 respondents stating they either agree or strongly agree. Students also reported feeling confident when they use new online technologies for education with 88% (n=66) of the 75 respondents reporting they either agree or strongly agree. This indicates that these students are generally comfortable with new software, such as using the flight simulator software, recording their screens and then uploading the video into PebblePad. This should mean that students would spend less time learning and carrying out these tasks than if they were less comfortable and confident.

Students were asked about PebblePad, specifically about the workbook design, and they reported it was easy to navigate, with 81% (n=60) either agreeing or strongly agreeing. Students also found the workbook design had a logical structure with 81.3% (n=61) of respondents either agreeing or strongly agreeing. Overall, students felt that PebblePad was helpful to their learning with 70.3% (n=52) either agreeing or strongly agreeing with this statement. Students felt that it was a useful experience to learn how to use PebblePad with 63.5% (n=47) of students either agreeing or strongly agreeing. The students generally felt that PebblePad was easy to use with 79.3% (n=58) either agreeing or strongly agreeing. This suggests that PebblePad was a good choice of a platform for the location of the tasks, the video upload and for the assignment completion process.

Students reported noticing improvement when they practiced the circuit task with 96.3% (n=79) of the 82 students reporting this. Students generally reported their flying accuracy improved. However, some students were more specific with one stating “my circuit geometry and spacing, I got mor[e] used to my checks and felt comfortable” while another noted “altitude stability, looking when turning, more stable air speed” and yet another that s/he “noticed improvement in proficiency of completing checklists and maintaining speed, altitude, etc.”

Yet another student stated:

> Improvement was made in the time I came in outside of class. I improved on my circuit overall as I was able to work under my own conditions and use the circuits maps provided to teach myself what speeds and flaps to maintain.

One of the tutors supported that the students were practicing out of class by stating, "I've been quite amazed about the amount of extra work the kids have been doing," with the other tutor commenting about "those who put the effort in" and that they are "showing a lot of interest."

The students were asked if they answered the questions when they uploaded the first video with 95% (n=75) reporting they did. This is reflected in the assignment data in PebblePad with most students answering most or all of the questions as well as uploading an initial video. The students were asked in what ways it helped with their learning with 62 students responding to this question. Students often recorded that it made them think about their performance or the actual task rather than just doing the task mindlessly. One student said, "Answering questions made me think more deeply about my performance and the various aspects I might not have thought of." Another commented, "It helped to prove the theoretical aspects of the course as you get to practice what you learn," which is quite positive.

There were a few negative comments that involved the idea that some focused feedback might have been helpful, "as I don't always know if I've done something wrong." However, tutors were in the room at regular times so they could have provided this feedback. Another student commented that it gave "a false sense of security regarding my performance regarding the upcoming assessment." This suggests the student may have been disappointed with the assignment grade. One student commented in depth by stating:

> It gave an indication to the direction of improvements that could be made with practice in the simulator, which could then be realised through repeated practice.

The students were asked to upload two videos, one at the beginning of the task and one at the end, which was the video used for the assessment process. The students were asked what worked well in terms of using PebblePad for uploading the videos with 75 responses placed into the survey tool. Overwhelmingly, student comments were positive about the upload with many students stating it made it easy to submit the assignment and that "everything worked pretty smoothly."

One student commented that "everything seemed to function logically and correctly" while another stated that "everything was easy to find, especially the video and the fact that you could watch your video while answering the questions," which allowed for ease to complete the final questions that were part of the assignment.

Limitations of the Flight Procedures Lab

It is not at all the intention of Griffith University that students entirely be taught to fly aeroplanes in this lab, but it is meant to be used as a teaching tool to enhance the understanding and internalisation of critical operational procedures and theory. It aims to improve student cognitive preparation for their forthcoming flight training resulting in more efficient learning experiences in the air.

Discussion and Conclusion

There are several key elements to creating a successful flight procedures computer lab. These include, computer work stations that include both hand and foot controls, software for flying, recording software, and ePortfolio software such as PebblePad to allow for scaffolded reflection.

In addition, the following guidelines ought to be designed to assist those implementing a Flight Procedures laboratory:

- Reflective questions should be designed to scaffold the students through a reflective thought pattern, thereby stimulating learning while self-discovering.
- The learning tasks are central to the Flight Procedures lab. Also, the peripheral material that each work station is equipped with, forms part of the learning toolkit. For example, a student has to calculate critical speeds by referring to the pilot's operating handbook and then apply them during the simulation exercise. This makes the learning journey realistic and challenging.
- Setting up the instructor work station correctly is critical. There needs to be access to the complete setup including the PowerPoint presentation, videos and supportive documentation for instructional purposes. This setup will allow for realistic live demonstrations of certain flight exercises as well as being able to record and play these back.
- Finally, a lab of this nature is reasonably space consuming and costly. It is important for all students attending class to have access to their own work stations, which may become a problem with larger student groups.
- Adequate provision for access to work stations should also be made after hours to make room for informal study and to practice the required assessment tasks.

Importantly PebblePad can be used to support student learning by providing tasks that can be taught, reflected upon and then practiced. It is reported here that students found PebblePad easy to use and that it assisted them in reflecting on their tasks and improving their assignment tasks through being able to practice. The two additional capabilities that PebblePad contributes to the Flight Procedures initiative are that it allows students to gather very specific, career-related ePortfolio data, which may provide them with a competitive edge for the future, and that it provides an easy way of tracking large and complex data quantities for research.

This paper describes an innovative computer lab set up for an aviation program at one Australian university. Various technologies included in the lab, and specifically the way they were utilised, have assisted with the lab becoming an early success. However, it should be noted that further research is warranted to ensure that the implementation is a continued success in the future.

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A SYSTEMATIC VIRTUAL REALITY-BASED APPROACH TO SUPPORT THE PROFESSIONAL DEVELOPMENT OF TEACHERS

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Abstract

The purpose of this paper is to present a virtual reality (VR)-based approach to teacher in-class training that will allow teachers to experience an entirely new way of training. The proposed virtual reality tool aims to provide strong support for teachers' professional development through dedicated applications that address real training needs. The overall concept of the VR tool is to address specific teachers' competences, defined based on an extensive documentation of existing teachers' competence models and significant guidance by experts. The implementation of the VR application followed a full design cycle, a five-phase process like that of the ADDIE model, targeting mainly the cultivation of empathy and reflection skills among the users. After conducting several experiments with in-service and pre-service teachers, promising results regarding the cultivation of empathy and reflection skills were observed.

Keywords: Virtual reality, teachers, teacher training, empathy, reflection

Introduction

During the last few years, teachers experienced unprecedented class management challenges that make a necessity investment in their professionalism by upgrading their skills and competencies. Lately, teachers' professional development has become a top priority for the European Union (EU), and special emphasis has been given within the European agenda. In line with EU objectives, this paper aims to propose the professional development of teachers using a contemporary virtual reality (VR)-based approach. There is a lack of research in the use of VR in teacher education, and thus this research aims to fill this gap. By taking advantage of the virtual reality technology, it is possible to provide in-service and pre-service teachers a safe environment, within which they are able to experiment and make mistakes but without the risk of harming real-life students. The proposed virtual-reality framework is an instrument that can be used to support teachers' continuous professional development through systematic individualized learning. The aim of this paper is to present the use of VR in teacher education through a five-phase methodological framework approach based on the ADDIE model, which includes the pedagogical framework, the development of the scenarios followed by the development of the VR application and the evaluation of the impact of the proposed approach.

Research results so far indicate that VR is a promising training method for teacher education, which entails a large educational potential. To the best of our knowledge this is one of the first systematic attempts to use a VR-based methodology to address real teachers' needs. The development of the VR application is linked to both strong theoretical foundations in education derived from the literature and real teachers' problems and requirements derived from an extensive literature analysis, survey and interviews.

Moreover, the implementation of the VR application followed a full design cycle, a five-phase process based on the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The VR tool addresses specific teachers' competences as outcomes, after an extensive documentation of existing teachers' competence models and significant guidance by experts who pointed to specific competencies of primary importance to teachers.

Literature Review

Problems and Challenges in Teacher Education

The most significant problem in teacher education is the lack of practice in teacher training programmes. Most universities and also lifelong learning programs for teachers rely on theoretical teaching that lacks a strong interaction with the school environment (Hagger & McIntyre, 2006). Thus, those programs do not provide job experiences or practicum that would give teachers the opportunity to learn on the job through the experience of their colleagues, instead of using trial and error techniques in the classroom that may negatively affect the students (Darling-Hammond, 2006). Hence, there is a theory-practice gap that needs to be addressed to lead to high-quality and well-trained teachers leading to high-quality education. Experiential learning can bridge the gap between theory and practice and virtual reality (VR) could offer an effective way for this type of training. Thus, priority should be given to "the classroom teaching expertise" (Hagger & McIntyre, 2006, p. 20), and VR can offer teachers engaging and immersive experiences, allowing them to experience real world classroom situations, reflect on their practice becoming "practically wise" and make the choices that best fit to their educational needs (Caena, 2014). Moreover, the development of 'extreme' scenarios will allow teachers to be trained via simulated stressful conditions that would be impossible to simulate in a real classroom setting.

Virtual Reality in Teacher Education

The last few years, the use of virtual reality environments in education to foster learning has attracted the interest of the scientific community due to its significant benefit to provide users the opportunity to "live and experiment situations that cannot be accessed physically" (Freina & Ott, 2015, p. 6). The significance of using VR in teacher education lies in the fact that VR mimics real-world situations allowing the users to experience realistic learning experiences that are transferrable to the real world. This fact makes the VR learning environment a suitable tool that can be used for the professional development of teachers. However, despite the extensive use of virtual technology in fields such as medicine and the military, to the best of our knowledge in the field of teacher education its use is extremely limited.

However, preliminary investigations revealed that the use of such a methodology in teacher preparation has considerable potential (Manouchou et al., 2016; Stavroulia et al., 2016). A key point of VR-based teacher training is that within the virtual environment teachers can make mistakes and learn from them but without influencing real students. By the same token, virtual classroom environments aim to provide an innovative training tool that can be used for constant professional development and updating teachers' skills so that teachers can remain productive. Furthermore, the use of virtual environments will allow teachers to take control of their own learning, monitor their progress and thus learn more.

Methodology

Research Question and Approach

The main research question that constitutes the fundamental core of this research is: Can a virtual reality-based learning paradigm be used for the professional development of teachers?

To answer the research question, a systematic approach including five phases was formulated based on the ADDIE model traditionally used by instructional designers and training developers (Molenda, 2003). The ADDIE model was used as a process for the development of the VR training tool. The five phases –Analysis, Design, Development, Implementation and Evaluation– represent a dynamic, flexible guideline for building effective training and performance support tools. Those five phases constitute a set of steps with specific outcomes that work together to enhance the overall outcome of the proposed VR-based approach. A description of the actions taking place in each phase follows.

Phase 1 – Analysis and investigation of Teacher's Needs

Apart from an extensive literature review research, a survey was conducted in Cyprus and Greece in order to register teachers' real training needs. The results of the survey provided critical information regarding teachers' real needs, and this identification was taken into consideration for the development of the scenarios. Moreover, one focus group interview with five in-service high-school teachers took place in order to reinforce the identification of the most important required aspects of teacher education. The results indicate the lack of practice in teacher training programs and the significance of implementing practice and on the job training within university studies.

Teachers reported that their training is mostly theoretical while it lacks practice, mentoring and counselling. Regarding the most important training needs, teachers reported the need of training related to dealing with students with special learning needs, students with disorders (vision, hearing and speech disorders), behavior management issues, classroom diversity, individualized learning and classroom management.

Phase 2: Designing the Competency Framework for the Proposed Virtual Reality-Based Investigation
Nowadays, teaching standards are higher than in the past and the teacher's role involves more than simply preparing the lesson and lecturing. Hence, teacher competencies need to be set in a wider context. The term teacher competencies refer to the "teacher professionalism," to "the multi-faceted roles of the teacher on multiple levels of the individual, of the school, of the local community and of professional networks" (European Commission, 2011, p. 7). There are several recent approaches regarding teacher competencies, and several models have been developed (Darling-Hammond & Bransford, 2005; European Commission, 2005; McDiarmid & Clevenger-Bright, 2008). Despite the differences among the various models, there are several sets of competencies that are common including pedagogical content knowledge, issues of inclusion and diversity, use of technologies, reflection, research and collaboration skills and adaptability to today's classroom challenges. Although the models that exist have identified the most significant competencies and skills for teachers it is impossible to address them all within the frameworks of the current research. Therefore, a specific selection had to be made based on the needs of the current research. A competency framework has been developed to describe the professional standards that the proposed VR application aims to strengthen ensuring optimum teachers' professional development. The proposed framework of competencies includes two key competencies that are: empathy and reflection.

Empathy. Empathy is considered a skill of paramount importance for teachers as it can foster the establishment of strong communication channels with the students promoting the development of a good classroom climate and students' satisfaction and involvement in the educational process (McAllister & Irvine, 2012; Stojiljković, Djigić, & Zlatković, 2012). Additionally, interviews with Greek and Cypriot experts (including teachers, special education teachers and academics) identified empathy as a high-priority skill for teachers. The cultivation of empathy skills is the only way for teachers to really understand their students, embrace their problems and take the necessary course of action for their well-being. However, despite the significance of empathy skills, most teacher education competence models do not include empathy as a key competence. An extended literature review revealed that empathy is included among key competences only in a model developed by the National Institute of Education (NIE) (2009) in Singapore.

This gap regarding empathy in European competence models in conjunction with the indications by the interviewed experts formed the basis for addressing the cultivation of empathy skills to the current research. Stojiljković et al. (2012) argue that there are two major components of empathy, the cognitive and the affective. The cognitive component deals with the ability of an observer to take another person's perspective, and the affective deals with the ability of an observer to understand another person's emotional state. For the purpose of the current research only the cognitive component is being addressed in order to investigate the possibility for a teacher to understand a student's problem (e.g., autism, myopia, etc.) by putting him/herself into the position of this specific student. VR offers the users the opportunity to experience the viewpoint of someone else, getting an idea of what his/her life might be like (Axelrod, 2014). This fact makes VR a potential future tool in the cultivation of teachers' empathy skills by allowing them to experience the perspective of their students and possible problems that they are facing.

Reflection. The development of critical reflection skills is essential for teachers (Hammerness et al., 2005). Through reflection teachers have the ability to evaluate their teaching practice and experience, re-examine and criticize it, aiming to make the necessary changes that will improve the quality of their work and themselves. Thus, the ability to reflect is considered an integral part of teacher professionalization and one of the basic standards that teacher candidates must develop in order to achieve self-development (Lai & Calandra, 2007). Unfortunately, research results, indicate that teachers do not possess the ability to reflect even after receiving relevant education, and, as a result, they face difficulties in critically reflecting on their teaching practices. Thus, it is essential to address the cultivation of reflective skills via VR.

Phase 3: Designing the Scenarios

Application scenarios were chosen and developed after the extensive literature review, survey and interviews with education experts in an effort to reflect real-life circumstances. The first scenario deals with students' vision disorders. One of the students has myopia, but he feels embarrassed to wear his glasses in the classroom, as he is afraid of being victimized. The student sits away from the blackboard, and the teacher, unaware of his problem, asks him to read the equations written in the blackboard. The student cannot read without his glasses, and the teacher believes that the student is indifferent during the lesson ignoring the myopia condition. As part of the application, users are given the opportunity to see the virtual class through the eyes of the myopic student allowing them to experience the problem (Manouchou et al., 2016).

The second scenario had to do with bullying in schools. During the design process, experts provided multiple examples of school bullying incidents, and they suggested that the most important aspect for the teachers is to be able to differentiate bullying incidents from simple teasing incidents among the students. Within the scenario, the user observes three different incidents involving bullying or "innocent teasing." For each of the incidents the user can select one of a series of choices related to the appropriate actions that need to be enforced for each incident (Stavroulia et al., 2016).

The third scenario had to do with multiculturalism and verbal bullying in a typical school classroom environment represented within the virtual world. The scenario begins with the teacher inside the classroom together with five students. The teacher introduces a new foreign student called Lynn to the classroom. Following her introduction to the class, Lynn receives verbal bulling from her Caucasian classmates. The user-teachers were given the opportunity to view the same incident in the virtual class from two different perspectives: the participant-teacher views the scene from the eyes of Lynn and the participant-teacher views the scene from the eyes of the teacher (see Figure 1).

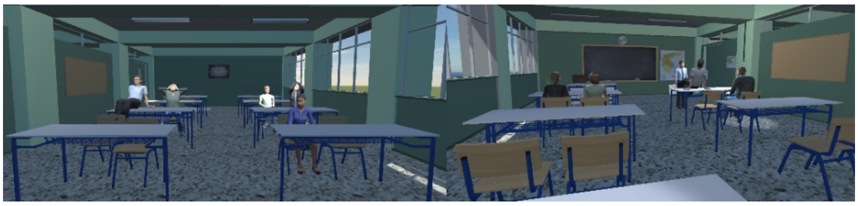

Figure 1. The two different perspectives within VR. Through teacher's eyes on the left and through the student's eyes on the right.

The fourth scenario was inspired by a real incident, and has to do with the use of substances given to a 12-year-old student by his classmates (Kounou, 2017). The incident takes place in the school outdoors space during break time. A female student (named Anna) is watching her classmate (Nikos), who is sitting on a bench, having done substance use. The second classmate in the scene (Kostas) is trying to pressure Anna to take and smoke a cannabis cigarette while the teacher approaches them. The user-teachers were given the opportunity to view the experience from three different perspectives: teacher perspective, student-drug user perspective and healthy female (Anna) student perspective (see Figure 2).

Figure 2. The three different perspectives within VR. Through teacher's eyes on the left, through the student drug user's eyes in the middle and through a healthy student's perspective on the right.

Phase 4: Development of the Application
Following the different scenarios considered, dedicated VR applications were developed using the Unity3D© game engine. In order to create a realistic immersive experience for the participants, an Oculus Rift VR headset was used as a means of viewing the application (see Figure 3).

Figure 3. The participants during the experiment wearing Oculus Rift.

Phase 5: Implementation and Evaluation
The evaluation stage aims to evaluate the effectiveness of the VR application, providing the information regarding its impact in the professional development of teachers. The assessment of the effectiveness of the VR-based training and the data gathered will provide significant insights regarding the impact of the VR approach in teacher education leading to the development of a tool to support the professional development of teachers and thus increasing the quality of education

Findings Derived from the Experimental Evaluation

In this section the main conclusions derived from the experiments are presented.

Experiment 1 – Vision disorders/myopia scenario. During the VR application teacher-users could see through the eyes of a visually impaired student in order to raise their awareness towards students' eye conditions and to help them identify students with myopia symptoms. Questionnaire-based results indicated that teachers who participated in the experiment reported that they entered the students' position and understand their vision disorder. Moreover, the scenario problematized the participants, and many admitted that it is highly possible that in some cases they had misjudged real-life students' participation in the lesson not because of indifference but due to a vision disorder.

Experiment 2 - Bullying scenario. The second experiment aims to assess the ability of teachers to identify and deal with bullying-related incidents. Within the scenario the teacher-users experienced different types of in-class and outdoors student behavior incidents, and they were asked to identify the bullying related incidents. The most significant result is that in-service and experienced teachers argued that training via VR cannot contribute significantly in the development of their skills as they already possess the skills necessary to confront bullying and proposed the use of the application for junior pre-service teachers. However, most of the teachers failed to recognize and distinguish the teasing incident from the bullying incidents indicating the need for further training.

Experiment 3 - Multiculturalism and bullying scenario. Three groups participated in the experiment, each consisting of 11 participants, and each experienced a different classroom setting among three: virtual environment with realistic class appearance, virtual environment with imaginary class appearance and physical setting in a real classroom (see Figure 4).

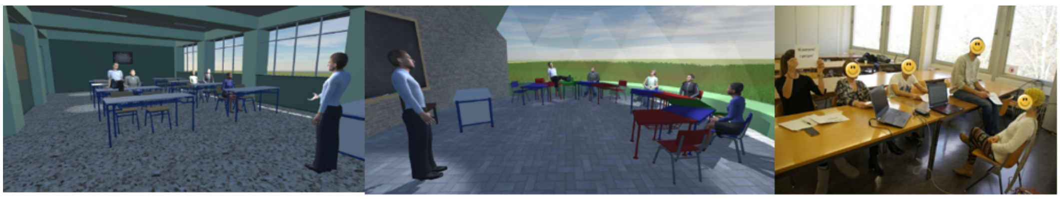

Figure 4. The three different classroom settings. From left to right: virtual class with realistic appearance, virtual class with imaginary appearance and real classroom.

The participants who used the VR system claimed that they would not prefer to be trained without the use of VR, while those who were trained with the physical (real) classroom setting claimed that they would prefer to be trained within a virtual classroom world. Concerning empathy, the results indicate cultivation of empathy skills. The participants of all groups claim the importance of entering the students' position to understand his/her perspective to take the proper course of action. The results also indicated the cultivation of reflection skills. There are indications that the VR system can help teachers change the way they will attend to the needs of the students and the way they will react to disruptive behavior among the students. Moreover, the participants argued that the experience within the VR environment regarding multiculturalism and bullying challenged some firmly held ideas, and because of this experience they will support more students of other racial and ethnic groups, while they will change the way they attend to the needs of those students. Additionally, it seems that this VR experience helped teachers discover faults in their teaching style or in their interaction with students that they previously believed to be right. Finally, participants' emotional and mood states were also investigated, and the results indicated that all participants reported more positive than negative states with minor differences between the three groups, with the most important being that the participants who used the VR tool experienced positive states at a higher level than those who participated in the real classroom environment.

Experiment 4 - Drug use in schools. Twenty-five participants (n=25) took part in the fourth experiment. The results of this experiment are under analysis; however, initial results indicate that the participants felt part of the virtual school and that the scenario had a strong impact on their emotional and mood states. The context of the scenario seemed to have a strong impact on them, and the results revealed that although before the use of the VR the participants had not reported high levels of negative states, the use of VR elicited a statistically significant change in participants' negative mood states, indicating that the non-pleasant scenario "touched" the users. Concerning empathy, the results indicate that there are changes in participants' responses after the use of VR. After experiencing the scenario with the drug related incident, participants reported that they should try to understand the students better, see things from their point of view in order to understand their problem (in this case drug issue) and assist them effectively. However, it should be noted that few teachers who had experienced a drug issue in their classroom reported that they do not feel that they must assist a student with such a problem and that the only action they should do is report it to the principle in order to avoid the problem.

Discussion

The aim of the current paper was to present the initial results of an investigation regarding the use of VR in teacher education. The proposed VR-based approach aims to present new opportunities for improving teacher training via using VR environments as part of a teacher training methodology that will allow in-service but also pre-service teachers to experience an entirely new side of training. The current research aims for the development of an integrated VR tool that will provide professional development to teachers, aiming particularly to cultivate empathy and reflection skills. To accomplish this aim, five phases have been identified based on the ADDIE model. The results so far based on the different scenarios that have been developed indicate the potential of using VR aiming to raise teacher's awareness and sensitizing them towards serious problematic conditions that they will encounter within their real classroom. The results indicate the possibility to cultivate empathy and reflection skills via an VR approach, allowing teachers to put themselves in the position of a student that faces various problems in the school environment, in order to experience the problem and raise their awareness. Nevertheless, further research is required after the analysis of the results that will reveal other issues that need to be addressed. Moreover, a new scenario is under development combining elements from the previous research and after modifications that were suggested from the experiments conducted so far that will be tested by several expert teachers and also pre-service teachers in an effort to create a tool that in the long run could be utilized as part of teacher education.

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NURTURING THE BUDDING IDEAS OF STEM ACADEMICS IN A UNIVERSITY-WIDE IMPLEMENTATION OF PEBBLEPAD

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Abstract

New technologies are often being implemented across universities from a top-down perspective, and often this prevents the nurturing of ideas and passions of academic staff. This paper explores a model to support STEM academics implement a new technology that could be used for any technology change. Data from the implementation is reported to confirm the success of this model with significant interest being shown across the STEM disciplines. Results show that employability, scaffolding laboratory skills, developing self-reflection, supporting weekly tasks and program wide initiatives were the major interests chosen by academics within Griffith Sciences.

Introduction

In 2015, Griffith University, in Queensland Australia, undertook significant strategic planning to implement a new *Griffith Model* of learning and teaching. One aspect of this model was to develop contemporary pedagogies to facilitate students' engagement with learning and to enhance employability skills, to prepare them to become "graduates of influence." The Griffith Model involved a planned and evolving shift of learning and teaching pedagogies, alongside course and program-wide redevelopment and renewal. A key aspect of this approach was to sustain program-wide development that was "intentionally designed" to support student development toward professional mastery. PebblePad personal learning software was purchased, and a university-wide implementation was undertaken to quickly embed employability and innovative learning and teaching goals into the curriculum.

In order to achieve these goals, Griffith Sciences devised a model to ensure that the fledgling innovations of our academics were not lost in the initial frenetic wider implementation. This paper showcases the Griffith Sciences Blended Learning Model and provides evidence of how this approach could support an implementation of learning technology whilst nurturing the ideas of its most important asset – academic and professional staff.

Background

In December 2015, a university-wide working party was formed to operationalise the learning and teaching approach provided by the Griffith Model. The remit of this group was to identify a desired future state, articulate a series of learning and teaching practices, analyse the current state, identify technology gaps, and finally identify bridging solutions to close these gaps. The working party undertook a university-wide evaluation of learning and teaching practice with the end result being a list of seventy-three learning and teaching practices that were considered essential to our ecosystem and the technologies that could support these practices (https://teaching-resources.griffith.edu.au/technology-ecosystem/).

In April 2016, the Academic Provost was finalising the university-wide strategy to implement employability as a priority agenda for the university. One of the actions flowing from this was to scope and adopt an ePortfolio platform to serve this agenda. An extensive implementation plan was put in place to determine an appropriate technology, and PebblePad personal learning software was chosen. At the beginning of 2017, Griffith University began its university-wide implementation of PebblePad with the Deputy Vice Chancellor Academic (DVC Academic) being a major advocate for this new technology. It was important that the DVC Academic wanted to see a visible, whole of university approach to embed and engage with the technology. Griffith University undertook a number of key university-wide initiatives introduced in the first two years. All were major initiatives, with significant implications for students and staff, requiring significant investment of time and resources. Some initiatives included: The Remarkable Me Challenge (Blair, Campbell, & Duffy, 2017), the Academic Innovators program (Campbell, Bourke, Trahar, & Nisova, 2017), and The Griffith Graduates of Influence program (https://www.griffith.edu.au/the-griffith-graduate).

Due to the complexity and speed of the university-wide implementation, much of the training and support options were not centrally available in the initial trimester offering. Griffith Sciences decided to develop its own model to support a bottom-up approach to complement the university-wide top-down approaches. The Griffith Science Blended Learning Model, described in this paper, was identified as an appropriate vehicle to support these developments.

Literature Review

EPortfolio systems have been implemented in various universities over the past ten years (Hains-Wesson, Wakeling, & Aldred, 2014; Slade, Murfin, & Trahar, 2017) with this project building on the 2008 Griffith ePortfolio project and the subsequent 2011 review of ePortfolios (Coffee & Ashford-Rowe, 2014).

In a recent review of the literature, Brown (2016) found that there were six influences to faculty adoption of blended learning, including the faculty member's interactions with the technology, academic workload, institutional environment, interactions with students, the instructor's attitudes and beliefs about teaching, and opportunities for professional development and support. Other researchers investigated a number of considerations for adoption, such as the need for faculty buy-in, developing an institution wide strategy, providing adequate structure and support and having effective faculty support (Spring, Graham, & Hadlock, 2016). Garrison and Vaughan (2008) suggest that "the selection and integration of media must be shaped by educational goals and design considerations" and "although technologies may have strengths and weaknesses that must be considered ultimately it is teaching and learning considerations that will have the most direct influence on learning" (p. 87).

The role of professional development in implementing new technology is an ongoing theme that has been reported in the literature over the years (Porter & Graham, 2016; Porter, Graham, Bodily, & Sandberg, 2016). Torrisi-Steele and Drew (2013) suggest that professional development is important "to facilitate integration of technology into the core of the teaching strategies so as to create innovative or improved student-centred, meaningful learning experiences" (p. 378). It is also important as it can provide clear, unambiguous expectations from faculty and help with faculty buy-in.

There are also different influencers depending on differing levels of adoption (Porter & Graham, 2016). It is suggested that innovators and early adopters would be more influenced by establishing adequate infrastructure, support and making sure that the institutional purpose is congruent with academic purpose. Porter and Graham (2016) go on to report that once innovators and early adopters are successfully implementing the technology then it may be time to consider changing approach to suit the needs of the early majority. These users are more interested in seeing compelling evidence of value. This is why it is extremely important to recruit innovators and early adopters to provide evaluation data to assist with advocacy and further professional learning opportunities. Finally, they suggest that the late majority and laggards are more influenced by solving issues of infrastructure, technical support and one-on-one training. Financial compensation, providing academics with additional time, reducing course load requirements or providing opportunities for promotion and/or tenure can all be options that speed up the transition into mainstream (Porter et al., 2016).

This investigation is part of a larger educational design-based research project, the purpose of which is to support Griffith Sciences academics in designing courses that utilise the principles of the Griffith Model whilst implementing ePortfolios/personal-learning environments. The project's aim is to develop blended learning principles that are appropriate in STEM higher education contexts, to develop a series of learning designs that can be shared, modified and utilised by other academics and to distribute these results internally and externally. The overarching research question framing the wider project is: "What are the guiding blended learning design principles for STEM higher education using a Personal Learning Environment / ePortfolio?" This specific study looks at a couple of preliminary sub-research questions:

- What implementation strategies/processes were used to support STEM academics to develop blended learning projects?
- What types of projects/issues were prevalent in the STEM disciplines?

Methodology

Design-based research has formed the methodological framework for the study. Design-based research was considered appropriate due to its iterative process that involves analysis, design, development, evaluation and documentation of learning design principles and ideas (Phillips, McNaught, & Kennedy, 2012; Reeves, 2000). The project followed a four-step process similar to that defined by Reeves (2000, p. 25), as depicted in Figure 1.

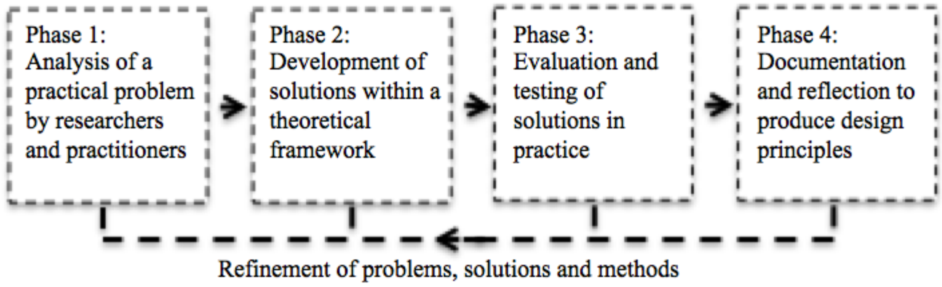

Figure 1. Design-Based Research Model (Reeves, 2000, p. 25).

This specific research involved data collection from staff involved with teaching PebblePad in their courses, interviews of two professional support staff within Griffith Sciences, usage data obtained from the PebblePad system and training data. Ethics approval was obtained in February 2017, prior to any data being collected throughout 2017. This study involved 19 course-based initiatives and five program-based initiatives throughout Griffith Sciences. Data used was from the initial program expressions of interest, including from the twenty four staff members participating in the model.

Results

The Griffith Sciences Blended Learning Model has been designed to support academics developing initiatives in blended learning (see Figure 2).

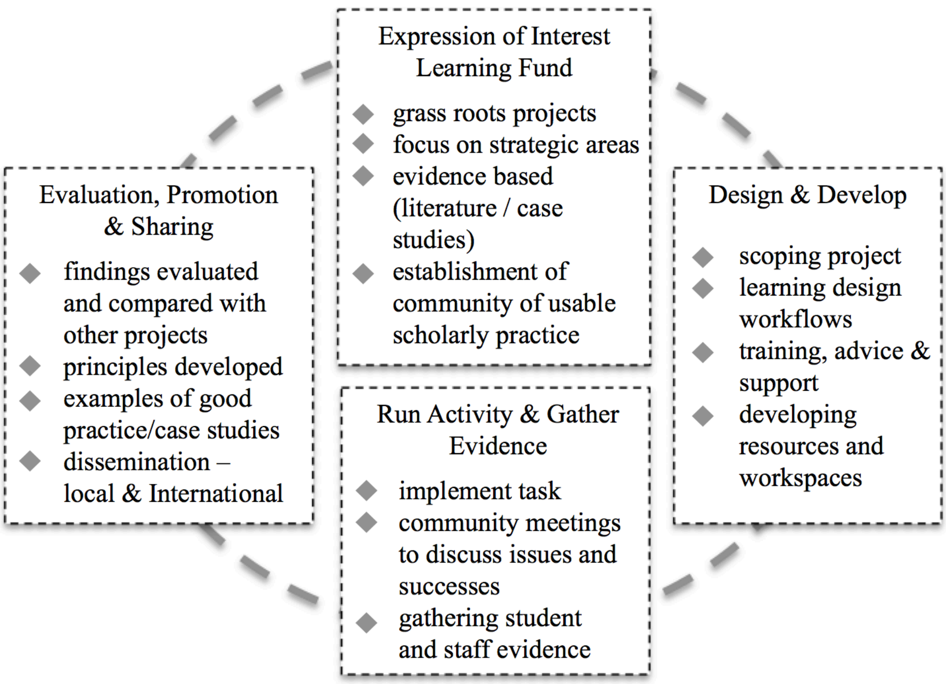

Figure 2. Griffith Sciences Blended Learning Model.

It is a four-step implementation process modified from the design based research process and includes: an initial call for interested parties, pre-trimester educational development, evidence gathering, and evaluation, promotion and sharing. It is a series of interconnecting components that allow Griffith Sciences to quickly build expertise and knowledge in the use of ePortfolios, share this knowledge amongst a medium-sized group of people, in the first instance, and then expanding that group and our reach in future iterations of the project.

Phase 1: Expression of Interest - Blended Learning Fund
At the beginning of 2017, the Dean of Learning and Teaching Griffith Sciences called for interested parties to express an interest to undertake a project using PebblePad. All Griffith Sciences academic staff had the opportunity to generate/articulate an idea (in a paragraph or two). Funding was provided for program-based initiatives, course-based initiatives and initiatives to support staff using ePortfolios for their own professional development. Applicants could nominate for more than one area, and they could use the funding for any legitimate use that would benefit the academic, for example, teaching buy-out, conference attendance or equipment. An ethics application was also completed to allow all participants to undertake some form of evaluation or scholarly practice allowing surveys, focus groups, usage data and learning resources to be included in scholarly articles and evaluation.

Phase 2: Design & Develop Within a Theoretical Framework
The second phase involved using a template designed in PebblePad to scope the idea and develop a learning design specific to a course. This template was used partially to normalise and showcase the technology. A learning design is developed for each project and included in a collection of learning designs that were later showcased and used in future iterations. The learning design became a starting point for early conversations to help the academic determine how to best support students completing their task. Afterwards, the academic, alongside the educational designer developed templates, resources and any necessary scaffolds and the educational designer creates bespoke instructional documents (pdf and/or video) for each task. Finally, a series of trainings sessions were run developing specific skills in PebblePad. A breakdown of attendance for Griffith Sciences Academics sessions is provided in Table 1.

Table 1

Session Attendance by Griffith Sciences Academics

PebblePad Training Sessions: University-wide and Tailored (*in italics*)			
An Introduction	39	Creating Activity Sheets	6
Supporting Reflection	4	Creating Interactive Resources	18
Creating Workbooks	2	Understanding the assessment lifecycle	10
Helping students reflect	*13*	*Creating an online study guide*	*26*
Total			118

Phase 3: Run the Activity and Gather Evidence
During the trimester, the focus moved towards ensuring that the project ran smoothly. A number of one-on-one support and training activities were provided. Instructions and resources were modified to suit changes to the learning task. A series of community lunch meetings were scheduled, to discuss issues, ideas and practice; and where educational designers were able to provide further one-on-one support wherever needed. (A community of scholarly practice is considered to be a significant aspect of the whole process.) Throughout the trimester, evaluation activities were conducted, with support from the learning and teaching team where needed.

Phase 4: Evaluation, Promotion and Sharing
At the end of trimester, the learning support team conducted a final community of practice meeting. This final community meeting was a debrief, considering the lessons learned and the opportunities and challenges that were faced within each project. As suggested by one of the professional staff:

> The meeting is also important as we discuss the evaluation data collected in various projects with the purpose of getting the academics to think about how they might showcase or present their findings so that other academics have an opportunity to learn from their experiences.

Many of the projects created a video case study and reflection of their activity to be housed on our university Learning Futures website (https://app.secure.griffith.edu.au/exlnt/entry/6405/view). Some of the projects were presented at an end-of-year ePortfolio Symposium. We also provided an opportunity for all of the projects to be included as a chapter in an edited book that is currently being developed.

Blended Learning Fund Projects 2017/2018
The Griffith Sciences Blended Learning Model was very successful. In 2017, there were 24 projects implemented and 23 “new” projects in 2018, with all of the 2017 projects being continued in 2018. In the Sciences, there were 3,683 unique users out of approximately 8,500 unique users across the university. Engineering had the largest number of projects (n=13), with examples from practical electronics, engineering science, international engineering practice, design practice, project management, and others. There was a large range of class sizes that implemented ePortfolios with the largest class size of 306. The main uses of the ePortfolios were to develop employability skills and practices, as a tool to support reflective thinking, for use within engineering laboratories, to support group projects, for field trip and industry field visits, and to document final projects and milestones.

There were nine projects in the Natural Sciences area. The Natural Sciences had the largest number of students (1,300+) and largest class size of 479. There were a variety of fields involved including biotechniques laboratory, biological systems, chemistry, physics, aviation, forensics and the professional practice in science (capstone) course. The main uses were to embed employability and professional skills, to develop laboratory skills and laboratory thinking, to support reflective activities, to scaffold lab experiences and to connect lab activities throughout and across a program.

In Information Technology there were five courses ranging from human computer interaction, information management, IT foundations, routing and switching and network security. The largest course was Human Computer Interaction with 331 students enrolled. It was mainly used to develop week-to-week tutorial or computer lab activities, but it was also used for developing reflection and employability skills, for collaboration, feedback and peer assessment. There were also four courses in planning (approximately forty students) and one in aviation (one hundred and forty) that also participated. Planning used ePortfolios within studio work, as part of their geographic systems course and also as part of their practicum. It was mainly used for reflection, as part of week-to-week studio activities and to build a portfolio. Along with the course-based initiatives, there were also five program-based initiatives. An ePortfolio was used as part of the professional practice process in both forensic science degrees used for embedding employability activities across seven courses and to build a professional showcase ePortfolio. It is also being used in the Bachelor of Science (Advanced) to promote reflective practice associated with research skills development, in particular to scaffold development of reflective practice across the program and to support employability and assessment. The Graduate Diploma of Clinical Physiology used it to embed employability initiatives, to showcase achievements in clinical placements, to develop professional identity and to transition students into employment. They will also be developing a showcase portfolio as the culmination of their study. The Bachelor of Applied IT used it as part of their work integrated learning to reflect upon their experiences. The Bachelor of Aviation used it within their three-part Flight Training courses to record flight experience through simulation and to reflect on these flight experiences to demonstrate understanding of principles in practice and to reflect on their practical skill development.

It is worth noting there were some challenges involved in the project. Specifically, time barriers for both the innovators and also for support staff were noted throughout. At the university, in the STEM area, spending time on learning and teaching can reduce research time, which is seen as an impediment to promotion opportunities.

Discussion

The Griffith Sciences Blended Learning Model proved to be very successful at generating this bottom-up interest throughout STEM disciplines at Griffith University. The combination of support, training, resources and conversation amongst different school groups has provided opportunities for cross-fertilization of ideas and practices. These strategies certainly have a place within a blended learning technology implementation such as PebblePad. The Griffith Sciences Blended Learning model provided academics an opportunity to develop their own ideas, with guidance, and allowed them ownership of the agenda, which supported better practice. An impressive aspect of the model was the spread of courses and Schools that took part. Twenty-four projects in the first year and a further twenty-three (based on ePortfolios and another twenty plus initiatives involving active learning through the Echo360 active learning platform) in the second year were significant numbers of participants in the initiative.

The most prevalent use of ePortfolios in the Griffith Sciences Blended Learning Model was not surprisingly employability and reflection. The university had issued a number of statements about the need for improvements in this area, and with a number of key academic performance indicators linked to student employability, it would have been expected for many of the projects to be involved in this area. Examples came from first year to final year, with a long-term plan to embed employability initiatives throughout programs within various Schools. What was worth noting is that ePortfolios also had a number of other uses that were just as valuable for courses in the STEM disciplines. Laboratory templates that support students thinking like a scientist were significant in a number of courses. The idea of scaffolding support for students in early laboratory templates and then reducing or “fading” this support in future iterations was suggested by a number of projects. As suggested by one of the project course convenors:

> The course initiative will help to consolidate understanding in the laboratory and application to future laboratory experiences. It will also assist student development of reflective practices and provide opportunity to solidify nature and purpose of laboratory skills…

who went on further to say that it can be “used to provide scaffolded opportunities to consolidate experimental knowledge and linkage to broader context and potential career pathways.”

An interesting aspect of the Griffith Sciences Blended Learning Model was the willingness by academics to experiment and innovate. There were a number of projects that saw the use of PebblePad as an opportunity to deliver learning in ways that they would not be able to achieve in the learning management system. The use of aviation simulators alongside reflective templates in the ePortfolio provided an opportunity for students to consider not only the practical aspects of flying but also the metacognitive thought that goes on in the head of a pilot. In a first year design based Engineering course, the use of a scaffolded workbook became a springboard for students to develop metacognitive skills involved in scoping a real world project and delivering solutions. In both instances, the ability to monitor progress throughout the course was considered essential as it highlighted the process and not just the final product. In Biology, students were able to use digital microscopes to record experiences into a laboratory workbook that developed practical laboratory experience with reflective thought. In each of these instances, the students were able to develop a sense of process and understand and articulate the types of thought needed to become an engineer, a scientist, or a pilot within the context of a real world product or a real world task.

Conclusion

The Blended Learning Model was designed to fund ground-up projects within the Sciences Academic Group, by giving incentive and time (via funding) to willing academics. These academics were then able to develop scholarly practice within their courses, generating lessons learned, principles of good practice in STEM and research outputs whilst creating a community of newly experienced practitioners armed with a variety of strategies and resources that they can use to develop better practice and support the next generation of users. This study proved that the Griffith Sciences Blended Learning Model could provide a bottom-up framework used in conjunction with top-down approaches to implement any new technology.

Results from the implementation confirm the success of this initiative, with significant interest being shown across the STEM disciplines, particularly within Engineering and Natural Sciences. Results also confirm that employability was not surprisingly the major reason for using PebblePad whilst other reasons included: scaffolding laboratory skills, developing reflection, for supporting week-to-week scaffolded lab activities and documenting field experiences. Integrating employability experiences was the major focus of program-based initiatives although aviation used the opportunity and funding to transform its flight training major by using PebblePad to support a flight simulation lab experience.

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A COLLABORATIVE BLENDED LEARNING APPROACH FOR LEARNING WEB PROGRAMMING

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Abstract

The learning of programming has been considered to be very difficult. To assist a class of 25 undergraduates to learn web programming, the researchers applied a collaborative blended learning approach in this study. After obtaining knowledge from lectures, the students were required to develop questions for generating an online quiz for the whole class. Results indicate that a high proportion of the questions were of high quality, and these reflected students' positive attitude. The students also demonstrated good performance in the online quiz, and it provided evidence of the effectiveness of the pedagogy. This study suggests that a collaborative blended learning approach could be applied to support students to learn web programming.

Introduction

With the development of technology, a webpage is no longer solely for displaying information in a static manner. Instead, many webpages nowadays have been designed in a dynamic way with multiple functions. The design of dynamic webpages involves sophisticated skills of web programming with the use of languages such as Extensible Hypertext Markup Language (XTHML), Cascading Style Sheets (CSS), JavaScript and Extensible Markup Language (XML). However, learning programming skills and concepts has been considered to be very difficult since it involves complex cognitive processing. Moreover, the linguistic intricacies of computer programming languages also make it difficult to learn.

In order to assist a class of undergraduates to learn web programming, the researchers applied a collaborative blended learning approach in this study. The use of a blended learning approach in designing courses, particularly in higher education, has been increasing (Mozelius & Hettiarachchi, 2017). Blended learning is generally referred to the pedagogy that combines face-to-face classroom teaching with an online learning component (Sharma, 2017). The teaching strategy in this study involved a blended learning component and a collaborative online learning component. In the following sections, the difficulties of leaning programming, the advantages of a blended learning approach and the underlying rationales of collaborative learning are discussed. It is followed by an elaboration of the method and results. A discussion and conclusions are provided at the end of this paper.

Literature Review

In this section, the researchers highlight the difficulties of learning computer programming. The rationales of the blended learning approach are then discussed. The importance of a collaborative approach to enhance learning is also explored.

Difficulties with Computer Programming

Programming can be regarded as a very useful skill. Particularly, it has been highlighted in recent developments of science, technology, engineering and mathematics (STEM) education due to its possibilities to develop the digital economy. The education bureaus of many countries, such as United States, England and Singapore, have initiated policies to promote the learning of computer programming (Department for Education 2014; Ministry of Education, 2017; Smith, 2016). The importance of computer programming is considered comparable with reading, writing and arithmetic. However, programming, such as using web programming languages in the creation of dynamic webpages, is a complex intellectual activity, and few students find it easy to learn. Although it is common to include programming courses in higher education, these courses are generally regarded as difficult and often have high dropout rates (Ahoniemi, Lahtinen, & Erkkola, 2007).

A major difficulty involves the linguistic intricacies of computer programming languages (Gomes & Mendes, 2007; Hristova, Misra, Rutter, & Mercuri, 2003; Jenkins, 2002; Truong, Roe, & Bancroft, 2004). The syntax of programming languages is very complex (Gomes & Mendes, 2007). These languages were developed for professionals instead of novices. Programmers are required to memorize a lot of complex syntactic details. Students normally find it difficult to detect simple syntactical and logical programming errors. In order to tackle the difficulties, many researchers have proposed methodologies and tools, such as the use of peer assessment strategy, graphical languages and intelligent tutoring systems, to help students learn computer programming (Gomes & Mendes, 2007; Jenkins, 2002; Ng, 2012; Robins Rountree, & Rountree, 2003). However, the difficulty of learning computer programming is still an eminent problem that requires academics to develop effective teaching and learning strategies. In this connection, a blended learning approach that has been increasingly used in higher education would be a possible strategy to assist students to learn programming.

Blended Learning

Blended learning generally refers to the pedagogy that combines face-to-face classroom teaching with an online learning component (Sharma, 2017). The use of blended learning approach in designing courses, particularly in higher education, has been increasing (Mozelius & Hettiarachchi, 2017). With the inclusion of an online component, the time students spent on learning can be increased. A blended learning approach can make use of online technologies to implement asynchronous teaching and learning. Individual learning and learner autonomy can also be promoted by a blended learning approach (Mozelius & Hettiarachchi, 2017; Sharma, 2017).

As suggested by McAllister and Irvine (2000), teaching methods can be divided into two components, namely content-based teaching and process-based teaching. The main purpose of content-based teaching is for transmission of knowledge and skills. It is usually conducted using a lecture-based didactic approach for learning educational policies, procedures and theories (Grossman, 2005). The process-based teaching methods, on the other hand, provide opportunities for students to carry out reflection and initiate meaningful dialogue. They aim to engage students in active learning. In order to integrate content-based teaching and process-based teaching into a coherent pedagogy, a blended learning approach was adopted in this study with a face-to-face component for content-based teaching and a collaborative online learning component for process-based teaching. Details of the design are elaborated in the Method section.

Collaborative Learning

Collaborative learning that involves social interaction has been vigorously advocated by academics (O'Donnell & Hmelo-Silver, 2013), especially since the contribution of Vygotsky (1978). On the basis of Vygotsky's work, researchers have regarded education and cognitive development as cultural processes. They stressed that knowledge is not only possessed by individuals but also shared among members of communities. People jointly construct understandings by their involvement and interactions in events that are shaped by cultural and historical factors (Drummond & Mercer, 2003). Interactions between students reflect the historical development, cultural values, and social practices of the societies and communities in which education institutions exist (Drummond & Mercer, 2003). From the sociocultural perspective, learning occurs in the mental processes of social interaction and dialogue. Students can thereby learn by negotiating and collaborating with others (McLoughlin & Marshall, 2000). According to Vygotsky (1978), cognitive processes first appear at the social (*intermental*) level. These cognitive processes will then be internalized and transformed into individual ways of thinking, which are characterized as the *intramental* level (Fernandez, Wegerif, Mercer, & Drummond, 2001).

In Vygotsky's (1978) research on youngsters, he identified the zone of proximal development (ZPD) as "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). Vygotsky recognized that the ZPD is critical for learning and further suggested that the development process lags behind the learning process. In this concept, an essential feature of learning is to identify the ZPD and equip learners with the capacity to proceed to this zone. This requires the awakening of a variety of internal developmental processes for learning that only operate when the learner is interacting with people in his or her environment and in cooperation with his or her peers. Once these processes are internalized, what has been learned becomes part of the learner's independent development achievement (Vygotsky, 1978). The ZPD can also be characterized as the dynamic region where the intermental level converges with the intramental level (Fernandez et al., 2001).

An important feature of ZPD is to learn with the guidance of adults or more capable peers. In fact, collaborations between students who have similar levels of conceptual understanding can also promote learning. Fernandez et al. (2001) categorized two types of interactions. The interactions between teachers and students are “asymmetric” in form, while interactions among students are regarded as “symmetric.” They defined the *intermental development zone* (IDZ) as a characteristic of a dialogical phenomenon created and maintained between people in interaction. They claimed that any joint, goal-directed task must involve the creation and maintenance of a dynamic, contextual basis of shared knowledge and understanding. Moreover, the success of any collaborative endeavor will be related to the appropriateness of the communication strategies participants use to combine their intellectual resources (Fernandez et al., 2001).

Actually, a number of researchers have adapted the social constructivist approach to deal with situations involving learners of more or less the same level of competence working on a task collaboratively (Littleton & Hakkinen, 1999; Ng, 2013). With the development of web technologies, it has been a common practice to integrate online collaborative learning activities in designing courses in higher education to enhance learning effectiveness (e.g., Brindley, Walti, & Blaschke, 2009; Lai & Ng, 2011). Therefore, it is reasonable to expect that the students would have better learning effectiveness if they are placed into online collaborative learning. In view of the difficulty of learning web programming, the researchers implemented a collaborative blended learning approach with the purpose to enhance learning effectiveness. This study attempted to explore the following research question: “What are the impacts of a collaborative blended learning approach in learning web programming?”

Method

The study was conducted in a course entitled Introduction to Web Technologies and Standards taught by the first author in a Bachelor of Education programme. This course provides students with fundamental concepts on Internet development, web technologies and standards. It also offers students the basic knowledge and skills of presentation, representation, query and transformation technologies on the Web. The course also gives opportunities to students to engage in hands-on experience in working with a variety of web technologies. Upon completion of the course, students should be able to develop fundamental concepts of Internet development and web technologies, demonstrate understanding on a wide range of web technologies and standards, and acquire basic skills of presenting, representing, querying and transforming information on the Web. A total of 25 students enrolled in the course, with 21 males and four females.

Collaborative Blended Learning Approach

The collaborative blended learning approach was comprised of a face-to-face teaching component and an online collaborative learning component. The face-to-face teaching component aimed to enable students to obtain conceptual knowledge and practical skills of web programming. Students were also provided opportunities to have hands-on practice to create webpages.

The first topic was Extensible Hypertext Markup Language (XTHML). It is the fundamental language of building a basic webpage. Students were then introduced to the language of Cascading Style Sheets (CSS) for formatting the styles of webpages. The next topic was JavaScript for creating dynamic functions in a webpage. The last topics were Extensible Markup Language (XML) and Extensible Stylesheet Language Transformations (XSLT) for dealing with data in webpages. At the end of the face-to-face teaching component, students were requested to participate in an online collaborative learning activity.

The purpose of online collaborative learning component was to engage the students in active learning outside classroom with collaborative efforts. The students were required to participate in two stages of learning activities. In the first stage, the students were randomly divided into four groups under the topics XHTML, CSS, JavaScript, and XML together with XSLT. Each student was requested to develop two multiple choice questions of a respective topic with a format specified by the lecturer for testing their peers on the knowledge of web programming. The students were encouraged to develop high-quality questions that were meaningful, challenging, without grammatical error, with reasonable choices and with only one correct answer.

The students were requested to send all the multiple choice questions to the lecturer individually via an online learning management system. After receiving all the questions, the lecturer reviewed the questions, made necessary amendments and then compiled a full set of multiple choice questions developed by the students for conducting the activity in stage two. The quality of the multiple choice questions would be evaluated to explore students' learning attitude in this activity. It was expected that students with better learning attitude would develop higher quality questions.

In Stage 2, the lecturer input all the questions into the game-based online quiz platform "Kahoot!" (Figure 1). This platform was designed with attractive interface and interactive features. It provided functions for the lecturer to implement an online quiz and track the performance of each student. The students were required to download the Kahoot! app and install it in their mobile devices. They were then requested to participate in the online quiz individually during a specific period of time outside the classroom using their own mobile devices. They were also informed that all the questions in the quiz were developed by students in the class. In this setting, they were arranged to learn in a collaborative approach. Their performance, including both the quality of the questions and their performance in the online quiz, counted 10% of the overall assessment of the course. Their performance in the online quiz would serve as a piece of evidence of their learning effectiveness of the overall strategy.

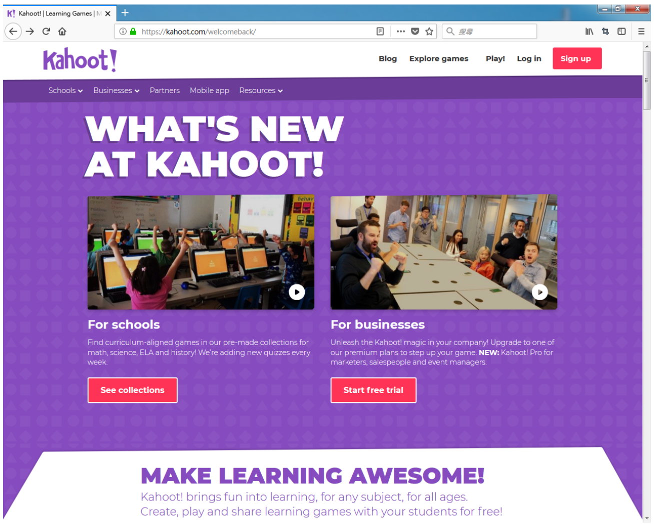

Figure 1. "Kahoot!" A game-based online quiz platform.

Results

As mentioned in the Method section, the quality of the multiple questions created by students and their performance in the online quiz was evaluated to explore the effectiveness of the collaborative blended learning approach implemented in this study. Respective results are reported in this section.

Quality of Multiple Choice Questions

Since there were 25 students in the class, a total of 50 multiple questions were created. Among all the questions, two questions were identified as having vague meaning and irrelevant choices of answers. These two questions were regarded as poor quality and were removed from the final online quiz. Regarding the remaining 48 questions, the number of questions on HTML, CSS, JavaScript and XML with XSLT were 12, 12, 14 and 10 respectively. There were 11 questions asking factual knowledge that simply required participants to choose the correct answer by recalling the contents covered in the course. The quality of this kind of question was regarded as relatively low since recall of knowledge was regarded as the lowest level of learning in Bloom's (1956) taxonomy of learning. A typical question was "What does XHTML stand for?"

Among all the multiple choice questions, 37 questions assessed participants' understanding on web programming. The quality of this kind of question was regarded as high since it was not to assess the ability to simply recall factual knowledge. It required the participants to have a good comprehension of the contents of web programming covered in the course.

A typical question is as follows. A summary of the quality of questions created by the students are given in Table 1.

What is the value of z after executing the following codes?

```
var y = 10;
var z = 0;
for ( var x = 0 ; y > x ; x++ ) {
        if ( (x%2) == 0)
                z++;
}
```

A. z = 2
B. z = 3
C. z = 4
D. z = 5

Table 1

Quality of the Multiple Choice Questions Created by the Participants

Quality of Question	No. of Questions	Percentage
Poor	2	4%
Low	11	22%
High	37	74%

Performance in Online Quiz

Regarding the students' performance in the online quiz, all the students participated in the activity. Among all the 48 questions, the number of correctly answered questions of each student ranged from 24 (50%) to 48 (100%). The mean and standard deviation were 39.7 (83%) and 5.8, respectively.

Discussion and Conclusions

As indicated from the results, a high proportion (74%) of questions developed by the students were regarded as high quality. This suggests that the students had obtained sufficient content knowledge for developing good questions for enhancing learning. They were also willing to contribute to peers' learning by paying efforts to design good questions. Their positive attitude toward the task was most probably due to the attitude change of identification suggested by Kelman (1958) that the students preferred to maintain a mutually supporting relationship. Under the setting of collaborative learning in this study, it appears from the results that the student regarded himself or herself as being similar to others or enacting a role reciprocal to that of other people. Students were then willing to expend efforts to design high-quality questions and to serve as good learning partners. This aligns with the opinion of Jung, Choi, Lim, & Leem, (2002) and his colleagues that peer collaboration are important in enhancing learning. Another possible reason of the high proportion of good questions might because the students enjoyed the design of the activity. They might find it interesting to challenge their peers by setting challenging questions. In this connection, more evidence collected in future studies might be required to explore students' attitude in the learning process.

On the other hand, the students had good performance in the online quiz and that provided some evidence of the effectiveness of the collaborative blended learning approach. Similar to the argument suggested by Mozelius and Hettiarachchi (2017) and Sharma (2017), the online component of blended learning had successfully encouraged the students to spend more time on learning. They were provided opportunities to learn individually with required autonomy. The result of good performance in the online quiz aligns with the findings from previous studies (Owston, York, & Murtha, 2013; Wu, Tennyson, & Hsia, 2010) that a blended learning approach could be beneficial to students' learning. However, since the sample size in this study was not large and there was no control group in this research, more related studies may be required to further confirm the effectiveness of the collaborative blended learning approach to enhance students' learning. With detailed elaboration, the researchers suggested a collaborative blended learning approach for enhancing the effectiveness of learning web programming in this paper for future reference.

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THE USE OF BLENDED LEARNING AS AN IN-CURRICULUM DISCIPLINE

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Abstract

This paper seeks to demonstrate, through a case study, the main aspects of the implementation and development of the discipline English at the School of Business and Hospitality of University Anhembi Morumbi (Brazil), member of the Laureate International Universities, aiming at the University internationalization. The course implementation occurred in hybrid modality, blended learning. We will show the implementation and development of the program, the receptivity of the students regarding the passage from English for Specific Purposes (ESP) to General English (GE) and some evaluative aspects of the hybrid model, plus some results related to student satisfaction in the program.

Keywords: English, blended learning, in-curriculum discipline, case study

Introduction

Since the advent of personal computers and technological advances in the last decades, language teaching has gone hand in hand with technology, which has become a valuable tool in the classroom for mother tongue and foreign language learning (Beatty, 2013; Boswood, 1997; Brierley, 1991; Chester, 1987; Sabourin & Tarrab, 1994; Lee, Jor, & Lai, 2005; Szendeffy, 2005; Towndrow, 2007).

When considering the paradigm shift, both in education and in the learning process, it can be observed that there are a number of assumptions that encourage the use of the computer (technology) in the acquisition of the mother tongue, foreign language and additional languages. In this perspective, it is known that digital information and communication technologies are able to establish context for collaboration and social interaction in which learners will build their own knowledge of the target language due to involvement in meaningful activities.

Technology in the area of education, and particularly in the area of language teaching, is already widespread. In the last decade alone, a large number of additional language teachers have been trained to master the technology to become familiar with its use in the process of teaching and learning English.

However, the change of mentality regarding the use of technology in the teaching of English has been slow; many still seem resistant to its use, but there are signs that the pace is starting to accelerate with the spread of *user-friendly* tools and software (Dudeney & Hockly, 2012). In this context, one of the main points for the adhesion of more teachers to the use of technology in language teaching has been their own experience within technology itself in distance learning (DL), especially owing to a growing number of professionals involved in several daily activities. Moreover, a great number of such professionals are only able to find time to professionally improve through online teacher training or educational courses.

In countries where there is more advancement in educational technology and government development, it is noted that one of the most popular technological tools in primary and secondary education is the *smart board.* According to Dudeney and Hockly (2012), the success of this type of technology is largely related to the fact that it has, in its core the metaphor – the blackboard – and it gives the computer a secondary or almost invisible role in the classroom. In the case of foreign language learners – the vast majority of them, especially the younger ones, are familiar with media such as blogs, Wikis, podcasts, streams, Twitter, Tumblr, Facebook, etc. It is expected that, due to this familiarity, the trend of using technological tools in education and teaching will increase dramatically in the coming years. The Virtual Learning Environment (VLE)[1] has shown considerable growth in recent decades, despite some resistance from some teachers and students. Moreover, society, in a generic way, has been impacted by the Internet, and only a few are able to live without it nowadays. Saliés and Shepherd (2013) state that linguistics itself cannot give up these spaces for its studies and analyzes and that the last frontier in which technology is impacting society is the Internet, in which more than 1,000 languages are represented. According to the authors, in consultation with World Stats[2], the ten most used languages on the Internet by 2011 were, in this order, English, Chinese, Spanish, Japanese, Portuguese, German, Arabic, French, Russian and Korean. Therefore, within this context of teaching and learning languages with the use of technology, we will present a study on the teaching of English as a curricular discipline at the university level, utilizing blended learning, in which we will discuss the design and implementation of the program, as well as its development and evaluation.

Why Choose Blended Learning?

Many papers on blended learning point to it as the learning that shares the best of electronic learning and traditional learning environments. Nevertheless, little is said that a blended learning environment can combine disadvantages of both environments when not well executed (Graham, 2006). There often seems to be an exclusionary approach to face-to-face or online classes. Some students may prefer the total on-campus experience vesus attending the traditional classroom while others opt for fully online learning. Some programs, however, offer a blended approach. This is the model we experienced and therefore will discuss.

In our case, for example, we had a face-to-face lesson once a week, with much of the course being done online. Another basic distinction in the 100% online, traditional and blended model is that 100% online courses can be composed of students from various places. For example, students in virtual classes may be from Brazil, Lithuania, Greece, soldiers serving in other countries, etc. Nonetheless, traditional on-campus courses are usually more localized or regional. Students tend to be in a context with members of a group who come from the same city or state and attend common environments. These groups tend to be more socially and culturally homogeneous. In terms of interaction, the online model enhances contact with other students in other areas, while the face-to-face version allows closer ties between students from the same community or nearby. Therefore, the advantage of the blended model is the mix of online and face-to-face students, enabling a better interactive network at the local, regional as well as global levels. Such a practice can affect factors such as school avoidance, employability, and the level of student interest.

An Investigation of Blended Learning

The case study presented here describes an investigation of blended learning developed between the years of 2012 to 2015 at Anhembi Morumbi University – São Paulo. As coordinators of the program through these years, we worked administering the teaching of English for the business school courses such as administration, marketing, international relations, foreign trade, and for the hospitality school that included hotel management and tourism. At its peak, during this period, the program had 10 hired teachers and 2,294 students, integrating the Laureate International Network. We have chosen this qualitative research method to examine real-life situations and provide the basis for the application of ideas and extension of the blended learning implementation.

The Program

The number of students who attended the program constantly grew, except in 2013-14 when there was a curricular change, when the discipline of English began to be offered only in the second semester in most of the courses. Divided among business school and hospitality students, as represented in Figure 1, total students reached: 1,508 (2012 – semester 1), 1,702 (2012 – semester 2), 1,728 (2013 – semester 1), 1,621 (2013 – semester 2), 1,900 (2014 – semester 1), 1,901 (2014 – semester 2) and 2,294 (2015 – semester 1). In general, the participation of the discipline in the curricular matrices of the courses was high.

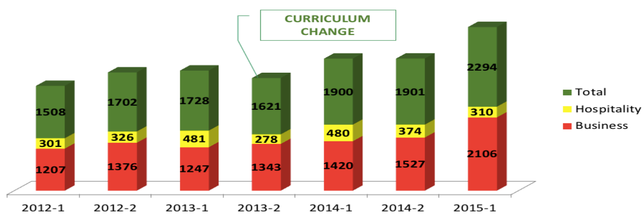

Figure 1. Number of students enrolled in the program.

English has taken 15% (320 hours) of the total course hours (3,000 hours). Figure 2 represents this proportionality.

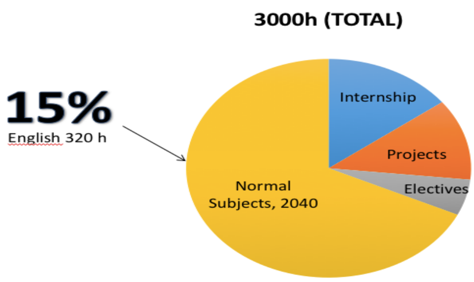

Figure 2. Total course hours and the number of hours of in-curriculum English.

The Blended Learning Methodology

The program employed the blended methodology and the hours of dedication to the discipline of English for all these courses, was part face-to-face and part online. The face-to-face classes corresponded to 50% of the course hours, the remaining hours were fulfilled in a virtual learning environment (VLE) that registered the presence, participation and performance of the students. The VLE used by the students was the CambridgeLMS online platform that corresponded to and complemented two books: *Touchstone* and *View Point* (Cambridge University Press). The books were used in the classroom, and teachers presented the topics face-to-face, both respecting the characteristics of the group of students and gradually demanding activities to be fulfilled in the VLE.

Group Leveling and Placement Tests

In pursuit of accreditation and quality indexes, the program established the following criteria and procedures in the division of student groups:

1. Once enrolled in the program, students sat for a placement test and were classified in terms of knowledge in the language. The CEFR[3] scale was used to level the students.
2. Students were divided into groups of no more than 30 students for each teacher in their respective classes.
3. To solve internal procedures, the Business Administration, Marketing and International Relations students from the first semester of 2014 on, were grouped into pools; we didn't consider their the course they were taking, but their level of English. This way, Marketing students could be placed together with International Relations students based on their level of English.

The division of the classes into pools respected the level of knowledge in the language, campus and period, not the course of the student. Figure 3 shows a sample of students' entry level at one of the university campuses.

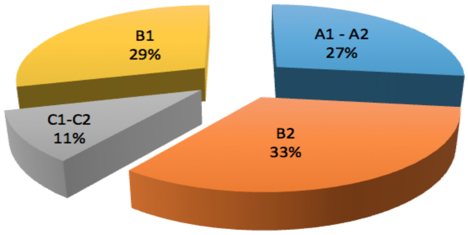

Figure 3. Levels of entry (CEFR) based on the leveling test - Campus Vila Olímpia 2014 – 2.

General English Teaching and ESP Teaching

The complexity of teaching English at the university level imposes the following dilemma: Should the course be geared towards the student's academic or professional background? In other words, should it focus on language learning for communication or on language use for the labor market? Besides, the students were used to having ESP[4] classes, and the implementation of the new curriculum, encompassing General English (GE) would be a paradigm change. The answer to such a question is not simple, and we believe that a hybrid education model is the best choice.

Justification

According to EF[5], a global education consulting company focusing on language, academic, cultural exchange, and educational travel programs, Brazil has a low level of proficiency in English (41th position), which impedes Brazil's insertion into a globalized context. This fact corroborates the idea that the model of English practiced in higher education (only ESP classes) is far from ideal, as the level of the majority of students who enter university is low.

The flexibility provided by the blended learning model allowed our teachers to work together with Second Language Teaching (ESL) and language teaching for specific purposes. The chosen model could privilege all modalities: (a) ESP in the face-to-face model, since the teacher was able to evaluate items such as language level, students' interest, relevance and relevance to elaborate significant activities for the students' professional training; (b) ESL in the online model, because the students, respected in their rhythm and level, could carry out the activities as many times as they pleased until they felt comfortable with a certain content. In a non-exclusive way in the classroom, the teacher interfered (synchronously) in the students' learning and worked on productive skills concerning language; the students, in turn, performed tasks at home concerning the application of English for their professional needs.

One major advantage of the blended model seems to be the teacher's sensitivity factor for delivering GE and the ESP approach in face-to-face and online activities, according to the particularities of each group. The level was also respected in our case: the higher the student's knowledge in the language, the greater the proportion of online activities in ESL, because their degree of independence in learning is greater.

Evaluation

With regard to the online evaluation system, we observed that it could be advantageous. The advantages of online assessment are: (a) assertiveness, (b) continuity and process assessment, (c) reduced demand for teacher activities, and (d) familiarization with common assessment models in the labor market. In addition, throughout the semester, two written individual performance assessments and one (or more) oral assessment (s) were performed and served as an online student performance check tool as well as a diagnostic tool for reorienting the teachers' work. In the specific case of the online performance of the apprentice, the Gradebook – a software present on the Cambridge LMS platform – was used to assign notes to the activities performed by the students. The Gradebook is useful for gauging miscellaneous skills notes, such as reading activities, listening comprehension, and even the ability to speak. By means of that, the written practice could be better tested in blogs, discussion forums and Wikis. Teachers were able to determine which assessment tools to use, provided they considered the four skills: reading, writing, speaking and listening.

In the case of the evaluation of the program, for us to check whether the program was working or not, we tested our students through the Cambridge Proficiency Exam. To do this, we used a sample of students who had reached the fourth semester of the English language course (English IV) of the program in May 2013. For the most basic levels, we chose *Test Level-2* (CEFR Level) – and for the more advanced students, we used the *Test Level-4* (CEFR Level). As the test was not compulsory, we obtained a sample of 208 students, of which 74 were tested for level 2, and the other 134 students were tested for level 4. The students, on the day of the proficiency examination, filled out a questionnaire with some personal information (age, address, etc.) and also answered a questionnaire about how they saw the progress of their English and how they evaluated the program. Here are some results.

Results

The students' satisfaction index with the program was measured by anonymous semester surveys conducted by teachers in the classroom. Surveys occurred from 2012-2 to 2014-1 and the results were very promising (see Figure 4).

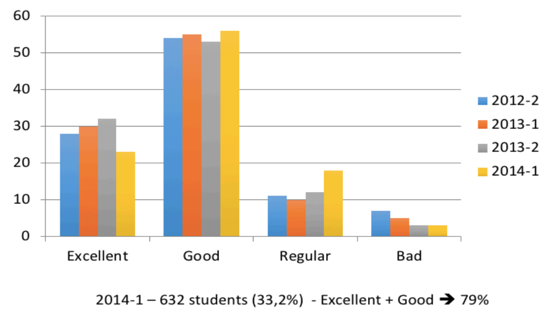

Figure 4. Percentage of students' satisfaction.

We believe that the good acceptance of the program is also due to the evident need to learn English because of its recognition as an international language. McKay (2003) estimates that by 2025 there will be more speakers of English as a second language than speakers of English as the first language because the language serves not only for local needs but also for communication on a large scale. This finding was very evident in the questionnaire that the students answered in the Cambridge English proficiency test on the subject (Figure 5). Questions 12, 15, and 18 indicated that students agree that English is important for work (question 12), international communication (question 15), and personal satisfaction (question 18).

		I strongly disagree				I strongly agree
		1	2	3	4	5
12	I want to learn English because I will need it for my job.	2.0%	5.9%	10.8%	14.2%	67.2%
15	I want to learn English because it makes travelling to other countries easier.	1.5%	6.9%	11.3%	20.7%	59.6%
18	Doing well in English is important to me.	1.0%	1.0%	6.9%	22.1%	69.1%

Figure 5. Cambridge English proficiency test questions.

Concluding Remarks

Test Level-2 (CEFR Level) result shows that almost 90% of the student sample was at A2 level (CEFR) or below. However, among Level 4 students – *Test Level-4*, showed that almost 95% were between level A2 and B2. The results obtained were valuable for the program evaluation and consequent planning actions for improvement.

In our specific case, during the implementation of the English Language course in the curriculum in the Business School courses of the Anhembi Morumbi University, using blended learning as a teaching methodology, we were able to understand some points that allow the reflection and evaluation of this model.

First, as positive points, we have the results of learners' evaluations (self-evaluation) indicating an appreciation for the program and the teaching methodology. In the area of contents presented, the students were tested, after being divided into two distinct levels, by the Cambridge Proficiency Test, and we obtained, as can be seen in the presented results, a promising scenario, viz., we had high levels of approval for both levels tested in comparison with the Brazilian test scores.

Nonetheless, we faced some challenges during the establishment and maturation of this project. For example, there were times when we had an insufficient number of levels, given that the CEFR scale has 6 levels and the maximum amount of levels offered, even with pools, was 3. This is due to limitations established by the institution, because it is a curricular discipline, which has scheduled and established days. Thus, it is evident that many students were left out of their ideal groups, viz., there were students who were below or above their level of knowledge of English. The teachers' effort to accommodate the situation was valid, but did not meet the specific needs of the students. Therefore, some curricular restructuring actions were speculated and outlined by the institution to remedy this deficiency, but all of them in the long term, because they required curricular and organizational flexibilization.

Although the majority of students considered the course good or excellent, many still, especially the most advanced ones, clamored for the insertion of the discipline English for Specific Purposes (not general English + ESP) because they believed that being in the university environment and professional context for each area, they should learn specific language related to the course they chose at the university. In general, teachers found it difficult to find and elaborate activities at the appropriate level for each group that addressed subjects relevant to the area of professional activity of each course and that required the use of the four skills in the language. It is our opinion that the most appropriate action in this case would be the organization of a sequence of contents for all semesters of the course that has in-curricular English. The topic addressed should dialogue with the other subjects of the students in that semester to become more relevant. An activity bank and ESP activities (by level) were created and shared among teachers and, as a consequence, there was little or no chance of replicated activities. The bank of questions and activities provides a diversification in the style of activity throughout the course and consequent reduction of the sense of strangeness on the part of the student.

Another challenge for blended learning in this project to be considered was the adherence to the VLE (Figure 6).

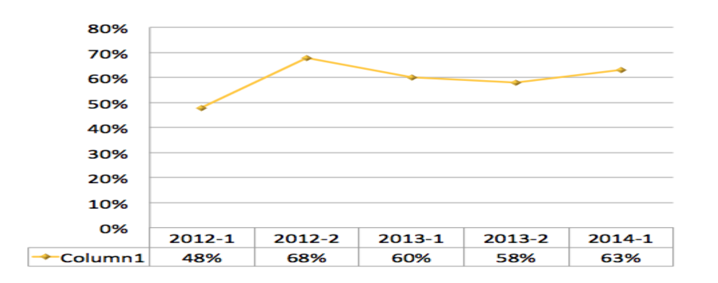

Figure 6. Percentage of students' adherence to VLE.

For effective learning to occur in this methodology, it is fundamental that the students perform their assignments in the period that is reserved to be engaged in online activities. The model implemented in the program provided for the non-obligatory adherence to VLE and respective activities in this environment.

Briefly, a bonus policy was established which, despite being appealing, did not reach all students and, as a result, an average of 40% of the students did not participate in the VLE (see Figure 6). Making participation in the VLE mandatory is a response to the problem that immediately came to mind. However, we agree that meritocracy directly affects the students' enthusiasm for learning and, apparently, factors such as will and interest – which drive the leading role in education – are especially important for learning a foreign or additional language. The period in which the students spend outside the school boundaries and even outside the VLE limits seems to be determinant in the progression of learning. Therefore, this is an issue to be addressed and deepened in further studies mainly in contexts in which the internationalization of the Brazilian universities is aspirated, such as the current one.

Notes

1. Also known in the American context as LMS (Learning Management System).
2. Access: http://www.internetworldstats.com/stats7.html
3. CEFR (Common European Framework of Reference) for Languages, which places students in levels A1 (beginner), A2 (elementary stage), B1 (low intermediate), B2 (high intermediate), C1 (operational effective) and C2 (proficient).
4. English for specific purposes.
5. Education First. (2017). EF EPI: Índice de proficiência em inglês da EF. Education First - English Proficiency Index 2017. Retrieved from https://www.ef.com.br/epi/

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THE IMPACT OF MOODLE QUIZZES ON STUDENT PERFORMANCE: THE CASE OF A STATISTICS COURSE

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Abstract

In this paper, the influence of students' activity in an e-classroom in a blended learning environment on their final exam performance is considered. The data set includes 92 participants of the *Basic Statistics* course. In the e-classroom, students self-study certain topics and check their newly acquired knowledge with quizzes. A strong correlation between the scores achieved for the quizzes and final exam points was discovered. Moreover, significant differences in performance were found between students who had completed most of the quizzes and those who did not. Therefore, the quality of individual study in an e-classroom positively influences a student's performance.

Keywords: blended learning, Moodle, students' activities, quizzes, students' performance

Introduction

Higher education institutions all over the world are increasingly adopting blended learning, which combines face-to-face and technology-mediated instruction (Porter, Graham, Spring, & Welch, 2014) with the aim of complementing each other (Graham, Woodfield, & Harrison, 2013). The use of Learning Management Systems (LMSs) has grown exponentially in the last few years and come to strongly impact the teaching and learning process (Cerezo, Sánchez-Santillán, Paule-Ruiz, & Núñez, 2016; Romero, Espejo, Zafra, Romero, & Ventura, 2013). Moodle is one of the most popular open-source LMSs. It has a full range of functionalities that other similar programs have, including tools for posting and sharing course information, conducting online discussion, and administering online quizzes. Moodle is also an environment that facilitates 'social constructionist pedagogy' by providing avenues for students to collaboratively engage in learning and other academic activities (Zhang, 2008). All kinds of learner activities are crucial for an effective online teaching–learning process, and it is therefore necessary to search for empirical methods to better observe patterns in the online environment (Neuhauser, 2002).

Blended learning has been used for over a decade at the Faculty of Administration of the University of Ljubljana, Slovenia. E-classrooms there are provided in the LMS Moodle environment. In order to improve the satisfaction of key stakeholders, i.e., students, teachers and faculty management, regular analyses are performed every half-year by an internal team of researchers. These results give managers and teachers insights into the contemporary situation and give opportunities for improvements and further development.

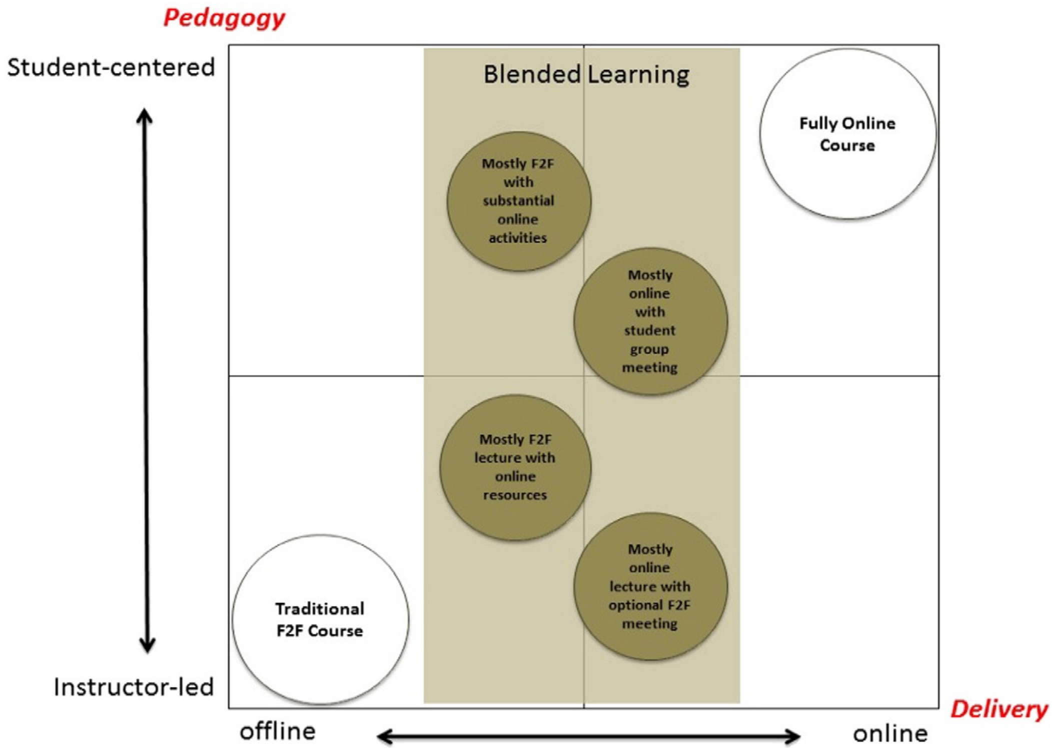
The purpose of our latest study was to examine the correlation between a student's active involvement in Moodle activities, specifically in quizzes, and the final exam results. The study's objective was to answer the following research question: "Is there any relationship between the total score achieved for the quizzes and the grade obtained at the final exam?" To provide an answer, we analysed data from the undergraduate course *Basic Statistics*. The paper is organized in the following way: we introduce the literature review, which is followed by the empirical study itself, including a description of the data, methodology and results. In the conclusion, we present the key findings, describe this study's main limitations and indicate possible avenues for further research.

Literature Review

When online higher education programs started to grow rapidly, they created a dynamic tension spawning ambivalence in certain sectors of higher education (Moskal, Dziuban, & Hartman, 2013), e.g., computer science (Romero, López, Luna, & Ventura, 2013), healthcare studies (Bergstrom & Lindh, 2018; Frantz, Bozalek, & Rowe, 2012), business studies (Ifinedo, Anwar, & Pyke, 2018), etc. A positive side effect of that tension included new learning environments that offered potential to maximize the effectiveness of contemporary teaching and learning. That movement had various labels such as mixed mode, hybrid, and combined, but blended learning has emerged as the dominant label for an educational platform that combines face-to-face and online learning (Moskal et al., 2013).

Evidence shows that the proportion of time devoted to online activities in a blended course is related to course performance (Romero, López, Luna, & Ventura, 2013). When using it in higher education courses, different proportions of the two types of learning are implemented, e.g., 50% face-to-face and 50% in the e-classroom, 70% face-to-face and 30% in the e-classroom, 60% face-to-face and 40% in the e-classroom (Chang, Dziuban, Hynes, & Olson, 1996).

While the definition of blended learning is clear and simple, its implementation is complex and quite challenging since virtually limitless designs are possible; depending on how much or how little online instruction is inherent in blended learning (Garrison & Kanuka, 2004). Diverse instructional models and best practices of blended learning have been reported from simple use of computer or online mediated technologies to full use of them for a complete course (Park, Yu, & Jo, 2016). Many combinations of learning, including blended learning, become possible when combining the type of pedagogical approach (instructor-led or student-centred) and the type of delivery (offline or online) – see Figure 1.



Source: Park, Yu, and Jo (2016).

Figure 1. Range of blended learning definitions.

The key stakeholders of the blended learning system are the institution's management, teachers, and students. Each tries to attain their particular goals. The management wishes to increase the efficiency of classroom resources and improve teaching by developing the members of staff. The teachers aim to adopt innovative, student-centred teaching practices. Students' goals are increased flexibility (in time and space) and expanded access, greater academic success and enhanced information literacy (Moskal et al., 2013).

According to Owston and York (2018), a consensus has emerged in the literature that students, on average, perform modestly better in blended courses compared to those in completely online or face-to-face courses across a broad range of subject areas and institutional offerings. However, learners often do not successfully adapt their behaviour to the demands of advanced learning environments, such as the LMS (Azevedo & Feyzi-Behnagh, 2011), because it requires greater independence and autonomy of the students for it is they who shall decide, for example, on what and how much to learn, how much time to invest, when to increase effort, etc. (Azevedo, Cromley, Winters, Moos, & Greene, 2005).

Whatever the motivation to blend, it is evident the strategy works best when clearly aligned with the institution's mission and goals while simultaneously addressing the needs of students, the faculty, and the institution (Dziuban, Hartman, Cavanagh, & Moskal, 2011). A clear vision and strong support are required when moving to a blended environment. It is only then that this modality cannot just succeed but become a transformational force for the university (Dziuban et al., 2011).

When preparing e-classrooms, there is a range of possible online activities in which students can engage and that motivate them to learn efficiently such as: announcements, links, lecture notes, resources, questions & answers, discussion forums, quiz items, group works, Wikis and assignment submissions (Park et al., 2016). Many studies have already investigated the impact of students' involvement in these activities, e.g., Cerezo et al. (2016) examined behaviour of students in a LMS and matched it to a different level of their achievement; Owston and York (2018) investigated the correlation between the time spent in an e-course and a student's performance. Romero, López, Luna, and Ventura (2013) investigated different data-mining approaches with a stress on the accuracy of predicting first-year computer science university students' final performance based on their participation in an online discussion forum. The forum may not only inform the students about their peers' doubts and problems, but can also inform instructors about their students' knowledge of the course contents via the thinking and opinions provided by students in forum posts.

The above issues became a challenge and basis for research. In our study, we focused on quizzes in an attempt to ascertain whether and how much the performance in solving the quizzes impacts students' performance at the final exams. The focus was not on the amount of time the students spent in an active role in the e-classrooms, but whether the effort to study new topics, as measured by the scores achieved for the quizzes, helped them gain more knowledge and thus better results in the final exams.

Data and Empirical Study

Blended learning at the Faculty of the Administration is being implemented in a ratio of 80–20, i.e., 20% of the content of each undergraduate course is provided in an e-classroom, both for the lectures (led by lecturer) and tutorials (led by assistant), including reading materials, assignments, quizzes, etc. Our data set consisted of 1st-year students of the professional study programme at the Faculty of Administration, University of Ljubljana, which is similar to the sample used in the study by Romero et al. (2013). Students enrolled in this program comprise the largest group of students at the Faculty. For our case study, we chose the *Basic Statistics* course, namely, one of the courses with the highest number of activities provided in the Moodle e-classroom. During a 15-week semester, the course includes 25 self-study topics covered neither in the face-to-face lectures nor the tutorials. Therefore, every week students must study one or two topics. The knowledge acquired of this additional content is then examined in two ways: (1) in the quiz that follows each topic addressed in the e-classrooms and (2) as part of the final written exam. A student has three attempts at each quiz and the best score is used as the final quiz outcome. All quizzes have the same maximum number of points a student can achieve, and the final score for the quizzes is calculated as the average of scores obtained for all 25 of them. To stimulate self-study, the result obtained by quizzes makes up 20% of the final grade of the subject, and a student obtains the remaining 80% at the final written exam at the end of the semester.

Methodology and Empirical Results

To investigate whether students' performance in quizzes relates to the knowledge they demonstrate at the final exam, we used data on 92 students who participated in final written exams. We scaled both final scores, namely at the exam and for the quizzes, between 0 and 100 points (i.e., percentage). The distributions of each variable in our data are shown as histograms in Figure 2.

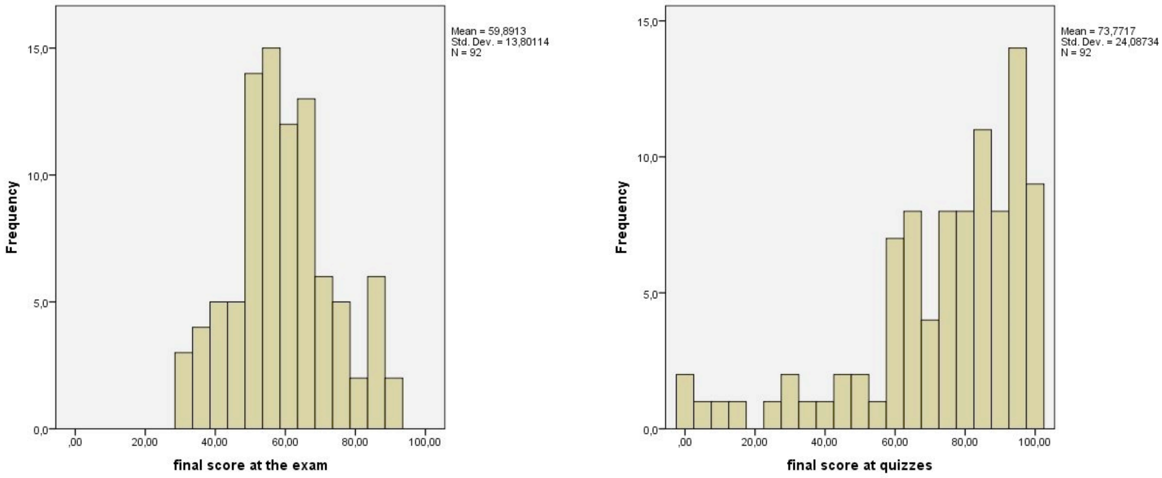


Figure 2. Distribution of scores at the final exam (left) and scores for quizzes (right).

Although the distribution of scores for the quizzes is more skewed to the left, both distributions do not deviate significantly from a normal distribution, namely *p* values according to a one-sample Kolmogorov-Smirnov test are 0.82 and 0.06, respectively. The mean score for the quizzes is higher (73.77) than that for the exam (59.89). The standard deviation is also higher for scores in the quizzes. Some students did not participate seriously in the quizzes – they simply took part at the start of the course – while others achieved maximum points for the quizzes as opposed to their exam scores, where maximum points were not achieved.

Altogether, 86% of the students achieved more than 50 points in quizzes. We computed a Pearson correlation coefficient between the final score for the quizzes and the final score at the exam. The correlation coefficient of 0.682 is highly significant (p = 7e–14), indicating a strong positive relationship between the score for the quizzes and for the exam. We can therefore conclude that a student who performed better in the quizzes on average had a better result for the final written exam.

Further, we investigated the relationship between scores in the quizzes and student's knowledge at the final exam in more detail. For this purpose, we divided the contents of the course into 11 topics (see Table 1). Questions and tasks in the final written exam were defined in terms of which topic they belong to. The topics in Table 1 are listed chronologically, which also corresponds to the order of basic topics to more complex ones. However, each topic is not covered by the same number of quizzes in the e-classroom

The case study participants were divided into two groups. The first group, named "Quizzes successful," consisted of 79 students (86%) who received at least 50% of points for each quiz. The second group of 13 students (14%) contains students with a worse performance in the quizzes (below 50%), named "Quizzes unsuccessful." Table 1 shows the mean score at the final exam for both student groups (measured in percentages) and the difference between the means. We computed *p* values (Sig.) using Student's t-test for independent samples.

Table 1

Mean Scores for all Topics Between Groups of Students (%), Difference Between Means and P Value

Topic	Quizzes successful	Quizzes unsuccessful	Difference	Sig.
1. Basic topics	69.62	59.23	10.39	0.13
2. Indices	60.91	58.41	2.5	0.78
3. Ranking, quantiles	45.67	24.15	21.52	0.02
4. Descriptive statistics (measures of Central tendency and variability)	59.29	45.5	18.94	0.02
5. Frequency distributions	81.74	67.31	13.79	0.01
6. Data collection	74.87	62.13	14.43	0.08
7. Probability	40.98	16.65	12.74	4.14E–03
8. Sampling	36.75	13.73	25.98	4.92E-04
9. Hypothesis testing	42.73	21.54	23.02	0.01
10. Correlation and regression	56.9	30.92	21.19	9.53E–07
11. Time series (forecasting)	68.01	49.07	24.33	1.95E–04

Table 1 shows the average performance in the group "Quizzes successful" was better for all 11 topics compared to the "Quizzes unsuccessful" group. With three exceptions (*Basic topics*, *Indices*, and *Data collection*), the difference in means is significantly greater than 0 (at the 5% level of significance). Two of the non-significant topics, *Basic topics* and *Indices*, are the first topics covered at the start of the course. These two topics cover basic principles of statistics where high school mathematics knowledge is enough for understanding. Therefore, the self-study of those two topics does not play a vital role in the results. The same principle applies to the topic *Data collection* which could be placed anywhere in the course since it is unrelated to any other topic and does not require in-depth knowledge.

The scores for the other eight topics indicate significant differences between the two groups of students. The largest differences can be found for the topics *Correlation and regression analysis*, where the difference of 21.19 points is highly significant, p = 9.53E–7, and *Time series* (forecasting), with a difference of 24.33 points, also highly significant, p = 1.95E–4. These two topics are the last two topics of the course, and both require knowledge of the previous topics to better understand them. They are also the most advanced topics and are covered in two quizzes, namely, four quizzes in total.

Conclusion

At the institutional level, the biggest advantage of blended learning lies in its flexibility that allows institutions to tailor the concept when making improvements for a new generation of students. It extends learning far beyond the boundaries of the traditional classroom (Moskal et al., 2013).

The case study of the *Basic Statistics* course imparts a message to future generations of students at the Faculty. Namely, students' continuous self-study during the semester in the LMS inclined to taking part in the quizzes or any other activities can help increase their performance at the final exam. These findings also confirm the Faculty of Administration has made a wise decision concerning the use of blended learning, providing the basis for retaining the same framework for studying in the future. In the next academic year, we plan to add more activities to the course *Basic Statistics* – the data collected from the next generation of students will enable a comparison of two sets of students based on different amounts of activities in the e-classroom.

The presented research is a case study of a specific course at the Faculty of Administration. Therefore, the primary limitation of the methodology used is its generalisation, as noted in a similar case study (Romero et al., 2013). In the future, we will establish a framework for analysing several courses by investigating students' behaviour in different e-classrooms and linking that to their performance at the final exams.

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BACK TO CONTENTS

TEACHING WITH DIGITAL TEXTBOOKS: POSSIBILITIES AND CHALLENGES FROM THE TEACHER PERSPECTIVE

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Abstract

An increasing amount of students' and teachers' work in the classroom involves digital technologies such as tablets and laptop computers. In this preliminary study, the use of digital textbooks in the classroom is explored through interviews with two teachers at an independent upper secondary vocational school. Both teachers use digital textbooks in their teaching and express difficulties in having time to review digital textbooks and supporting student work in the classroom. At the same time, the teachers report possibilities to individualise learning activities for students, providing structure for students as well as increasing accessibility to the textbooks during non-school hours.

Introduction

New digital technologies are now a natural part of society as well as in schools (Säljö, 2010). In many classrooms, teachers and students work with their own laptops or tablets in one-to-one (1:1) initiatives, meaning one laptop or tablet per student (cf. Richardson et al., 2013). The possibilities for teaching and learning with these technologies and creating supportive conditions for Technology Enhanced Learning (TEL) appear to be strong (Balanskat, Bannister, Hertz, Sigillò, & Vuorikari, 2013). Internationally, policy pushes forward the need for teachers to help students gain 21st century skills such as critical thinking, problem solving and digital competence in the digitalised classroom (Organisation for Economic Co-operation and Development [OECD], 2012)). In the Swedish context, these intentions are also expressed in policy. However, despite high levels of digital access in schools, use remains at a low level (National Agency for Education, 2016; The Swedish Schools Inspectorate, 2012). This may mean that many students, despite the intentions of policy, are not developing the digital competence they need for future work and studies (Voogt, Erstad, Dede, & Mishra, 2013).

In Sweden, several projects have investigated the implementation of digital technologies in schools (cf. Håkansson Lindqvist, 2015; Jedeskog, 2007; Tallvid, 2015). Recent reports show that while accessibility to technology in Swedish schools is relatively good, for example through on student one computer (1:1) initiatives, the technology is not being used as expected (National Agency for Education, 2016). Thus, further proposals to strengthen digitalisation in schools were addressed in an official government report on digitalisation (The Swedish Government, 2014) and *The National digitalisation strategy for schools* (The Swedish Government, 2017). Using the concept of *adequate digital competence*, policy aspires to strengthen and support students' digital competence and teachers' and school leaders' professional development within the area of digitalisation. It appears that the uptake and use of digital technologies as educational tools requires continued efforts in professional development for teachers and school leaders (Grönlund, 2104; Håkansson Lindqvist, 2015; Tallvid, 2015; Vrasidas, 2015) and takes time (Ertmer & Ottenbreit-Leftwich, 2013; Vrasidas, 2015).

In helping teachers to support students' learning with digital technologies, it could be anticipated that the digital textbook would have a strong role (cf. Gu, Wu, & Xu, 2015). However, it appears that teachers' use of digital textbooks may be similar to the uptake and use of digital technologies on the whole. The Swedish Association of Educational Publishers reports a low level of investment of digital textbooks per student compared to investments in laptops, i.e., 27 SEK compared to 1 770 SEK per student (Swedish Association of Educational Publishers, 2013).

Aim and Research Questions

The aim of this paper is to explore, identify and describe the possibilities and challenges related to the uptake and use of digital textbooks in the upper secondary classroom. The paper seeks to examine teaching activities in the use of digital textbooks from the teacher perspective. The following research questions are hereby put forward:

1. How can teaching activities regarding the uptake and use of digital textbooks in the classroom be described?
2. Using the Ecology of Resources Model (Luckin, 2010), how can possibilities and challenges in the uptake and use of digital textbooks in teaching activities in the classroom be understood as conditions for TEL?

The paper aspires to contribute to the area of TEL through the use of digital textbooks.

Short Survey of the Field

Digital textbooks can be seen as an important part of an electronic schoolbag as well as a main resource for learning (Gu et al., 2015). There are challenges such as design and development (cf. Gu et al., 2015) and implementation in the school context (cf. Horsley & Martin, 2015; Kim, Kim, & Choi, 2012), from both teacher and student perspectives (cf. Joo, Park, & Shin, 2017; Millar & Schrier, 2015; Weisberg, 2011). Researchers note challenges related to technology and copyright issues, but also possibilities such as providing both up to date information and multimedia-based learning (Gu et al., 2015). There is also an opportunity for teachers to use the digital textbook to support learning activities of students both inside and outside of the classroom (Horsley & Martin, 2015). Understanding teachers' uptake and use of digital textbooks as users is needed in order to determine the conditions and aspects of digital textbooks that can support TEL (cf. Gu et al., 2015). In the Swedish context, research related to the uptake and use of digital textbooks for teaching and learning in the classroom context appears to be relatively unexplored. In summary, the literature appears to focus on design, development, implementation and the need for further study of how teachers in practice use digital textbooks to support students' learning. More research is needed in general (Swedish Association of Educational Publishers, 2013) and more specifically, for quality control of an expected expanding educational area. There is also the need to exploit digital textbooks as a research instrument for studying learning (Gulz & Haake, 2014).

Theoretical Framework

The Ecology of Resources Model (Luckin, 2010) will be used as a framework, in order to examine and describe the teaching activities. The possibilities and challenges for teachers regarding digital textbooks will be analyzed using the three resource elements, *environment*, *knowledge and skills*, and *tools and people* and the theoretical concept of *filters* (Luckin, 2010). In the model, filters may restrain or impede the learners' (teachers') access to the resource elements available. By studying and identifying possible filters, it is possible to alleviate the filters and gain access to the resources to a greater extent.

Method

The data for this preliminary, or exploratory, study were gathered through semi-structured interviews with a sample size of two teachers. The teachers were chosen as they both were teachers of Swedish and English and both had experience working with digital textbooks. Both teachers work at an independent upper secondary vocational school. The school provides vocational training in 11 different programs, from building to electrical programmes to florist and restaurant programs. At the time of the interviews, which took place during December 2017 and January 2018, there were some 110 students and 12 teachers at the school.

Data Collection Design

In this small preliminary study, semi-structured interviews were used as a data collection method as a starting point. In the interviews, an interview guide was used, with 12 questions, regarding both background information and how the teachers used digital textbooks in the classroom in practice at the upper secondary school level. Examples of the questions were how the teachers used digital textbooks in the classroom, the choice of digital textbook and possibilities and challenges from their perspectives as teachers as well as their views on the student perspective. One of the interviews took place at the school, while the other interview took place at the teacher's home. Both interviews took approximately one hour. The interviews were transcribed in verbatim. In this paper, the teachers' views have been reported using fictitious names, *Sara* and *Jane*. Sara is 35 years old and has been working at the school for about one year. In her present position, she is temporarily employed at the school and teaches the subjects of English, Swedish and Swedish as a second language. Jane is 56 years old and teaches the subjects of English and Swedish at the school. She is also responsible for the subjects of English and Swedish at the school.

Approach to Data Analysis

According to Hjerm and Lindgren (2010), meanings can be coded by applying names and documenting a description of the contents. Thus, the interview transcripts were coded and categorised according to Hjerm and Lindgren's method in which the teachers' answers to the interview questions were coded using content analysis. These codes were then analysed and placed into categories of meaning. These categories were then analysed using the Ecology of Resources Model (Luckin, 2010) and the theoretical concept of filters. Through the identification and analysis of filters it is possible to alleviate filters and gain access to the resources available to a to a greater extent. In this paper, how possibilities and challenges related to the uptake and use of digital textbooks can be said to manifest filters is used for analysis and to support understanding.

Findings

In this section, the findings from the interviews are presented according to themes found within the resource elements *environment, knowledge and skills* and *tools and people*.

Environment

The findings related to the resource element Environment are presented according to the following themes: *choice of digital textbook and resources, supporting students' independent work, access to laptops in the classroom activities,* and *bridging schoolwork between school and home.*

Choice of digital textbook and resources. Sara describes a high level of freedom to choose the digital textbook to work with in her teaching activities. However, digital textbook selection is a time-consuming process: "Being new [as a teacher], to find the right digital textbook … It takes time, but at the same time I think it is fun, but I really have put a lot of time into finding good things." Sara also explains that sometimes there is a trade-off in the structure of the digital textbook and the content:

> For example, the digital textbook that I am using right now, there is also a paper-based textbook. But I think that the other textbook is better. So there is a balance between using the paper based version and the digital version together.

Sara also describes that finding Internet resources to use, as digital textbooks or in place of digital textbooks, is also time consuming due to the large amount of resources available. Jane also notes the freedom to choose textbooks: "There have never been any problems in ordering textbooks."

Supporting students' independent work. When working with students using digital textbooks to support students' independent learning, Jane expresses the need to give the students time to find their own way of working. Jane explains that she uses an older version of a digital textbook with students who have difficulties reading and writing:

> The head office laughed at me. You're still using that book… but there is an order and a structure… and it is actually order and structure that students need. It saves a lot of time, both for the students and me.

The idea of structure and order to support students' work is important according to Jane: "I have tried several versions of digital textbooks… and both the Swedish teacher and I feel that it [this book] is chaos compared to the earlier version." Sara notes that one hope she had with her work with digital textbooks was that the students would be able to work more independently. Here the challenges lie in technical aspects, for example, "What is my User Identification (ID), what should I click on now, and so on." Sara also sees large variation in student use, with some students being "very digitally competent" and other students who "hardly know how to start a computer and really don't understand" with some students changing the passwords on purpose as a way to avoid working. According to Jane, one of the challenges with digital textbooks, as well as laptops, is distraction, especially among students who lack motivation: "I have a lot of students and just can't check them all, all of the time."

Access to laptops in the classroom activities. Sara describes that the students use the laptops in the classroom, but they are not the students' own laptops as in 1:1. Here, the challenge is in accessing the laptops: "Will I be able to use the laptops during his lesson?" However, new laptops were going to be provided which would also make access to laptops at the school easier. Sara also sees possibilities in 1:1: "I don't think that it would solve all of the problems, but I think in one way, that the students would appreciate it."

Bridging schoolwork between school and home. According to Jane, many of the students enjoy working with digital textbooks. The students also enjoy being able to work with the textbooks both in the classroom and at home and do not have to carry the book with them: "They can go in to the laptop at home and log on and practice English at home." The students have the opportunity to work in a digital textbook that bridges schoolwork between the classroom and home environment.

Knowledge and Skills

The findings related to knowledge and skills are presented in two themes: *own knowledge and skills* and *students' knowledge and skills.*

Own knowledge and skills. Both teachers report having their own knowledge and skills for their teaching activities. Sara is confident in her knowledge and skills and feels quite comfortable working digitally. She does not see any challenges: "It is more about finding routines, to get into the habit. The challenges have been more resources, having enough laptops and enough time to find the right digital textbook." Sara also notes that professional development would help to use digital textbooks in a more efficient manner in which she perhaps could gain time: "Instead of taking time, I could use the time efficiently." Jane sees the need for constant professional development to help students: "There is always something new and you have to keep thinking all the time. How do I solve this right now?" Jane has taken the advantage of the students' skills: "Since, I don't know a lot myself. I need to use the students for help [laughs]." Jane also feels free to ask colleagues for help: "I am going to have Sara help me and teach me… so that I know how it works."

Students' knowledge and skills. In regard to students' knowledge and skills, both teachers in this study see the need to support students' knowledge and skills. Sara sees the importance of facilitating students' digital competence: "There are certain aspects of digitalisation that they [the students] are not familiar with… how to do a PowerPoint presentation for example." Jane also reports different levels of digital competence among students:

> They come with different levels of laptop skills. On the one hand, we have the gamers, who know how the laptops are built and they know all about the processors and the graphics adapters, they know it all, but they can't use Word.

Jane sees an opportunity for digital textbooks in motivating students: "A digital textbook can actually awaken motivation, desire and interest, which is good. They have sat in the classroom with a blank piece of paper – write. And maybe one question on the whiteboard." However, there are challenges, especially for students who have difficulties in working with digital textbooks: "But, the students who can't manage this? If you [students] can't find things and find structure in the digital textbook […] we just lose these students."

Tools and People

The findings related to tools and people are presented in two themes: *digital textbooks as tools for students with special needs* and *functional aspects of digital textbooks as tools.*

Digital textbooks as tools for students with special needs. Both teachers in this study see possibilities in using digital textbooks as tools for student with special needs. Sara notes that she has ordered digital textbooks specifically for students with special needs, for the support they provide: "In Swedish, I have ordered digital textbooks for those students who have difficulties -- both writing and reading difficulties. A lot of it is about providing speech synthesis, text to speech and things like that. Despite the tools provided through the textbooks, Sara also perceives other challenges: "I don't think that they [the digital textbooks] are really pedagogically well-structured." According to Sara, another opportunity for students incorporated into the use of digital textbooks is the use of self-correcting tasks, which provide direct feedback to the students. Jane describes a change in the overall use of digital tools: "There are students who have worked with laptops and who are somewhat digitalized. You can see that they have used tools more than just the laptop, not digital textbooks, but digital tools to help them." One example, according to Jane, is the use of text-readers: "It is easy for students to find errors."

Functional aspects of digital textbooks as tools. Sara notes a function that the digital textbooks she works with do not provide. This is the possibility for students to work directly in the textbook:

> That they can work directly in the textbook… that they don't need to have a separate document on the side, when they are reading a text in Swedish for example, reading a text and doing tasks related to the text.

Sara also notes overall difficulties in the pedagogical structure of the digital textbooks, for example being able to have an overview of the structure of the book: “You almost needed to have the paper version to understand the set-up of the book.” Sara explains that students need to be able to move back and forth in the different chapters in the book, which can be difficult at times. Jane also gives an example in which students must work in the paper-based book to be able to complete tasks on the laptop, which is a challenge. Here, Jane explains:

> This is not structured and is a disadvantage, in my view, you should be able to combine the laptop and the book if you want to read and at the same time be able to do the same thing on the laptop.

Jane notes that dyslexic students who have difficulties with structure, have even more difficulties when the book is needed to work on the laptop: “It doesn’t really work and I don’t have the time to sit and help the students, and all of the students in the class need help at the same time.” According to Jane, the students enjoy working with the older versions of the digital textbooks because they are interactive, which means that the students tend to be more active when working. Beyond the organization of the content structure in the digital textbooks, Jane also notes that a newer version of a digital textbook does not necessarily mean that the subject content is new: “The texts are not updated. The structure and the organization of the texts are good, but the texts are old.”

In summary, for Sara and Jane, the possibilities for students are found in the digital textbooks themselves, which can provide structure and digital tools for the students. Digital textbooks can help students to be active and motivated in their learning and provide access for schoolwork both at home and at school. The challenges appear to be distraction due to access to the Internet when working with digital textbooks, access to laptops in the classroom and the functional aspects of the digital textbooks.

Discussion

The possibilities and challenges as perceived by the interviewees can be analyzed using the Ecology of Resources Model (Luckin, 2010) and the theoretical concept of filters within the resource elements *environment*, *knowledge and skills* and *tools and people*. In their teaching activities it will be necessary for teachers to support the use of digital textbooks in the classroom (*environment*), promote own digital competence and students’ digital competence *(knowledge and skills*) as well as increasing their own use and students’ access and use of digital technologies and digital textbooks in their learning (*tools and people*).

In the resource element *environment*, the need for teachers to support the use of digital textbooks manifests a filter. Teachers’ capability to provide the learning activities for using the textbooks in the classroom, and the conditions for TEL will be important to support students’ use of digital textbooks in the learning environment for both teachers and students (Horsley & Martin, 2015; Kim et al., 2012). Supporting students’ learning in this classroom could also be considered to manifest a filter. In this study, teachers express challenges in supporting students’ use of the digital textbooks. How teachers can efficiently support students' individual and collaborative work will be of importance for creating conditions for TEL (Grönlund, 2014; Håkansson Lindqvist, 2015; National Agency for Education, 2016; Tallvid, 2015). In regard to the implementation of digital textbooks and other resources, time manifests a filter in several aspects. Teachers need time to implement the textbooks as digital technologies in their teaching (Ertmer & Ottenbreit-Leftwich, 2013; Vradidas, 2015). Teachers also need time to find, review and evaluate digital textbooks and other digital resources (Gulz & Haake, 2014). How teachers and schools can take on this task efficiently to advance the uptake and use of digital textbooks will be of importance for creating conditions for TEL in the classroom environment as well as in the home environment (Horsley & Martin, 2015; Voogt et al., 2013).

In the resource element *knowledge and skills*, professional development in ICT and subject-related skills for teachers are important (Grönlund, 2014; Håkansson Lindqvist, 2015; Tallvid, 2015; Vrasidas, 2015) in order for teachers to implement digital textbooks as a natural part of the digitalized classroom (Gu et al., 2015). This involves making the use of digital textbooks become a habit, according the teachers in this study. From the teachers' perspectives their knowledge with regards to working with the textbooks could be considered to manifest a filter in this resource element. Teachers need time to learn and increase their skills in working with digital textbooks and resources to support students' learning. This may take place both individually and in collaboration with other teachers, as noted by the teachers in this study. For teachers, the students' ICT skills could also be said to manifest a filter in this resource element. If the students are to increase their knowledge through the use of digital textbooks, they must have the ICT skills to manage the digital textbooks in practice (Voogt et al., 2013). Basic ICT skills are needed, as noted by both teachers, for being able to work and learn independently. The large variation in students' digital competence, as reported by both teachers in this study, can also be said to manifest a filter in this resource element (Håkansson Lindqvist, 2015; Tallvid, 2015). For teachers, supporting students' ICT skills and digital competence as well as introducing subject content knowledge may at times be a difficult balance.

Increasing teachers' own uptake and use of digital textbooks and providing possibilities to increase students' uptake and use of digital textbooks in school activities in the classroom could be considered to manifest filters in the resource element *tools and people*. Here, the technical challenge of not having enough laptops, or access to laptops, can be considered to manifest a filter in this resource element. Access to laptops is a basic condition for supporting TEL through the use of digital technologies (cf. Voogt et al., 2013). In addition, students' use of a laptop for non-school activities on the Internet when using digital textbooks manifests a filter in the resource element *tools and people.* Here, the motivation and desire which digital textbooks may inspire, according to the teachers in this study, will perhaps lessen the risk of distraction and help students to focus on their schoolwork and take advantage of the possibilities for learning (cf. Gu et al., 2015; Joo et al., 2017; Millar & Schrier, 2015; Weisberg, 2011).

One of the most interesting findings in this study is the perception of the amount of time required to review digital textbooks and select textbooks that are specifically suited to individual students in order to support students' learning. Despite having to perform several demanding tasks and a lack of time, both teachers in this study prioritise this review and selection work in order to support their students and strengthen the use of the digital textbook (cf. Gu et al., 2015). This may involve using an older version of a digital textbook with more organized learning content or it may involve other digital resources as an alternative digital textbook. It also includes reviewing a large number of digital textbooks, as well as other digital resources. Thus, for teachers, this work could also be considered to be a filter in this resource element. The findings highlight that teachers need technical and pedagogical support in the use of digital learning tools, including digital textbooks. This would help ensure that the most appropriate digital textbooks are selected in support of students' learning, and that the conditions for TEL are met (cf. Gu et al., 2015).

Implications for Practice and Future Research

The findings of this small preliminary study are of interest, as they show teachers' interest and initiative in the uptake and use of digital textbooks as well as alternative digital materials as resources in their teaching. Here, the teachers prioritize this time-consuming task in order to support students' learning in the digitalized classroom. How schools as organizations can support teachers' activities, both individually and collaboratively, to both make the work with digital textbooks more efficient is an important question for future research. Further how beneficial conditions for TEL can be created in the classroom to support students' learning with digitalized textbooks is of importance to study.

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THE CONFLICT BETWEEN EVOLVING TECHNOLOGY AND THE DIGITAL DIVIDE

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Abstract

The digital divide in higher education concerns digital literacy in addition to access to the Internet and digital devices. Higher education institutions often assume basic levels of digital literacy and access to high-end mobile devices, which creates conflict for lecturers that are expected to teach with technology. The challenge is in incorporating learning technologies that can bridge the digital divide. A preliminary review of the literature published in the last five years investigated teaching with technology and the realities of the digital divide. Classroom Response Systems (CRS) and videos were identified as potential candidates for implementation in resource deprived institutions.

Introduction

The exponential growth of knowledge and the rapid development of new, digital technologies are resulting in changes in the workplace, and consequently in higher education (Binkley et al., 2012). These fast-paced changes lead to inequalities in terms of access to technology and the Internet as well as inadequate skills to utilise technology, this phenomenon is referred to as the digital divide (Bornman, 2016). The evolving information society and technology create, and further enhance, these digital inequalities and exclusions (Robinson et al., 2015). Due to poverty and underdevelopment, Africa provides an example of an underdeveloped region. However, South Africa is regarded as one of the most developed countries in Africa in terms of Information and Communication Technologies (ICT) infrastructure (Bornman, 2016).

The nature of the information society of the 21st century means that individuals are required to adapt to rapid technological changes. It is therefore important that engagement with ICT must be improved across the entire spectrum of learners within higher education (Bornman, 2016), including those from both resource deprived and resource rich institutions. Higher education institutions need to be cognisant of these challenges when teaching students in the 21st century. In order to adapt to these demands and improve academic performance higher education institutions need to address (at least) the use of learning technologies which enhance the following:

- Development students' expert knowledge;
- Development of generic competencies for the 21st century; and
- Development of students' abilities to reflect on learning (Kong & Song, 2015)

The majority of students in the ICT Faculty at the Tshwane University of Technology come from rural (African) environments, where they received poor quality education (Spaull, 2013; Spaull & Kotze, 2015). In an effort to improve academic performance, the University's management promotes a blended learning approach by encouraging lecturers to augment classroom practices with technology (Jeffrey, Milne, Suddaby, & Higgins, 2014). However, the adoption of appropriate technology in teaching is delayed by infrastructure limitations which contribute to the digital divide.

The question addressed in the present paper is: *How can the perceived conflict between the use of technology and the digital divide be addressed?* This paper explores the conflict that arises, as exemplified within the South African context, when the use of technology in higher education learning environments is hampered by the lack of technological resources and skills.

Methodology

A preliminary literature review, which forms part of a larger study by the researcher, was done. Keywords such as digital divide, digital inequalities in South Africa, mobile learning, e-learning, blended learning, use of technology, benefits of technology and 21st century skills were used to search for relevant articles. Journal articles were retrieved from several academic databases via the library portals of the Tshwane University of Technology as well as the University of Pretoria. Articles were sourced, in the date range 2012 to 2018 to make provision for the rapidly advancing nature of technology. The articles were reviewed to explore and identify the key issues that might be relevant to the South African digital divide as well as the use of technology in different education environments, including resource-deprived and resource-rich institutions. After identifying key issues related to the conflict, possible, technological solutions are discussed that could address the digital divide preventing further disadvantages.

Aims and Objectives

The focus of the present paper is on identifying candidate ICT, which may be implemented for teaching and learning within resource deprived higher education institutions in order to help address the digital divide.

Preliminary Literature Review

The following sections summarise the key observations from the preliminary literature review.

The Digital Divide

ICTs and the prevalence of digital devices are spreading rapidly at an uneven pace (Rath, 2016, p. 75). Robinson et al. (2015) highlight the role of digital engagement in the workplace, in education as well in the health services. Robinson et al. argue the digital divide results from the following:

- The gap between users and developers in a technologically advanced economy.
- Inequalities resulting from a lack of technology engagement or digital skills that can hamper the efficient use of technology.

Robinson et al. (2015) also discuss the effects of life course, gender, race, economic status and health on the digital divide. They argue that the ability to efficiently handle the flow of information is only to the advantage of certain individuals, which in itself creates more inequality. Nyahodza and Higgs (2017) emphasise the fact that imbalances are caused by the socio-economic status of students in higher education, specifically referring to the levels of poverty in South Africa. In agreement with Robinson et al. and Nyahodza and Higgs (2017), Bornman (2016) points out that the digital divide is more than the lack of access to the Internet (infrastructure) and technology, her research also refers to the effects of gender, population group and educational levels on the digital divide.

Higher education institutions should utilise and apply new technologies in training to prepare students for technologically rich work environments. However, the reality is that digital inequalities exist on higher education campuses worldwide, and this needs to be addressed without creating more inequalities in terms of students' technological development and preparedness for the workplace (Binkley et al., 2012; Ricoy, Feliz, & Couto, 2013).

The Use of Technology in Higher Education

In a higher education environment, improving academic performance and student engagement have always been key objectives. Efforts to implement technology in meeting these objectives are well documented (Adedokun-Shittu & Shittu, 2015) and some of these technologies are:

- The Internet is part of the infrastructure that enables the use of technology (Sampath Kumar & Manjunath, 2013).
- Classroom response systems (Dunn, Richardson, Oprescu, & McDonald, 2013; Wong, 2016).
- Mobile phones and Tablets (Gan, Li & Liu, 2017; Hanbidge, Mackenzie, Sanderson, Scholz, & Tin, 2017; Hatun Ataş & Delialioğlu, 2018).
- Social media, i.e., Facebook and WhatsApp (Chiroma et al., 2017; Gachago, Strydom, Hanekom, Simons, & Walters, 2015).
- Videos (de Araujo, Otten, & Birisci, 2017; Long, Logan, & Waugh, 2016).
- Learning Management Systems (Wichadee, 2015; Zanjani, Edwards, Nykvist, & Geva, 2017).

It is clear from the technologies listed above that students are no longer restricted to traditional (printed) study material to help improve their academic performance (Sampath Kumar & Manjunath, 2013). The above listed technologies, individually and in combinations, could be used to create opportunities for students and lecturers to improve learning and student engagement. It is worth mentioning that the majority of the above, and many other, technologies are dependent on internet access (Sampath Kumar & Manjunath, 2013).

The Internet

New technology and improved broadband can be utilised to support education systems and the distribution of knowledge, widening the access to information to improve quality of teaching and learning (Broadband Commission, 2016). According to the International Telecommunication Union (ITU), in 2016 approximately 53% of South African households had access to Internet and 54% of South Africans used the Internet (Broadband Commission, 2016). In a local South African context, the General Household Survey of 2016 (Stats SA, 2018) indicate that only 9.5% South African households have Internet (at home). However 53.9% of households have access to the Internet via mobile devices (see Figure 1). The availability of mobile devices is empowering more people to access the Internet, but the digital divide is still evident, especially in rural South Africa.

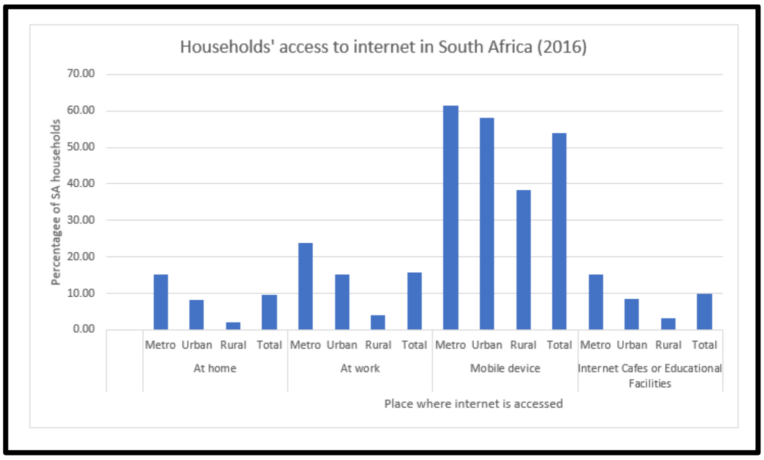


Figure 1. Households' access to the Internet by place of access and geo-type in South Africa, 2016 (Adapted from Stats SA, 2018, p. 51).

Higher education institutions in South Africa provide internet access to students in computer laboratories as well as Wi-Fi hotspots on campuses. Many universities in South Africa do not assume that students own smart phones, tablets or laptops and have access to Internet where they live (off-campus). Enforcing compulsory devices and internet access could contribute to the digital divide. At TUT a policy of supplying devices to students is being considered. The main concerns that were mentioned by stakeholders, staff and students are the determination of minimum requirements, cost (devices and mobile broadband) and security-threats. The challenge is to find a means of providing access to study materials and resources on campus and off-campus, that not only can improve student engagement and academic performance but also not impact the students and the institution financially.

In an effort to incorporate technology in the classroom, the review was focused on identifying technologies that could improve student engagement with mathematics specifically. Only two of these technologies are discussed in this paper, namely Classroom Response Systems (CRS) for formative assessment, and the use of videos to augment printed study material.

Classroom Response Systems (CRS)

Students must engage in their own learning to improve their academic performance, and success and the role of the lecturer is to motivate students and create an environment that stimulates learning (Dunn et al., 2013). Ivala and Kioko (2013) state that students who engage with their course work are motivated and interested in their studies. Lecturers could use rapid, formative feedback to embed assessment in the teaching and learning process to foster engagement. However, regular assessments in large classes impact the lecturers' workload considerably, and one of the solutions is the use of Classroom Response Systems (CRS) (Dunn et al., 2013). One of the most well-known, and popular solutions is Clickers™ (https://www.cmu.edu/teaching/clickers/; https://www.sun.ac.za/english/faculty/healthsciences/chpe/ultresources/clickers-audio-response-systems). Clickers™ are portable electronic devices that are used for polling and formative assessment and make use of radio-frequency or infrared technology to transmit and record student response during a lecture, typically in the format of multiple choice questions (Buil, Catalán, & Martínez, 2016; Dunn et al., 2013). The disadvantage of Clickers™ is the cost to the institution or the students, thus further contributing to the digital divide.

Several online, free, web-based CRSs are available; however, they require internet access and devices for each student in the class. Currently there is no internet access in lecture venues (at TUT), only in the computer laboratories. A few of the free, online CRSs are:

- Kahoot (www.kahoot.com)
- Quizizz (www.quizizz.com)
- Poll Everywhere (www.polleverywhere.com)
- Mentimeter (www.mentimeter.com)

In the search for a free, mobile application for formative assessment that does not require students to have internet access during lectures, Plickers™ was discovered.

Plickers™

"Plickers™ is a powerfully simple tool that lets teachers collect real-time formative assessment data without the need for student devices" (www.plickers.com). The mobile application is available for Android and iOS, the lecturer is the only one in the class that needs the application on his/her device. Plickers™ can be used for various activities, for example:

- Attendance
- Polling
- Formative Assessment

To use Plickers™, the lecturer creates an online account, which is password-protected, meaning access to marks and names of students is protected. The Plickers™ are used as an assessment tool that is especially valuable for formative assessment during contact sessions (Krause, O'Neil, & Dauenhauer, 2017, p. 34). After downloading and installing the application on his/her mobile device, the lecturer can compile multiple choice or True/False questions on the online platform. The lecturer creates a class by assigning numbers to students and each student receives a unique QR™ code on a sheet of paper. Each QR™[1] code has a number and four sides marked A, B, C and D (see Figure 2).

During a class, the lecturer can project a question on the screen, and students are given time to provide the answer. When the lecturer prompts the students, the students respond by holding up their barcodes with their choice of answer at the top (turning the paper until the correct answer is in the top position). The lecturer then takes a picture of each row of students in order to scan the answers and the application on the mobile device records the answers. In doing so, the lecturer can immediately determine whether the class understands the concepts that were assessed. Records of individual students are captured and saved, and reports (.CSV files) can be exported to spreadsheets for grading purposes if needed.

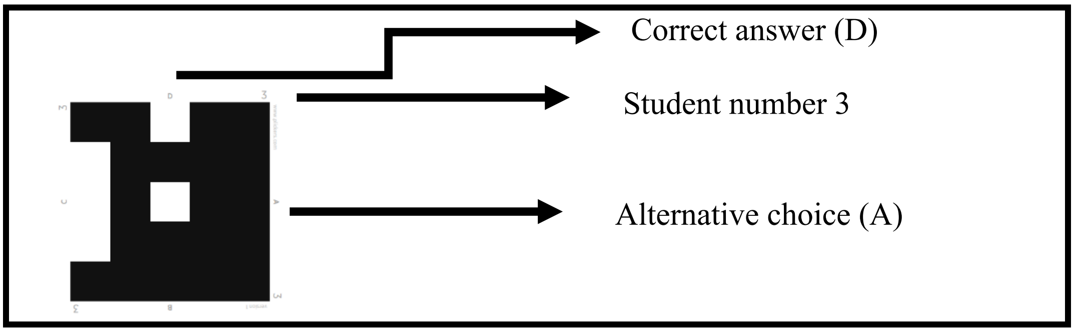


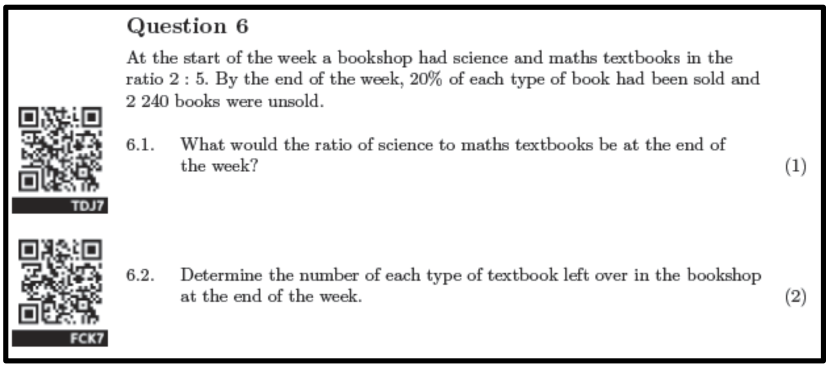
Figure 2: Plickers™ card example (www.plickers.com).

The use of Plickers™ is not limited to a specific location or venue, the only technological requirement is that the lecturer must have a mobile device that can connect to the Internet. Plickers™ therefore enables lecturers to utilise technology, encourage students to engage and do formative assessment without increasing the digital divide.

Videos in the Classroom and Beyond
Online videos have become popular, and numerous videos are accessed online on a daily basis, especially with the popularity and availability of mobile devices (de Araujo, Otten, & Birisci, 2017; Li, Liu, & Ouyang, 2016; Long et al., 2016). On YouTube alone, 300 hours of videos are uploaded every minute and 60% of people prefer these online video platforms to live TV channels (https://fortunelords.com/youtube-statistics/). Statistics indicate that more than 50% of YouTube views come from mobile devices (https://fortunelords.com/youtube-statistics/) which is attributed to the popularity of mobile devices: approximately 2.4 million mobile devices are sold per day (http://www.worldometers.info/). In a study done in South Africa, it was found that 84 % of undergraduate students had mobile devices in 2014 (Potgieter, 2015). The popularity of online videos and the availability of educational videos online have profound possibilities for teaching and learning environments. However, the challenge is once again to overcome the digital divide when utilising online videos in teaching and learning.

At TUT, for example the majority of students come from underprivileged environments, and, due to the cost of mobile data being quite high in South Africa, this further contributes to the digital divide. Although the students are comfortable with watching videos on their mobile devices (Hulsizer, 2016), making use of online videos to augment classroom teaching in mathematics at TUT has proven to be unsuccessful. This is due to the fact that students indicated that they cannot afford access to the Internet when they are not on the campus.

A local, South African solution called "Paper Video" has the potential to improve student engagement with mathematics content and to improve academic success in mathematics (www.papervideo.co.za). Paper Video is a set of mathematics videos based on examination questions for grades 8 to 12. Each question has a unique QR™ code and a 4-digit code which is linked to a video explanation of the solution (see Figure 3). The explanations are presented by a teacher with extensive experience and in a local accent and context. Each student receives a USB adaptor with a microSD card on which all the material is available; they only need to access the internet once to register their material. They insert the microSD card in their mobile devices, install the application and start watching the relevant videos. Students can also access the videos on a laptop or PC by using the USB adaptor. Students' mobile devices can now be turned into a teacher that can be accessed anywhere, anytime, without the need for internet access. However, the videos can also be accessed online where students have access to the Internet (https://papervideo.co.za/).


Question 6

At the start of the week a bookshop had science and maths textbooks in the ratio 2 : 5. By the end of the week, 20% of each type of book had been sold and 2 240 books were unsold.

TDJ7 6.1. What would the ratio of science to maths textbooks be at the end of the week? (1)

FCK7 6.2. Determine the number of each type of textbook left over in the bookshop at the end of the week. (2)

Figure 3. Paper video example.

The mathematics skills that the students need are addressed by the material of the grades 8 to 12 Paper Video Exam Papers. This range of Paper Videos, addresses the gap between school and university. The lecturer has access to an online dashboard to monitor the use of the resources.

In addition to making use of this technology and the microSD card, lecturers can also record their own videos and distribute them to students without the need for mobile data. Students can download them in the computer laboratories and watch them on their mobile devices anywhere and anytime, once again addressing digital inequality with technology, without widening the divide.

Conclusion

The digital divide is a reality in higher education which leads to inequalities caused by the pace at which technology evolve. Without disadvantaging students further, the digital divide can be addressed, even by making use of technology. There is a variety of offline mobile applications available to lecturers and students, many of which are free. Lecturers should explore mobile applications and online solutions that could improve students' engagement and academic performance without disadvantaging them technologically. The literature review conducted suggests both CRS and paper video technologies have the potential to enhance teaching and learning in mathematics without requiring internet access and specific devices. A pilot study to evaluate the efficacy of Paper Video in promoting blended learning is currently underway at TUT. The results of the pilot study will be used to inform decisions regarding its future implementation within the classroom.

Note

1. A QR™ code is a machine-readable code consisting of an array of black and white squares, typically used for storing URLs or other information for reading by the camera on a smartphone.

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ICT AND DIGITAL DIVIDES

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Abstract

The purpose of this paper is to gain knowledge about what constitutes digital divides and digital inequality and how these relate to social background, marks and digital competence in upper secondary school, as well as what implications this may have for learning management in a digital learning environment. The study is based on data from 17,529 upper secondary school pupils and has a mixed method design. Findings from this study show that there is a clear connection between social background and the marks students earn. Furthermore, the study shows that there is a clear connection between social background and students' digital competence. The findings from the study will have implications for teachers' class management and digital competence in a digital learning environment in upper secondary school.

Keywords: Digital divides, digital inequality, digital competence, class management; ICT

Introduction

During recent years, digital competence has held a central position in a number of policy documents. In schools, it has become the fifth basic competence (L06). At the same time, upper secondary schools in Norway have a world-class technology park (1:1); pupils have their own mobile telephones, and they have high screen time – 36.9 per cent have over eight hours screen time per day (Krumsvik, Egelandsdal, Sarastuen, Jones, & Eikeland, 2013). All this makes for students who are well versed in the technology, and internationally these students are normally known as the Net Generation (Tapscott, 1998), Millennials (Howe & Strauss, 2000) and Digital Natives (Prensky, 2001a; 2001b). Thus, the stage is set to accommodate ample computer use in today's schools, and the earlier differentiation in terms of access to technology appears therefore to be much less today than previously – both nationally and internationally (OECD, 2015). Nevertheless, are there other types of digital divides or digital inequality between students and groups of students in the current digitalized school day? Moreover, how does the teacher's class management and digital competence relate to this topic? These are the questions that this paper seeks to answer.

The SMIL (Sammenhengen Mellom IKT og Læringsutbytte[1] study is one of the largest ICT-studies ever performed in Norwegian upper secondary schools and has encompassed 17,529 pupils and 2,524 teachers in seven counties in eastern Norway (Krumsvik et al., 2013). The Norwegian Association of Local and Regional Authorities (KS), the University of Bergen (UiB) and the Eastern Norwegian County Network (ØS) have initiated the study, and the research group Digital Learning Communities at UiB has been responsible for the research part. One backdrop for this paper is a wish to ascertain from the SMIL study whether there is a connection between parents' educational level and the pupils' mark average in lower secondary school, and how this relates more specifically to pupil's digital competence in the school. Do we find a digital "Matthew effect" here (Merton, 1973)? Or not? We know from the USA, for example, that Information and Communication Technology (ICT) implementation in school resulted in "…the creation of a technological underclass in American public schools" (Cuban & Tyack, 1998, p. 125) that followed traditional socioeconomic differentiation. Moreover, already 15 years ago, the Organisation for Economic Co-operation and Development (OECD) in its study, *Understanding the Digital Divide* (2001), warned of the risk of "falling through the Net" as particularly damaging to already vulnerable social strata and groups of students. Castells (2001) also claimed that if measures were not taken, ICT and the use of Internet would reinforce the already existent social differentiation linked with social class, education and ethnicity. In Norway, Frønes (2001) found tendencies toward digital divides between minority and majority pupils, and Nævdal's (2004) study showed tendencies toward digital differentiation between boys and girls in school in the ways they used their PCs and how this impacted their academic performance. Torgersen (2004) also found gaps between minority and majority pupils' access to and usage of PCs and found that this also had a certain relevance in terms of academic achievement. In the most recent study by The Programme for International Student Assessment (PISA), another phenomenon – digital inequality – is cited as a factor that increasingly more researchers are becoming aware of (OECD, 2015). Nevertheless, little is known about what constitutes digital inequality in Norway – and particularly about how this is reflected in the upper secondary schools.

Steffensen, Ekren, Zachrisen, and Kirkebøen (2017, p. 44, our translation) divide school results in the following manner; *pupils' background* (socioeconomic characteristics and past achievements), *contributions of schooling* (teachers, teaching materials, and classroom environment) and *coincidences* (variations in pupils' (actual) presumptions; pupils who have a bad day at a test/exam; noisy builders on the day of the test/exam, and random drills of a topic that the pupils will be tested on in a test/exam) that are necessary to examine.

In this paper, the pupils' background and contributions of schooling are of most relevance. Steffensen et al. (2017, p. 10, our translation) affirm that the contributions of schooling "can be interpreted as the grade point average or average result that we can expect that a school would have had if pupils at the school were average with regards to the characteristics of the pupils that are included in the calculations". We can observe that teachers, teaching materials and classroom environment are central factors in the contribution of schooling. These three factors are central in the teacher's classroom-management, and Marzano, Marzano and Pickering (2003) and Hattie (2009) point out in their findings that classroom-management has a positive effect on pupils' learning (d=0.52). In addition, Koedel, Parson Pdgursy and Ehlert (2015) show that teachers are not a homogenous group, and they find great variations between the contributions of individual teachers on pupils' learning (and where classroom-management makes out the actual core in this landscape). Furthermore, Chetty, Friedman and Rockoff (2014) have investigated the effect of teachers changing schools, and the study confirms the importance of teachers' contributions on pupils' learning. It is evident that the contributions of schooling are significant for pupils' success in school. In their report, Steffensen et al. (2017) note:

> The schools and the municipalities with the highest contributions manage to raise all the groups of pupils: they improve both pupils with and without parents with higher education, pupils with and without an immigrant background, and pupils with and without previous lower achievements. (p. 96, our translation)

Implicitly with these findings there are also great variations between the schools, and Steffensen et al. (2017) further argue that "[…] it seems that attending one of the schools that contributes the most over attending one of the other schools that contributes the least, is equivalent to one years' worth of learning progression for the pupils at the school" (p. 96). A comprehensive study from the United States shows the same tendencies: "[…] the most effective teachers generate learning in their students at four times the rate of the least effective teachers" (Wiliam, 2011, pp. 534-535). In the next part, we will take a closer look at social background and the contributions of schooling in a more digital learning context.

The fact that young people use ICT very frequently in their digital lifestyle is a well-known fact, but there is a need for research on academically oriented use of ICT (Litt, 2013). Different digital skills have also been associated with digital differentiation (Buckingham, 2006; van Dijk, 2008). The study of Büchi, Just, and Latzer (2015) revealed that research in the area demonstrates digital divides both within and between countries. In their own study, they found that digital divides in five different countries have changed from lack of access to technology (first-order) to different usage (second or third-level digital divide). Based on this backdrop, the main objective of this study is to gain knowledge about what constitutes digital divides and digital inequality, and how this relates to social background, marks and pupils' digital competence in upper secondary school. Moreover, what implications does this entail for teachers' digital competence and their class management in a digital learning environment.

The research questions are:

- Is there a connection between pupils' social background, marks and digital competence in upper secondary school and how do the school leaders and teachers perceive this relationship?
- Is there a connection between pupils' digital competence and digital patterns of usage, and how do the school leader and teachers perceive this relationship?

- What pedagogical implications for teachers' class management and digital competence in the digital environment does this study offer?

Digital Divides and Digital Inequality

Digital divides can be described as an expression intended to capture the manner in which digitization of society and the education system can create unintended side effects for various pupils and groups of pupils. This is often termed the digital gap, digital inequality, digital illiteracy, etc. Hargittai (2003, p. 2) defines the *digital divide* as "the gap between those who have access to digital technologies and those who do not; or the gap between those who use digital technologies and those who do not understood in binary terms distinguishing the 'haves' from the 'have-nots.'" Previously, access to technology was important in the overall picture, but it is the international consensus today that access alone is no longer a reliable indicator that permits assessment of digital divides or digital inequality (Dolan, 2016). This is due to the fact that access to computers has been significantly improved both inside and outside the schools in a global sense, along with the strong growth and spread of mobile telephony during the past five years (OECD, 2015). Hargittai (2003) has also seen that this development has changed a number of underlying premises for digital divides and has therefore revised his definition to take this development into account and to coin a more precise expression – digital inequality, "that emphasizes a spectrum of inequality across segments of the population depending on differences along several dimensions of technology access and use" (p. 2).

Krumsvik (2008) discussed some of these implications in his article. He posits several prospective digital divides and digital inequalities, all of which require more research-based knowledge. We need more knowledge about relevant phenomena, and about how digital divides and digital inequality manifest themselves in terms of how pupils master learning objectives, the courses, tests and exams in a digitized academic setting. For example, Wolfe, Bolton, Feltovich and Niday (1996), Russell (1999, 2002), and Horkay, Bennett, Allen, Kaplan and Yan (2006) detected clear performance-related differentiations between taking exams using pen and paper versus taking them on a computer, and they found that the digital divide and the pupils' digital competence played a clear role in achievement. Manger, Vold and Eikeland (2009) found in their study that the national test in English for 5^{th} grade-level pupils measured primarily the pupils' digital competence and to a lesser degree their knowledge of English. Perhaps the most sensational finding was the results of the most recent PISA test (OECD, 2015) in mathematics, which revealed that when Shanghai pupils took the same PISA test on a computer, the results fell by 50 PISA test points (which corresponds to approximately one year of schooling) in contrast to when they took a paper-based version of the test (Jerrim, 2016). Pupils from the USA, however, scored 17 PISA test points better on a computer than on paper; Norway scored 8 PISA points higher on the digital version, and in Sweden (12 PTP) and Russia (7 PTP) boys did considerably better than girls in mathematics, despite no gender-related differences between these groups on the paper-based test. It is also interesting to note that there were fewer socioeconomic differences across countries on the computer-based PISA test than there were on the paper-based test.

From these studies, one can discern the outlines of a feature in which digital differentiation, digital inequality and digital competence appear to come into play, but at the same time, we must be wary of singling out a sole factor as an explanation in this complex area. Nevertheless, we must not exclude the fact that pupils' digital competence and digital inequality come into play when the pupils take quizzes, tests and examinations on their computers rather than using pen and paper. Dolan (2016) mentions that "just as the term 'digital natives' has become a defining feature of the Millennial generation, we are beginning to determine through research that these same tech-savvy students may lack specific online skills when evaluating text or performing other academic tasks" (p. 31). Therefore, it is important to acquire more empirical knowledge about what Dolan (2016) addresses: "Instead of a divide defined simply by the difference between the "haves" and the "have-nots", we might now define it as a divide between the "cans" and the "cannots"" (p. 31).

Does the SMIL study (Krumsvik et al., 2013) reveal that schools still reproduce various social inequalities with respect to social background and academic marks, and does this have an impact in terms of the field of digital competence in the schools? New international digital currents such as these need to be investigated more closely here at home – empirically, of course, but also theoretically. Because, as Dolan (2016) expresses it:

> The research reflects the actual use of technology is heavily influenced by the socioeconomic status of both the individual and the school they attend. This achievement gap has often been referred to as an "opportunity gap," defined as a difference in either economic or academic resources available to students. The integration and use of technology in schools are following this same pattern. (p. 32)

DeBell and Chapman (2006) find the same tendencies as Dolan (2016) found in his study. Goodwin (2011), Schnellert and Keengwe (2012), Downes and Bishop (2015), Thomas (2007, 2008), Wenglinsky (2005), and Wiburg (2003) find in their studies that teachers' (and schools') ability to integrate and use technology in a teaching situation directly or indirectly also reflects the very conception of why digital divides occur. With this as a backdrop, more in-depth knowledge is needed about whether the situation is the same in Norway and about what constitutes digital divides/digital inequality and how these relate to pupils' social background, marks and digital competence.

Theoretical Perspective

It is very solidly documented that students' social background is highly influential on their performance in school and for their acquisition of cultural capital (Aschaffenburg & Maas, 1997). In Norway, it has been shown that pupils' social background strongly influences academic performance in general (Bakken, 2014). What, then, about ICT and digital learning methods in this perspective? In a newly published review of literature pertaining to ICT use and digital differentiation, one international finding is that:

"Socioeconomic status appears to be one factor that is common across all findings, from the availability of technology to students to the ways in which students use the available technology in and outside of schools" (Dolan, 2016, p. 27). It is difficult to explain why this occurs based on any single theory, but some "theoretical lenses" seem to be of special relevance in this context. Boudon's (1974) theory of values emphasizes that school and education have different values in the working class and in the middle class. Goldthorpe (2000) takes a similar approach and underlines that educated parents know more about the educational system and value it much more highly than do less educated parents. Hernes (1974) emphasizes that parents from higher social strata are far more active in stimulating the same basic skills that school emphasizes already before young people start school. Furthermore, Bernstein (1975) is also concerned with language development as a premise in this new environment and finds that lingual socialization occurs differently in different social strata. Lareau (2000) maintains that the working-class parents delegate learning to the schools, are less familiar with the curriculum and the content of courses and in general take a more distanced stance to the school than those of middle-class parents. Bourdieu (1977) claims that this issue is linked with cultural capital and that the middle class's children will normally be socialized into developing for themselves a cultural capital that schoolteachers value.

These "theoretical lenses" mentioned above make a backdrop for being able to understand mechanisms and different "explanatory models" for how social background influences pupil performance in school. One might ask, nevertheless, whether these will have sufficient "explanatory power" in a digitized education system? Bakken (2014) says that the pupils' opportunity to use his/her digital skills is one of several factors that influence the pupils' learning environment in school, but we still lack empirical evidence in terms of how this contributes more directly to pupils' achievement. One might also ask whether or not digital divides and digital inequality have both similarities and dissimilarities in terms of the more established theoretical approaches to understanding this complex field. In accordance with the more "digitally theoretical" approaches to the field, the international view is the widespread notion that research on the digital gap and digital inequality has to confront particularly theoretical challenges. Thus, Leu et al. (2015) ask: "How can adequate theory be developed when the object that we seek to study is itself ephemeral, continuously being redefined by a changing context?" (p. 2). The extremely rapid technological development thereby presents special challenges when the research subject is in many ways a "moving target" in an era when today's digital technology quickly becomes "yesterday's technology" and thus creates obstacles to defining the field in consistent terms. At the same time, it is clear that by introducing the aforementioned "theoretical lenses," we bring Attewell's (2001) distinction of the first and second digital gap closer to reality. Attewell (2001) suggests that whereas one could speak of a digital divide as a more or less unambiguous term linked with access to technology, the term alone is no longer sufficient to describe reality. Attewell (2001) maintains that *access* to technology is an indicator that can no longer be evaluated in isolation – it must be seen in relation to patterns of usage, and we thereby move on to the second digital divide. Hargittai (2003) has a similar distinction in which the digital divide represents technological access; whereas digital inequality represents the way technology is used, for example in academic contexts. Both Attewell (2001) and Hargittai (2003) point out that when it comes to the second digital divide and digital inequality, several tendencies point towards this being linked with social background. However, since the area can still be characterized as a “moving target,” there remains a paucity of grand-scale studies that can document this type of connection. Castells’ (2001) perspective on the emergence of the network society and its side effects in relation to vulnerable groups also points in the direction of social background being the deciding factor in how individuals master technology both in education and in working life. North, Snyder and Bulfin (2008) build on Bourdieu’s (1977) terms *habitus* and *taste* and argue that digital preferences among young people are influenced by distinctive features such as class, which is something more than merely socio-economic status. To gain a deeper understanding of what this pattern of usage is, a digital competence model by Krumsvik (2014) was used in the SMIL study. It was specially developed with the Norwegian school context in mind, as well as teacher training, and it is thus particularly suited to use with the data that the study encompasses.

In summary, one might conclude that the “theoretical lenses” mentioned above are an underpinning for the research questions in this study. Below, we will examine more closely the methodology in the study.

Method

Since this is a study that applies mixed method research, the research issues and research questions below were developed based on Tashakkori and Creswell’s (2007) guidelines for mixed methods-issues, and process and variance theory questions are given equal weight (Van de Ven, 2007). Survey data among 17, 529 pupils in seven counties have been collected to answer the quantitative part of the research questions and thirty (30) individual semi-structured interviews and 10 observations (2 hours each) in the subjects Mathematics, English and Norwegian over an 8 week period comprise the main sources for answering the qualitative research question in the study. Choosing this type of design implies a linking of the different qualitative and quantitative element in both the design and in the analyses, so that they will supplement one another and provide a more holistic idea of the research area.

We have chosen to relate this design to an “explorative, sequentially mixed-methods design” (Creswell & Clark, 2011; Fetters, Curry, & Creswell, 2013). The *sequential design* means that the different phases build on each other and “in an exploratory sequential design, the researcher first collects and analyzes qualitative data, and these findings inform subsequent quantitative data collection” (Fetters et al., 2013, p. 2137). This implies a form of integration through *building* (Fetters et al., 2013), which in this study means that the results from the qualitative interviews generated items for inclusion in the survey. Further, we carried out an integrating through *narrative* where both qualitative and quantitative results are reported in the same article in different sections through *contiguous* (Fetters et al., 2013). The coherence between the quantitative and qualitative findings is mainly based on *confirmation* and partly on *expansion* in this article (Fetters et al., 2013).

To create theoretical and empirical robustness for the research questions, the theoretical supports are linked with digital competence (Krumsvik, 2014), digital divides (Attewell, 2001), digital inequality (Castells, 2001; Hargittai, 2003) and education and social background (Bourdieu, 1977; Hernes, 1974).

Results

In this section, we will present the quantitative and the qualitative results.

Quantitative Results

Table 1

Mark Distribution from Lower Secondary School in Relation to Mother's Highest Completed Education. Per Cent.

	Mother's Education				
Mark Average	Primary school	Upper secondary – vocational	Upper secondary - general	Univ. – short	Univ. – long
2 to 3	13.9	8.1	6.6	2.9	2.8
3 to 4	41.4	35.5	33.9	20.7	17.3
4 to 5	35.6	43.9	44.6	51.8	48.8
5 to 6	9.2	12.4	14.8	24.5	31.0
(N)=100 %	(2,162)	(3,552)	(2,861)	(5,134)	(3,615)

Note: χ^2=1 529.0, p<.000; gamma correlation=0.33.

Table 1 shows how upper secondary schools pupils' former marks from lower secondary school correlate with mother's highest completed education level. Fewer than one out of ten pupils (9.2 per cent) have obtained the highest marks when mother highest completed education is primary level. However, almost one out of three pupils have top-level marks from primary school when mother has a high university degree. At the other end of the scale, only 2.8 per cent of the pupils having mothers with high university degree got the lowest marks, while 13.9 per cent with mothers having only the lowest level of education got the lowest marks. The gamma coefficient indicates that the overall rank correlation between mother's education background and pupils' success in school, when it comes to marks, is moderate. (Using mother's or father's education level in this matter produced equal results; hence, this is not shown separately here.) The next question is, however, if we will see the same distribution pattern when the parents' highest completed education levels are different. Table 2 shows this.

Table 2

Distribution of Marks from Lower Secondary School According to Their Parents' Highest Completed Education, Where Education/Degree Levels Are Different. Per Cent.

Mark Average	Father's or Mother's Highest Completed Education, Different Levels			
	Upper secondary - vocational	Upper secondary – general	Univ. – short	Univ. – long
2 to 3	12.3	8.1	4.4	3.5
3 to 4	42.6	37.3	26.1	21.2
4 to 5	35.9	42.7	51.2	49.4
5 to 6	9.2	12.0	18.2	25.9
(N)=100 %	(959)	(1,810)	(3,037)	(3,597)

Note: χ^2=559.0, p<.000; gamma correlation=0.29.

The gamma coefficient now indicates a slightly lower correlation when the parents' education levels are different. However, the pattern we saw from Table 1 is more or less the same. One out of four pupils (25.9 per cent) with one parent having a high degree from university obtained the highest mark level from lower secondary school, while this goes for only 9.2 per of those with a parent having vocational school as highest. To analyse this further, we need to see what happens to pupils' mark distribution when both parents have the same level of highest completed education. Table 3 gives us the answer.

Table 3

Distribution of Marks from Lower Secondary School According to Their Parents' Highest Completed Education, Where Both Have the Same Education/Degree Level. Per Cent.

Mark Average	Father's and Mother's Highest Completed Education, Equal Levels				
	Primary school	Upper secondary – vocational	Upper secondary - general	Univ. – short	Univ. – long
2 to 3	17.8	8.7	8.2	1.9	1.9
3 to 4	45.1	38.1	36.3	19.3	12.6
4 to 5	31.7	42.1	43.4	52.2	49.2
5 to 6	5.3	11.1	12.0	26.6	36.3
(N)=100 %	(1,031)	(1,996)	(864)	(1,903)	(2,107)

Note: χ^2=1 383.30, p<.000; gamma correlation=0.46.

The rank correlation coefficient gamma is here 0.46, which indicates a strong moderate association between parent's education level and the children's lower secondary marks. Very few pupils at all get the lowest mark when both parents have a university degree, whatever level, only 1.9 per cent. More than one out of six pupils (17.8 per cent) got the lowest mark when both parents have only primary school as the highest completed level. Moreover, more than one out of three (36.3 per cent) of those with both parents having a higher university degree got top-level grades in lower secondary school; 5.3 per cent of those with both father and mother on the lowest level of completed education are to be found here.

We then ask if parents' level of education also have effect on the children's level of digital competence. In Table 4, we take into consideration the same background combinations as shown in Tables 1 to 3, in addition to mother's highest completed education level.

Digital competence is measured on a scale from 1, showing the lowest level of competence, to 7, the highest level measured. On average the pupils' digital competence was 5.5 on this scale (see Total in Table 4). The F-values indicate that the observed group differences are significant. However, they are small, and the eta coefficients show only a small effect.

Table 4

Digital Competence According to Various Combinations of Mother's and Fathers' Highest Completed Education Level. Means and Standard Deviations (St.D.).

Highest Completed	**Mother's Highest**		**Mother's or Father's Highest, Different Levels**		**Mother's and Father's Highest, Equal Levels**	
	Mean	St.d.	Mean	St.d.	Mean	St.d.
Primary school	5.3	0.96	-	-	5.2	1.02
Upper secondary - vocational	5.4	0.86	5.3	0.90	5.4	0.86
Upper secondary - general	5.5	0.85	5.4	0.84	5.4	0.86
Univ. – short	5.5	0.80	5.5	0.83	5.5	0.79
Univ. – long	5.6	0.83	5.6	0.82	5.7	0.82
Total	5.5	0.85	5.5	0.84	5.5	0.87
F value/p	59.5/.000		25.3/.000		56.0/.000	
Eta	0.12		0.09		0.17	

Moreover, we see equal pattern as observed from Tables 1 to 3 above. When the parents' highest completed education level is primary school, the children's digital competence score is at the lowest, increasing slightly when the parents' education level also do so, and when both parents have a high university degree, their children have the highest measured digital competence (5.7) among these pupils.

Qualitative Results (in Light of Quantitative Results)

In this section we will handle the qualitative results in light of the quantitative results. We found that indicators of secondary digital divides, i.e., "can" and "cannots," were evident in the focus group interview with the project group (consisting of 7 members from the counties involved in the project). Here, it became clear that the way that the pupils used ICT varied significantly according to their academic background, and that this usage of ICT could both inhibit and promote learning. While on one hand, the so-called weak pupils were easily distracted by ICT; the strong pupils used their digital devices as a way to take breaks in between tasks:

> (…) it depends on the pupils' prerequisites, motivation (…) I think that the clever, structured pupils would intentionally use digital medias as a headrest, while for the unmotivated pupils it [digital medias] would be a magnet to inhibiting learning. (P1)
>
> (…) the weakest pupils are the ones that are most distracted and the clever pupils manage to use ICT in a constructive way (…). (P6)

The leader of the National Pupils Organization mentions in the interview that:

> (…) I think that pupils that have parents with high education has been part of the digital professional expertise because the parents have seen that is important, while students from, may well say, less academic homes have not had parents that emphasized it. And then there is the competence of students has been acting about anything other than professional, so it's a social cohesion issues in here too. (EO)

What other factors seem to influence these patterns on a more concrete level? We find a correlation between parental education and how much screen time pupils use, where pupils whose parents have lower educational level have the most screen time. Screen time spent is clearly declining with increasing mark average. The variation (standard deviation) between students also diminishes. In several interviews the informants mention that they think pupils' screen time is too high and for some (weak) pupils unhealthy (they stay up late at night playing and are tired at school). The parents have the main responsibility for such issues, but one school owner mentions in an interview that schools are giving the pupils one laptop each and learning supportive infrastructure (digital teaching aids, learning platform, etc.), but they do "nothing to follow up what is happening in the home, where the pupils have a PC as their disposal 24 hours a day"(SEF5).

Several other informants state that a way to combat digital divides can be to improve the collaboration and dialogue between the school and the home. For instance, several informants mentioned that they provide tailored support to for pupils' use of ICT at home to those pupils and areas that struggle with poor Internet access and infrastructure at home. However, the school owner and school politicians mention that this arrangement is about the pupils having access to a laptop that they can take home with them and organization of learning aids (digital learning resources, learning platforms and so on). The informants that do mention that they provide tailored support for pupils' use of ICT at home, note that they arrange for access to computers at home and the use of teaching aids. Other arrangements that were mentioned in the interviews were:

- Homework can be handed in through the school's learning management system. (SLF12, LF11 & LF61)

- Lessons and links are made available on the learning management system so that pupils who are absent from school can work from home or prepare themselves for the next lessons. (SLF31, LF51, LF41)
- The teacher creates learning activities that instigate the use of ICT at home (LF32 & LF61). An example of this kind of learning activity is that pupils "are assigned tasks where they have to use sources on the Internet to answer the question" that they are to submit digitally. (LF61)
- One teacher mentions that she has tried out new ways of assigning and for pupils to submit task such as through flipped classroom learning.

On the other hand, the interviewed school owner and the school politician note pupils that struggle with poor Internet access have the possibility to work at the school. The school politician, however, expresses understanding that this is not without its challenges for the affected pupils:

> It is clear that it becomes difficult, and then the pupils must sometimes be at the school to work (…) and then ICT will be less used compare to if they could sit at home and use the computer, and get to know the tool. (FPF7)

However, in general the access to ICT is very good for the pupils, but the 8 weeks of observations in classrooms (in three subjects) shows clearly that the user patterns differ between different groups of pupils. Some pupils are more into "off-task" ICT use in classroom situations and are on Facebook, SMS, digital newspapers, watching YouTube-videos, etc. From the observations in classrooms it seems like these pupils lack motivation and are easily disturbed by digital distractions. From the quantitative survey we find that "off task"-use of ICT at school goes down the better the mark average is from secondary school. We also find that digital competence of pupils also helps to reduce "off task" ICT-use at all stages. Much screen time spent on PCs, mobile, etc. contributes also to "off –task" ICT-use when the other variables are controlled for. From the interviews with the school owners and school leaders we find the following statement regarding "off-task" ICT activities in classrooms:

> (…) it's great professional activity I would say on the one hand, but it is also too much activity in ICT in areas they should not be, such as Facebook. (SLF12).
>
> (…) It is much "off-task" activities and it is one of the frustrates teachers that students work with other things than they should. (SEF5 P195)
>
> We know it is a challenge because teachers report that they think it's too much "off-task" activity. (SEF3A P155)
>
> I think that the good, structured students will be able to use digital media as a calculated conscious breather, while for unmotivated students so I think it will be a magnet into the learning retardant. (P1)
>
> (...) The weakest students are those who are most distracted and the talented students they are able to use ICT in a constructive way (...). (P6, 483)

Some school owners and school leaders say that class management is a key word to avoid “off-task” activities:

> It is the sort of a question about the teacher's lack of leadership then. It's supposed to in my view not occur. (SEF3B)

In addition, nine teacher informants were asked about pupils “off-task” ICT use and the question: “To what extent do you believe there is a connection between low ability class leadership in teaching and high level of ‘off-task’ ICT use in classrooms among pupils?” All nine informants answered that they believe it "largely" is such a relationship. Two of the explain it further in the interviews:

> Yes, I believe it is a strong correlation. If the teacher don’t really cares what the pupils do, so the pupils do what they want. (LF32).
>
> Yes, I think that classroom management is very important for students not to use it for “off-task” activities. (LF21).

The representative from the National pupil organization states that:

> (…) what it really is all about, that you need teachers who set clear boundaries for when and to what ICT is used. (…)(EO)

From other parts of the SMIL-report we found that teachers’ digital competence is the most influential factor for good class management skills (Krumsvik et al., 2013; Krumsvik, Jones, & Eikeland, 2016). Teachers as role models also affect the pupils’ digital expertise at all stages and pupils who agree that the teachers have to be good role models, emphasizes ICT use as part of well-being at school to a higher degree than those who do not perceive that teachers are such role models.

But what other factors can directly and indirectly give us a broader understanding of digital divides and digital inequalities in the Smile-schools? The clearest effect on pupil’ digital competence has average mark of school and the more pupils feel dependent on PCs and mobiles, the lower digital competence they have. Much screen time spent on PCs, mobile, etc., contributes to “off-task” ICT use when other variables are controlled for and there is a systematic relationship between being dependent on mobile and PC-usage and “off-task” ICT use. We also find a tendency of pupils’ themselves recognizing “pitfalls” of digital distractions, because the lower parental education is, the higher the desire for teachers to take more control of computer use in the classroom and the lower the pupils’ digital competence is, the more teacher management pupils wants.

Implications

The first research question of this paper was: Is there a connection between pupils’ social background, marks and digital competence in upper secondary school and how do the school leaders and teachers perceive this relationship? The paper shows a clear and systematic connection between the parents' educational level and the pupil's average marks in lower secondary school. Barely one in ten pupils with parents whose highest educational level is lower than secondary school have an average mark of over five, while for the highest two educational levels it is one in four and almost one in three. At the other end of the scale, only just over two per cent of pupils with parents who had a university education have the lowest average mark from lower secondary school. There are also clear gender differences in average marks. Every fourth girl has an average mark between five and six, but only every sixth boy (15.6 per cent). There is a clear coherence between the quantitative –and the qualitative part in the study where the qualitative findings *confirm* the quantitative findings in the study. This social reproduction of social inequality is especially in line theoretically with Hernes (1974).

There is also a clear and systematic connection between the parents' educational level and the pupils' digital competence. Pupils of parents with long university education score 5.7 and pupils with parents with only primary school score 5.2. This difference is high and indicates digital inequality based on social background. There is also here a clear coherence between the quantitative –and the qualitative part in the study where the qualitative findings *confirm* the quantitative findings. This divide is in line with Dolan's (2016) terms the "cans" and the "cannots."

The paper's second research question was: "Is there a connection between pupils' digital competence and digital patterns of usage, and how do the school leaders and teachers perceive this relationship?"

We find that there is a connection between the digital patterns of usage attached to their digital competence and to their academic background in the quantitative part of the study. The qualitative data showed that the way ICT was used by the pupils varied significantly, and this usage of ICT showed that it could both inhibit and promote learning. The school leaders and teachers stated that while on one hand, the so-called weak pupils (with lower marks and low parents' education) were easily distracted by "off-task" ICT use, the strong pupils (with high grades and high parents' education) avoided this more and used their digital devices far more professionally. The quantitative – and the qualitative – findings in this part of the study can be described as *expansion* where the quantitative data show the strength of associations and the qualitative findings show the nature of those associations (Fetters et al., 2013). Also here we see a tendency of digital inequality between pupils' groups, which is in line with Attewell (2001) and Hargittai (2003) descriptions of such divides.

The final research question of the paper was: "What pedagogical implications for teachers' class management and digital competence in the digital environment does this study offer?"

The implication of the study is the awareness of the fact that the school seems to reproduce social inequality in the digital era and this is also attached to pupils' digital competence. The terms *net generation*, *millennials* and *digital natives* that often are used to describe todays' digital self-confident generation as homogenous, must be reconsidered in light of a more heterogeneous underpinning. In light of these clear findings, contributions of schooling

(Steffensen et al., 2017) become especially important. Here we find that teachers' digital competence and class management seems to be very important to decrease digital inequality (Krumsvik, Ludvigsen, & Urke, 2015; Krumsvik et al., 2016) and must be considered as the "ground pillars" of the contributions of schooling in the digital era. The pedagogical implications of this is that to avoid digital inequality to expand it will be very important to increase teachers' class management and digital competence in the years to come. This is line with Bolick and Bartel (2015) who underline that digital learning environments add new layers of complexity to matters of classroom management.

Note

1. When translated from Norwegian to English, the title means "the relationship between ICT and learning outcomes."

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IMPLICATIONS OF ICT ON BELIEFS AND TRADITIONAL BEHAVIOR NORMS AMONG THE ARAB YOUTH IN ISRAEL

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Abstract

This study presents and discusses differing views about the implications of information communication technologies (ICT) on Arab traditional culture in Israel. It analyzes perceptions of the participants regarding the contribution of ICT to changes and developments in Arab culture and its implications on youth behavior and cultural concepts. Findings show that ICT is perceived as a technological development that conceals positive and negative consequences. The encounter between ICT and Arab society has created processes of social and cultural change. The accelerated development in ICT dominates Arab youth life intensively. Therefore, youths perceive their traditional culture as meaningless and incompatible with current day life.

Introduction

Culture reflects values, beliefs, perceptions and interaction with the other. In all human societies people consciously create patterns of behavior amongst and between their members and the physical environment in which they live. These patterns usually direct, guide, control and stimulate people towards harmonious social existence (Scupin & DeCourse, 2001). What constitutes people's culture is what they believe and use as artifacts, the way they communicate, their mode of dressing, their thoughts and the way they relate with each other on a regular basis and is equally transmitted from one generation to the other.

The developments of human culture deeply affect the human soul and create in the human being new perceptions regarding the human existence to which he or she belongs (Al-Rasi, 1967). In the current era, developments in information technologies and the increasing employment of computerized systems are perceived as fundamental factors that contribute to the developments in human culture and occupy the main discussion that focuses on various kinds of processes and changes. The development and employment of ICT is obvious in this regard, and it opens different windows onto various worlds and enables open communication with all the parts of the globe.

Digital technologies have transformed the cultural scene profoundly. New forms of creation, production, distribution, access and participation have revolutionized entire industries, such as book publishing, education, arts, entertainment, etc. McLuhan asserts that with every technological and social "advance,"

> All media work us over completely. They are so pervasive in their personal, political, economic, aesthetic, psychological, moral, ethical, and social consequences that they leave no part of us untouched, unaffected, unaltered. ... Any understanding of social and cultural change is impossible without knowledge of the way media work as environments. (McLuhan & Fiore, 1967/2001, p. 414)

McLuhan's remarkable observation that societies have always been shaped more by the nature of the media by which men communicate than by the content of communication, is undoubtedly more relevant today than ever before.

Different types of human communication become available by the aid of different means of communication, starting with oral or written communication and ending with sophisticated means such as ICT. A culture that is based on oral communication is different from the viewpoint of creation, presentation, understanding and preservation of symbols and messages from written culture, printing or electronic communication. This difference is connected to ways through which people in such cultures see, hear, remember, learn, and act. These types of communication affect and design the manner in which society and culture communicate with themselves and within themselves. Around them, new social structures are built that affect and are affected by the means of communication.

The approach of *technological determinism* (McLuhan & Fiore, 1967/2001) claims that technology, including the computer, has a central power in designing the given manners and style of society. Technological changes are likely to cause deep political and cultural changes as they change the structure of information and knowledge, the power in society and the possibility of human beings to communicate and associate with each other. Postman (1998, p. 40), argues that new technologies create new types of human beings:

> A new type of clear determinism is recognizable here with regard to the described fictional world; technology has already arrived, and we have to use it because it is here; we will turn into the people that technology wants us to become; whether we liked it or not, we will redesign all our institutes in such a way that fits in with technology…

Carey (2009, p. 160) stated, “Changes in communication technology affect culture by altering the structure of interests (the thing thought about), by changing the character of symbols (the thing thought with) and by changing the nature of community (the arena in which thought developed)”.

Arab society in Israel is a traditional society in its basis and has unique cultural characteristics. Since the establishment of the State of Israel, the Arab population has been undergoing processes of continuous change in which many factors, starting from approximation of Israeli culture, and ending in economic competition and achievements. Among the generations that were born and educated in Israel, a bicultural system approach was born, which is also characterized by bilingualism, and internalization of Israeli social values, etc. (Rouhana, 1987). However, these changes did not affect fundamental cultural values as the Arabs continued to preserve their cultural experience and continued living as a minority that is different from the majority, not only in their ethnic origin and their national belonging and attachment, but also in their language, religion, traditions and lifestyle (Al-Haj, 1996; Najjar, 1998). The process of introducing computers into Arab society and the Arab-Education System in Israel started in the second half of the 20th century. In the late nineties, this process was enhanced, and the employment of ICT entered nearly all fields of life. Najjar's (2003) research findings show that ICT accelerated the processes of change in Arab society, increased the number of factors that are active in it and affects its cultural nature and its traditional characteristics.

ICT's accelerated development has intensively dominated Arab society, especially the lives of youth. The youth do not find a meaningful place for traditional values and principles in their everyday life. They are more independent, and their behavior is uncontrollable. They demonstrate superiority to everything called traditional culture, including their parents and their extended family.

This study examines the interaction between ICT and changes in cultural perceptions among Arab youth. It analyzes perceptions of the participants regarding implications of ICT on beliefs and traditional behavioral norms among the Arab youth.

Study Questions

1. Is introducing ICT into the Arab society in Israel perceived as a contribution to the changes and developments in the Arab traditional culture?
2. Are the people who use ICT aware of its implications for youth behavior?
3. Does the introduction of ICT into the Arab society affect cultural conceptions among Arab youth?

Methodology

The present study was carried out according to the qualitative approach in order to examine cultural processes in light of the encounter between ICT and Arab society. This study followed Sabar's method (2006) of examining individuals' subjective realities found in participants' perceptions. Often, the goal is to either describe or understand a certain aspect of human nature or experience. However, rather than use quantitative methods, qualitative investigators adopt a more subjective, personal approach. The developments and changes found due to ICT were examined through participants' subjective realities- realities that help us understand the social and cultural phenomenon through the exposure and examination of individual perspectives.

Sample

The sample includes 33 participants: 11 educators, 11 pupils, and 11 parents. The participants were chosen from 14 schools in Nazareth: 8 middle (junior high) schools and 6 high schools. In choosing the sample an attempt was made to create maximal representation of the population being studied via basic and specific characteristics such as age, sex, education and socio-economic level. Judgment sample, also known as purposeful sample, is the most common sampling technique (Miller & Salkind, 2002). In it, the researcher actively selects the most productive sample to answer the research question.

Data Collection

The data collection technique in this study used structured interviews, with the purpose to learn about the interaction between introducing ICT into the Arab society and the cultural implications and in order to get an impression of the cultural and social components of the study sample.

Data Processing

The data were processed and analyzed according to qualitative research methods. Empirical material gathered from interviews was processed into texts, and each text was analyzed into content units. The content units were categorized and sub-categorized as joint topics and went through a quantitative process (Ryan & Bernard, 2000). After the categorical structure was solidified, the findings were surveyed, analyzed and discussed. The primary categories found were: (a) perception of ICT in the Arab society, (b) implications of ICT on youth behavior, and (c) impact of ICT on cultural conceptions

Findings and Discussion

In the current era, people believe that technology works well, and they rely on it and accept its promises. However, they feel its shortcomings when access to it is not allowed to them when they are satisfied with it (Postman, 1998). Research shows that ICT affects the traditional culture and contributes to significant changes in cultural concepts, especially among the young generation. However, regarding the manner of its affects, they are manifold and diversified. (Barakat, 2000; Najjar, 2003).

Perception of ICT in the Arab society

In general, ICT is perceived in Arab society in Israel as a factor that influences the existing traditional culture, but regarding the manner of its influence, attitudes are diversified: 22% of the educators and the students think that the impact of ICT is positive thanks to the comfortable exposure to international cultures and thanks to the large amount of information that the Web makes available to all users, irrespective of their social or cultural affiliation.

One participant noted:

> ICT is a great comfortable source of information, an international communication tool that approximates people from the whole world to one another. The Internet opens to the Arab woman and the Arab children a window onto the world that is not controlled by the people who surround them. It enables them to reach virtual places that are impossible to reach in real daily life.

In this section of people, ICT is conceived of as a great data base, a practical store of information that gives answers to people with special needs in all fields – a fast and effective international means of communication, which, unlike other means of communication, breaks the borders of time and place at the lowest cost. Besides, it connects between Internet groups from all parts of the world. Exposure to the culture of the other broadens horizons, and the network that spreads into all directions enables people to visit places that the actual reality does not allow them to reach.

On the other hand, 45% of the participants think that ICT's influence is bidirectional. The way it is used and the degree of exposure to it are the elements that decide the type of its effect – positively or negatively. This attitude is common to all the participants from all the social sections.

One parent stated:

> ICT is a tool that can be used positively or negatively and its effect is also either positive or negative. It is a medium of communication that enables to have a link to all kinds of fields and therefore, it is not just a store of information but beyond that. Exposure to immoral sites has negative effect and forces itself on cultural values.

Communication by ICT is more efficient, and collecting of information is easier and more comfortable. However, the doors that this technology opens for free information allow nonintellectuals to express themselves, to adopt an equivalent status with other intellectuals, and thus, to influence the contents in their own ways and according to their interests. On the other side, it allows them to influence the users and society as a whole. In this context, it is important to point out that people of economic and technological power control the ICT industry. This situation creates imbalance in the information that serves mainly the people who have power.

In view of this, ICT is not a neutral data store; it is beyond that. The goals of communication can lead to a reliable or unreliable information store, and, thus, the effect of ICT on learning and culture will be according to the reliability of the site. The "positivity" or "negativity," the "danger" or "benefit" will be subject to the tendencies of the person himself. But still the person's curiosity to discover the hidden, in addition to the temptation of advertisements that the common sites suggest to the users, interferes in the users' decisions.

On the other hand, there are about 33% of Arab educators in the study who see only the negative influence of ICT. This attitude is due to the free exposure of immoral contents that put the cultural values at a great risk.

According to an educator:

> The effect is negative because the exposure that ICT allows does not contribute to the education of children, but the opposite. We did not protect our fine values and did not change inefficient things, but became more superficial whether in our external appearance or in our behavior.

Behind this conception lies the discernment that non-guided superficial exposure that lacks any educational goals of contents in the net does not deepen existing cultural understanding and does not develop new cultural insight; on the contrary, this conception causes abandonment of high cultural values and contributes to the creation of a tendency of superficiality that is expressed in external appearance and immoral behavior, especially among the young people. This perception is ostensibly realistic but, in its basis, it is not connected to ICT only, but also to the users and the contents that they look for and internalize. It is possible to suppose that this point of view is connected to the students' behavior and the difficulty that the educators find in dealing with such behavior. In this context, Aljabary (1994) argues that Arabs have to adapt themselves to the new reality not out of submission but out of awareness and ability to control the new developments.

Implications of ICT on Arab Youth Behavior

Of the participants, 50%, especially educators and students, see ICT as a factor that has a negative effect on the youth because of the uncontrolled exposure to dangerous information and the parents' ignorance of their children's activity on the Web. This contributes to cultural and value disintegration among the youth and causes health damage to them. This is the view of 71% of the educators, 43% of the students and 30% of the parents.

An educator said:

> The danger of the Internet lies in its influence on the children's behavior that results from their uncontrolled exposure to dangerous information such as pornography, terror, violence and robbery.

A student said:

> I think that's what happens to teenagers, they are losing their direction because they don't know how to act, and the result is less values, aggression, audacity, and physical damage due to prolonged sitting and stress.

ICT is a world in itself where everything is open and penetrable. The children's tendencies and their curiosity, together with the temptation that many sites offer, attract the young generation to inappropriate directions of ethical information such as pornography, and to other sites that represent contents of violence, suicide, murder, robbery and terror.

Tyler (2002) pointed out that because people do not want to, or are unable to, restrain themselves on the Internet, they behave in an immoral way because it creates anonymous conditions for communication and expression. Tyler also introduces similar concerns connected to other arenas on the Internet starting from children's gambling to pornography. In such cases, people use the Internet to behave and perform things that they would not be able to do in non-anonymous situations. ICT provides access and permission to anyone who is interested in sexual materials or gambling or violent and threatening expression on sensitive subjects such as nationality, race, religion, etc.

The ICT communication environment allows applications such as Chat, WhatsApp, and Instagram, attracts the children and occupies a large space of the time that is intended for pastimes and recreation with the family, studies or free time. Communication through these environments is mostly aimless and empty of any cultural or educational content. Subrahmanyam, Kraut, Greenfield, & Gross (2000), found that the youths communicate with their friends through chat in order to exchange a short conversation, some gossip, and news of the day according to their taste. The study findings show that ICT allows creation of relations and acquaintances between boys and girls that are likely to end in a meeting in reality. Such relationships are probably appropriate for Western culture, but not appropriate in the traditional culture, and can lead to undesired outcomes.

These things reflect the new reality of the young people in the era of ICT. As a result, around their E-activity and their connection with virtual communities, the young people build their own secret social and physical circles and groups. They withdraw into themselves, keep away from their family members, and even create immoral virtual relations. From their point of view, this is an expression of dissatisfaction and rebellion against the traditions.

The changes that take place in society today show a phenomenon of over permissibility among young people. In addition, a long sitting opposite the computer screen is at the expense of physical activity, such as sport and physical fitness, which are very significant from the point of view of development and health.

Opposition of educators in this regard is strong and absolute in comparison to parents and students. The difficult mission of education is put on educators – education, teaching, inculcation of cultural values and raising achievements. They are the ones who come into intensive contact with the students and they are the ones who experience the significance of the unguided and uncontrolled exposure of students’ behavior, their approach to others and their thoughts. The more the progress develops and the exposure increases, the coping with the youth becomes more difficult. This harms the teachers' commitment to their students and performing the obligations of their position.

In spite of that, it is appropriate to point out that ICT is not free of positive effects on young people. The field points out a lot of samples of the use of ICT by young people for the needs of learning and its contribution to increase their personal, social and cultural awareness, and to provide tools to cope with unknown cultural situations.

ICT is perceived as a technological development that carries within itself positive and negative elements. The kind of impact it has on young people is subject to the goal and tendencies of its user as it is also subject to the contents carried. ICT, according to McKenna and Bargh (2000), is a kind of "social laboratory" in which people test their tendencies before they adopt them rather than a “place” where people hide from the taboo or hidden personal aspects. It enables people to perform activities that they are already involved in in other ways but in a more effective way and more open possibilities in order to meet their needs. In order to achieve the positive potential at all levels, it is important to inspect children's surfing and limit it to fixed time frames.

Impact of ICT on Cultural Perceptions

A decade after the gradual entrance of computers into Arab society, information technology was conceived of as an additional factor but not the main one, in a series of factors that influence the traditional culture of the Arabs in Israel, though, in most cases, the connection between the two variables was negated (Najjar, 1998). The findings of this study show that in the course of the last decade there have been changes in the point of view of the majority. Today, all the social classes consider ICT as another significant factor that affects the culture of the Arab population in different ways.

Twenty four percent of the participants think that encounters with ICT have positive effects on the existing culture because it affects the consciousness of the people and contributes to openness and social development. These perspectives are common among participants from all social sections but they are more prevalent among students who put a special stress on the relationship between the two sexes:

A parent:

> The traditional culture spoiled our life and turned it into a backward society. The exposure that ICT provides affects traditional attitudes and thoughts that were derived from the era of agriculture. It is possible to feel that our society is being made more flexible, especially towards women and children.

A female student:

> Today, I do not fear the teacher; I argue with him in all issues because today everything is open, and I make him consider my thoughts.

A male student:

> The effect is on the openness of people. Today, girls spend time with boys, the families know about it and agree. This was not accepted before. The change is also affected by the desire of the young people to be free of the ties of the traditions.

Exposure to different fields of information and meeting via the Internet with international cultures assists people to be open and be free of traditional thoughts and conservative attitudes that hinder every initiative of change and progress. The significance of this outlook is that there are people in the Arab society who understand tradition as a tool that prevents development. They oppose the traditional culture and accuse it of blocking development, and they encourage progress and every factor that contributes to the emancipation of society from the ties of the traditions. From this point of view, ICT gains its highest support from the young people who grasp it unequivocally as having positive effects in the cultural context.

The buzz of electronic media predominates youths' lives and their daily communication habits center on tweets, Facebook, Instagram and chats. This technology allows them, especially the girls, to make relationships with the other sex, which is unaccepted by the conservative traditional culture. However, in this era, there are no borders, and the more the observation is strict, the options to evade it increase. Therefore, there are lots of parents who are aware of the fact that the era has changed and the control has slipped from their hands. They are aware of the existence of relationships between their children and other children of the other sex. Some of the parents do not agree to that openly but they do not object to it actually. Some of them even allow their children consciously to enjoy things that they were not allowed to do themselves.

Such parents believe that, in the current era, education has to be open and not threatening, and, therefore, exposure to what used to be considered "taboo", according to the traditional culture, is not necessarily immoral. Exposure can be another additional way to teach and increase awareness of the young people about what is taking place around and inside them. This finding is not consistent with the rules of traditional culture, but it hides within it signs of change in the common traditional concepts. On the other hand, it indicates the contribution of ICT to this change.

On the other hand, 35% of educators see just one dark effect of ICT on society and culture. In their opinion, ICT has negative effects on the Arab culture and its values because the development in information technology, in which the Arabs are not participants, turned them into people who imitate other people and follow them without looking deeply into things or paving a cultural road for themselves.

One teacher said:

> ICT in our life is causing a loss of our cultural and human values. Today, there is no traditional family; the father's authority decreased and the computer separated the members of the family. There is less solidarity and unity and more individualism, and each one is drowned in himself. The children today are not well educated, and they do not give respect to the adults. We received everything ready-made from other societies and stuck them to ourselves without checking what is suitable and what is not. Even our language, which is a basis of culture, is being assimilated.

A large number of educators in the study perceive ICT as a product of the Western culture that includes cultural aspects that are not consistent with the Arab culture and that leads to cultural assimilation. This is obvious in the behavior of the young people and interaction between people. Through their intensive connection with young people, there are educators who maintain that the more the Arabs have a strong connection with ICT, the more they separate from supreme human values in the Arab culture.

The developments in which Arabs are not participants shake their confidence in themselves, just as exposure to the culture of the other and its adoption shake their cultural foundations. In this context, Sharabi (1991) asserts that since the beginning of the connection with the West till today, the Arabs have adopted in their daily life Western work-styles, ways of thinking and behavior without verifying or assessing them. They accept them just because they are Western!

Barakat (2000) claims that the connection of the Arabs with modernization did not go beyond imitation and estrangement, and it did not develop to the degree of a struggle, opposition and free interaction of equality, respect and appreciation. According to his opinion, the Arabs failed to bring the Arab society to modernization because their connection with the West moved between its imitation, on the one hand, and attempts to keep away from it by withdrawing into themselves and returning to the past as a reaction to the Western hegemony, on the other.

It is possible to see that in the given society, differences are numerous, and the consistency ranges from the radical conservative that blocks progress, to the liberal modernist that turns to progress at any price. Between these, there is a third group in between who are actually lost but is expected to return to its traditional life because the local social atmosphere always pulls back towards traditionalism and conservatism.

The described condition of Arab society in Israel is a product of a long process of change, in which many factors are active including approximation to the Israeli culture, rise in the level of education, increases in economic competition and achievement. The access of ICT into the Arab society accelerated the process of change. It constituted an additional significant factor that affects traditional Arab culture in different ways as the new young generation freed itself completely from its cultural attachment and belonging, and they see in traditionalism a factor that perpetuates social backwardness.

Summary

The present study was carried out according to the qualitative approach in order to examine cultural processes in light of the encounter between ICT and the Arab society in Israel. It presents and discusses different points of view about the implications of ICT on Arab traditional culture in Israel. It analyzes participants' perceptions regarding ICT's contribution to changes and developments in Arab culture and its implications on youth behavior and cultural concepts.

The findings suggest that ICT is not neutral, and it is perceived as a significant influence on cultural conceptions and traditional behavioral norms, especially among youth. All the social groups that participated in the study perceive ICT as a technological development that conceals positive and negative consequences. The essence of its influence on youth depends on the purposes and tendencies of the user as it depends on the contents it stores.

ICT is a medium for unlimited communication that allows access to any area of knowledge. Through the windows of the information, ICT can increase the knowledge, enrich the culture, and deepen people's insights towards themselves and towards their culture. However, when the discussion is about the effect of ICT on the youth, it is found that its influence is generally negative. The uncontrollable exposure to dangerous and non-cultural information, on the one hand, and the indifference of the parents in the activities of their children on the Web on the other hand, are perceived as principal factors in this context.

With regard to youth behavior, individualism increases; less family cohesion takes place, and contempt for cultural values and detachment from their cultural and historical context grow. To youth, it is an expression of discontent and rebellion against tradition.

This behavior is expressed in disrespect for adults, less tolerance and audacity. This behavior, which contradicts all educational values, is not accepted and is generally rejected, particularly by educators.

ICT represents a modern culture, which is intrinsically different from Arab traditional culture. It is a two-sided currency whose one side illuminates the culture and the other side depresses it. Even though, the Arab society is trying to keep up with it. However, in using ICT, Arabs should focus on enriching and illuminating their superior cultural and social values among young generations in particular. For that, the Arab society is required to be active and creative in order to overcome the challenges with which the ICT era faces the Arab culture.

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DEVELOPING AUTHENTIC DATA LITERACY IN PRE-SERVICE TEACHER EDUCATION PROGRAMS THROUGH ACTION RESEARCH

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Abstract

In this paper, we discuss the results of a study that investigated how best to prepare Pre-Service Teachers (PST) for professional experience in an Australian university. Recently, there has been a gathering interest in data literacy in the higher education system. In order to develop the PST's data literacy, we developed an online module of work whereby PST worked together to produce a range of data driven visualisations. Forty-four PST participated in the study. Data sources discussed include PST post-intervention surveys and deliverable action research projects. The preliminary results of the study indicated that the perceived benefits of the data literacy initiative for PST was that it improved their teaching and understanding of what works in a classroom.

Introduction

Data literacy, as a graduate Pre-Service Teacher (PST) skill, is garnering increasing attention both in academic and government spheres due to the potential benefits for its application to learning and teaching strategies and the development of education policies. Competency in data literacy is seen to be beneficial in that it can inform decision making in regards to school and system improvement and in the determination of educational approaches on the basis of learning and teaching events, such as national benchmarking examinations (Datnow & Hubbard, 2015). It has been argued that educators need to be taught how to use data to: identify sub groups; challenge views on students and student progress; understand student thinking; and to confirm what they know about students (Quint, Sepanik, & Smith, 2008). It is clarified in the research that educators are increasingly responsible for using multiple sources of data about student learning and school improvement decisions (Bocala & Parker Boudett, 2015; Coburn & Turner, 2012). Educators and those training to be educators (i.e., PST) need mastery of more than content knowledge and pedagogical knowledge. They also need to be able to work individually and as part of collaborative conversations on using evidence to make instructional decisions (Bocala & Parker Boudett, 2015). The point being made in the literature is that educators need to be able to collect appropriate data to inform learning and teaching decisions and to be able to present these decisions and their effects to key stakeholder groups. They also need access to authentic classroom experiences, which can be problematic for PST as much of their experience is theoretical and placed outside of the classroom. This may result in a disconnect between developing data literacy skills and applying these skills to a classroom setting when they enter the workplace. This study was aimed at contributing to the development of PST's digital and data literacy so that they could make informed educational decisions whilst on professional experience in a high school classroom. While students may seem to be more technologically connected in that they have access to a range of devices and have grown-up in technology rich environments, research has shown that this does not necessarily translate to confidence in using technology in the classroom or an understanding of how technology can be used to support learning and teaching decisions making (Martin & Ndoye, 2016; U.S. Dept. of Education, 2012). From being able to visualise data in meaningful ways, teachers can then make informed decisions about how to recalibrate and refine their own practice to better support their students.

The study reported on this this paper was undertaken as part of a research project between two Australian universities. The study centres on developing an understanding of how PST develop data literacy and how PST use both the language and skills to (a) describe results, (b) diagnose learning and teaching issues, (c) predict what will be happening in the future, and (d) design and develop appropriate visualisations of the data to communicate with key stakeholders. The research questions addressed in this paper are: What factors influence PST's design choices when selecting methods of data analysis? How do design choices impact upon understandings of learning and teaching data?

Background

Data literacy in the classroom is garnering increasing attention both in academic and government spheres due to the potential benefits for learning and teaching strategies and policies. The theoretical lens that underpins this research study is *multiliteracies*. It is put forward here that multiliteracies provides a valid framework for which data literacy can be unpacked and understood in pre-service teacher education. This section of the paper provides an overview of pertinent literature that has influenced the conceptualisation of the research study.

Data Literacy

There is a focused body of literature on the importance of teachers using data. This seems to stem from international calls to increase the visibility of evidence-driven practices in education. Mandinach, Friedman and Gummer (2015) draw attention to the increased focus on data literacy in their research by clarifying that governing bodies in the United States, such as the Council for Accreditation of Education Preparation, have recommended that data literacy is included in their national standards. They stress that teacher preparation programs need to include data driven processes in their programs. In their study into the prevalence of data literacy units in preparation programs, they found that 92 per cent of the institutions participating in the study had components of data use for education decisions integrated into at least one course. Although they do clarify that the actual extent of the training is often not clear (Mandinach, et al., 2015). What this does demonstrate is that at an international level, there is an increased focus on ensuring transparency in educational decisions on the basis of educational data.

The gathering interest in data literacy in the education system in Australia, where the study was set, has been linked to these international educational and economic trends. Researchers in Australia have indicated that there is a growing vertical accountability linked to the competitive economy and high standard of living. Bennett (2006) stipulated that it is the global economy that is driving this shift towards data and accountability as a highly trained and skilled workforce is good for investment and also for a high standard of living. A highly trained and skilled workforce is seen to be an economic asset. This in turn has pushed back on the schools to ensure that there is better transparency in reporting processes and increased accountability across the education sector from the schools through to the tertiary providers. Moreover, good data promotes transparency and accountability within the system; it provides stakeholders with the information that they need to make valid and informed decisions (Marsh, Bertrand, & Huguet, 2015). It can be argued then that the increased focus on data use may be underpinned by economic factors.

In the higher education sector, this drive is translated as a need to support PST to be able to make data-driven decisions to support learning and teaching in the classroom. Therefore, data literacy can be viewed as a favourable graduate capacity. *Data-driven decision-making,* or *data use*, refers to the process of making educational decisions on the basis of data (Lai & Schildkamp, 2013). We draw upon Lai and Schildkamp's definition of data here in the context of schools and education systems as information that is systematically collected, analysed and organised to represent some aspect of school. That data may be derived from qualitative and quantitative methods of analysis. Data literacy, in essence, refers to the capacity to manage, understand, evaluate, critique and present data in a meaningful way (Athanases, Bennett, & Michelsen Wahleithner, 2013). Data literacy for teachers includes three skill sets, with these being: (a) *problem-focused skills*, such as knowing how to frame questions, identify problems and to make informed decisions; (b) *data-focused skills*, which include knowing how to access, generate and interpret data; and (c) *process-focused skills*, which include knowing how to engage in collaborative inquiry and to evaluate cause and effect (Mandinach & Gummer, 2013). Hence, to be considered to be data literate, those training to or already working in schools should be able to understand, analyse, and to act upon multiple forms of data about student learning (Coburn & Turner, 2012). Data literacy, therefore, draws upon an understanding of aligning data with standards, disciplinary knowledge and practices, pedagogical content knowledge and knowledge on how children learn in order to make effective and appropriate learning decisions (Gummer & Mandinach, 2015). Data literacy for teachers is not simply being able to collect, analyse and present data, it is being able to understand multimodal forms of data to improve learning and teaching decisions, and, in this sense, it is linked to multiliteracies.

Multiliteracies

The theoretical lens that underpins this research study is multiliteracies. While multiliteracies is generally associated with school contexts, it is argued here that multiliteracies provides a valid framework for which data literacy can be unpacked and understood in PST education. The New London Group put forward the term *multiliteracies* to explain the wide variety of multiplicities now understood as valid texts, literacy practices, and semiotic relationships. The New London Group (1996) were aiming to “broaden the understanding of literacy and literacy teaching and learning” (p. 61) by accounting for multiplicity in languages and textual forms. Cope and Kalantzis (2009) later reflected on why literacy is of value, and they posited, “Education provides access to material resources in the form of better paid employment; that it affords an enhanced capacity to participate in civic life; that it promises personal growth” (p.4). According to Smith (2017), a multiliteracies lens can enable a learner to see the ways in which people make meaning with multimodal texts by using a variety of both culturally and historically contextualised designs. Individuals may filter and layer these texts in a designing process and finally produce a redesigned product to suit their specific context. Additional knowledge processes advocated in multiliteracies pedagogy includes: theorising, functional and critical analysis of texts; appropriate and/or transformed application of new knowledge; and student agency where learners take risks, collaborate, solve problems, advise, and mentor one another in partnerships (Healy, 2008; Kalantzis & Cope, 2012). There is, therefore, a focus on using an overarching metalanguage to articulate a design process that can facilitate the refinement and redesign of an artefact or pedagogical approach. This is relevant to how PST can filter and refine the learning data that they encounter to make specific classroom decisions.

Table 1.

Theoretical Framework

Multiliteracies Characteristic	Data Literacy Skill	Event Description
Situated Practice	Problem focused skills Process focused skills	PST undertake an action research project (ARP) while on professional experience. The ARP is generated by the PST for their subject area and year group. This is an authentic classroom experience.
Critical Framing	Problem focused skills	PST must develop a research question to frame their ARP and must apply a design process.
Overt Instruction	Data focused skills	PST undertake a week-long intensive in teaching methods, collecting and using learning data and undertaking research in the classroom.
Transformed Practice	Process focused skills	PST apply their data collection and analysis to address their research question. PST develop a "journal article" to present their findings.

There are four key characteristics of the multiliteracies pedagogical approach that resonate with the development of a PST's data literacy. These being (a) *situated practice*, (b) *critical framing*, (c) *overt instruction*, and (d) *transformed practice*. According to the New London Group (1996), *situated practice* is learning grounded in students' own life experiences drawing upon a constructivist understanding of how people learn. *Critical framing* provides a framework for developing critical questioning strategies within discourses. *Overt instruction* is the use of direct instruction to teach the required "metalanguages" to provide a linguistic understanding of the components of the texts and grammars. *Transformed practice* is where learners apply their new understandings to develop a range of revised artefacts. Table 1 articulates how the three skills sets for data literacy are underpinned by a multiliteracies theoretical framework. In summary, the theoretical framework generated for this study draws upon multiliteracies and requisite data literacies skills. It is envisaged that the theoretical framework will be added to and unpacked over the duration of the study.

Research Design

This study used a mixed-method approach to the data collection. Two sources of data are reported upon here. These being a post-intervention survey and document analysis (student journal articles). The study was conducted from July to November, 2017. Table 2 outlines the data collection schedule.

Table 2.

Data Collection Schedule

Month	Event
July	Intensive workshops on teaching methods, data collection and analysis, and action research. (Collection of workbooks and screen capture data - not reported on here) (1 week)
July - September	School placement where action research study was implemented. This included the collection of their data for their action research. Collection of research questions (not reported on here) (10 weeks)
September	De-briefing session (administration of post-intervention survey) (4 hours)
November	Submission of final assessment (collection of journal article). Additional de-briefing (20 minute individual consultation)

The study comprised a one-week intensive of 20 hours of face-to-face workshops in July; a ten-week professional experience block (school placement) in a local high school from July to September; and a follow-up de-briefing session in September where the post-intervention survey was administered. The submission of the final assessment (journal article) was in November. The PST were introduced to the metalanguage of basic statistics, such as *visualisation, data sets, mean, range*, and *outliers*. They were also given training in a range of applications that could generate box and whisker diagrams, scatter plots, and frequency tables. While it is not reported on in this paper, the research team were also investigating a range of learning conditions, such as the PST working in pairs either side by side (condition A) or via head set (condition B) to solve several problems using R. R is an online visualisation software.

After the intensive week, the PST had to undertake a 10-week school placement. Whilst on placement, the PST had to undertake an action research project on an aspect of their teaching that they identified as needing further consideration (i.e., an educational problem). The PST had to design an action research project that could demonstrate that their learning and teaching strategies had a positive impact upon their students learning and could demonstrate Proof of Ongoing Learning (POOL). The approach taken here was that action research is a systematic investigation into one's own practice with the aim of improving teaching and learning through professional development (Ulvik & Reise, 2015). It is argued that in order for action research to be successful in PST education, the project must be grounded in the student-teachers' own work and own questions (Ulvik & Riese, 2015). The PST had to collect learning and teaching data as evidence of the effectiveness (or not) of their strategy. They were required to collect a minimum of two sources of data, where one source of data had to produce empirical results that could be presented through a visualisation (box and whisker diagram, dot plot, etc.). In short, the PST in the first two weeks of their professional experience had to design a learning and teaching strategy to implement in one or more of their classes. For the following eight weeks of professional experience they were required to collect data to show that their intervention or strategy resulted in learning gains for their target population/s.

Participants

The study involved a cohort of 44 third year pre-service teachers at a metropolitan university in Sydney. Teacher education is a four-year degree. The pre-service teachers were studying two teaching areas, for example, maths and English. Thirty students completed the survey. This is a 68.2 per cent response rate and is viewed as an acceptable response rate in social sciences research (Nulty, 2015). All students completed the journal article. No persuasive measures or incentives were offered to participants.

Data Collection and Analysis

Pertinent survey results and preliminary analysis of the documents (journal article) are presented in this paper. The survey was a 15-item instrument that used both multiple choice and open-ended questions. The survey has been developed from a reflective survey used by Quinn and Kennedy-Clark (2015) on PST's perspectives of online learning. The documents that were collected were the PST's final assessment, which was a journal article. The PST were provided with a journal article scaffold and were required to write an introduction, background (literature review), methods, results, discussion, and conclusion. A simple descriptive analysis of the survey was undertaken. The results of several questions are presented here. A thematic analysis of the journal articles was undertaken. Preliminary results of the thematic analysis are presented here.

Results

Prior to analysing the PST's journal articles, which presented the findings of their action research study, the survey results were analysed. Only relevant survey results are presented here to address the research questions put forward in this paper.

The first research question asked: What factors influence PST's design choices when selecting methods of data analysis? Item two of the survey asked: Describe your action research project and why you selected this area for investigation (i.e., what did you do, how did you plan it, and why did you investigate this area). Given that this item was asking PST to describe their own studies that they undertook in their classrooms, there was a diverse range of answers. The research topics covered differentiation, gifted education, assessments, and communication. Also, given that the action research topics centred on investigating a problem within their classrooms, these topics all fall within the scope of what teachers would normally encounter in their classrooms. In survey item six, the participants were asked to provide their data collection methods. In Figure 1, it is evident that pre-tests and post-tests and student work samples formed the basis of the students' data.

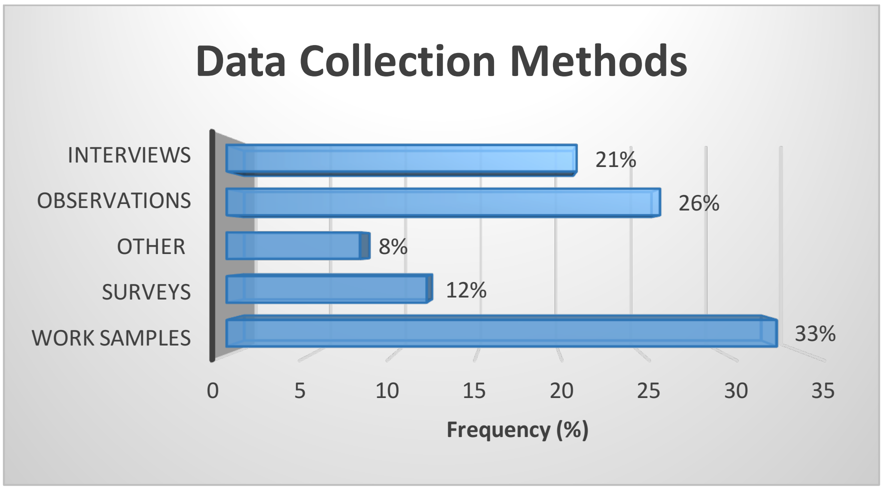

Figure 1. Data collection methods.

The aim of items eight and nine was to elicit how students established whether or not their measures were effective using data that they had collected. In item eight participants were asked: How did you analyse your data? (i.e., What did you do to make sense of your data?) The responses for this item demonstrate that 47 % (n=14) of students used comparative analysis between test results or other student work samples. Twenty percent (n=6) of PST provided descriptive responses about analysing data into graphs and tables and noted that it was related to the visualisation of the data. Twenty percent (n=6) indicated that they used document analysis of student work. Thirteen percent (n=4) students either provided no responses or unrelated responses. The PST were asked in item nine how they represented their research findings in their action research journal (i.e., How did you show what you found?). This was a multiple-choice question. As PST were expected to collect multiple sources of data, we assumed that they would provide multiple responses to this item. In some instances, three to four responses were provided. Results are provided as percentages. Figure 2. Displays the types of data representation methods used by the PST. The most frequent means of presenting the results was text description.

In item ten, PST were asked why they selected these methods of representation. The responses fell into two categories. Sixteen PST (53%) indicated that it was the most appropriate or effective way to show their results. Twelve of the PST (40%) indicated that representing the data as they did was the easiest was to do so. One pre-service teacher did not respond and one PST provided an invalid response. What is evident here is that the pre-service teachers could identify procedures to collect and analyse data in order to demonstrate POOL. From the different measures used it is evident that they selected strategies to answer their questions; however, what is not evident is whether or not they actually selected valid measures or presented their data appropriately. It can be put forward that PST were able to make basic choices regarding the collection and visualisation of their data. However, this is a self-reporting survey, and PST may not have the capacity to unpack their choices.

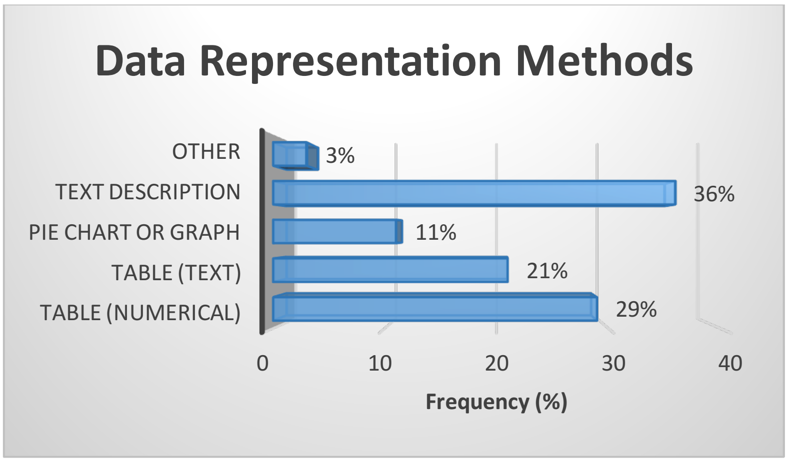

Figure 2. Types of data representation in the action research journal.

The second Research Question asked: How do design choices impact upon understandings of learning and teaching data? A thematic analysis of the journal articles provides examples of how the PST represented their findings. Here we looked at how PST presented their own findings. Only a preliminary analysis of the documents has been undertaken at this stage, and the results presented here are simplistic. What we found was that PST used a range of basic visualisations, such as graphs and tables. Pie charts, although they were not raised in the training, were frequently used. Figure 3 provides an example of a student pie chart. Note that there are no data labels on the chart.

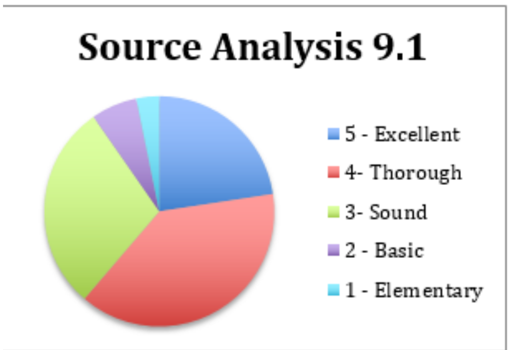

Figure 3. PST data visualisation (pie chart).

The PST also tracked individual students or student cohorts across test or exam scores in order to demonstrate learning gains and to demonstrate POOL using line graphs. Again these were not covered in the training. For example, Figure 4 provides an example of student progress across the 10-week intervention.

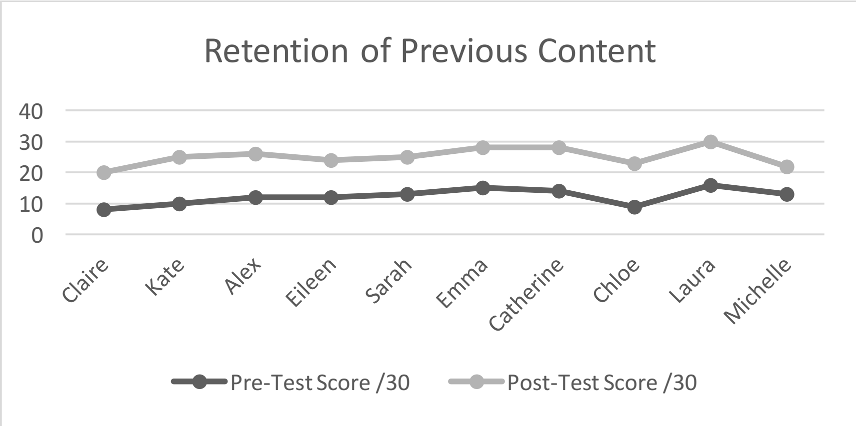

Figure 4. PST data visualisation (line graph).

Some students put forward more complex visualisations, such as box and whisker diagrams. No students used R to develop their visualisations, despite the training. What we argue here is that the students had a basic understanding of how to collect and analyse data, and they were able to use this information to make changes to their learning and teaching strategies. So in this respect, the intervention worked in that the PST could ascertain a limitation or challenge, implement a learning strategy and teaching initiative, and report upon their findings. However, the selected visualisations were basic or simply not appropriate for the purpose. What needs more work is their development of a more nuanced understanding of how to represent the data meaningfully.

Conclusions

While all of the PST successfully completed the action research journal, there was a naivety in the representations of the data. It is acknowledged that this is only the preliminary analysis of the first phase of the study. Currently, further research is being undertaken that has increased the PST's exposure to the explicit teaching of the requisite data literacy skills. In the most recent study, the PST were given explicit instruction in the appropriateness of different visualisations. It is hoped that through increased exposure to explicit instruction that the PST may develop a deeper understanding of how to represent and use learning and teaching data to inform their classroom decisions.

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MENTOR IN THE MIDDLE: REIMAGINING THE ROLES OF TEACHER AND LEARNER THROUGH MINDFUL TECHNOLOGY

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Abstract

Though technology can isolate individuals, mindful use of technology can have profound positive effects on relationships and learning outcomes. This paper describes the first year implementation and preliminary results of a "Tech and Trek" 1-to-1-iPad initiative at Hiram College. We suggest that when coupled with appropriate professional development, mobile devices such as the iPad can liberate instructors tethered to the front of the classroom and allow them to act as "mentor in the middle." At the same time, students can also assume the mentor role, increasing their engagement in the learning process.

Introduction

As technologies are introduced and gain traction, they can deeply impact – or even disrupt – interpersonal dynamics at the same time they facilitate wider access to information. For example, the introduction of the TV and its integration into homes in the 1950s and 1960s led from families gathered around the fireplace or the radio in the evening to families lined up facing a television set, and home decorating followed suit: "By the early 1950s, floor plans included a space for television in the home's structural layout, and television sets were increasingly depicted as every-day, commonplace objects that any family might hope to own" (Spigel, 1992, p. 39). The model of family members gathered around a single TV morphed in many families to individual family members viewing their own TVs, e.g., in individual bedrooms, the laundry room, the kitchen, or the study. However, the more recent explosion of mobile devices may have driven a return to the TV as focal point in a common room, with a twist: "families are once again gathering around the main television set, but they are bringing their tablets and smartphones with them" (Garside, 2013, para. 2).

Just as TVs – and mobile devices – are impacting social dynamics in the home, emerging learning technologies can impact the relationships among instructor and students, driving innovation in teaching and learning practices, and a rethinking of traditional interactions among instructors and students. This is especially true of mobile technologies like the iPad. These technologies can liberate both instructors and students.

They can liberate instructors from the front of a technology-enhanced classroom, where for decades they have been cabled to a panel or directly to a projector in order to display multimedia course content. Instead, the instructor is freed from the shackles of the technology and able to move among the students, viewing and discussing their work, providing feedback, adjustments, and support, much as a yoga instructor does when assisting a student into a yoga posture.

Similarly, mobile technologies can liberate students from the traditional role of “receivers” of information, since students as well as instructors can utilize technology to share content from where they are sitting. The notion of student as teacher is not new, but current technologies facilitate and expand that role in a way that has not previously been possible.

Conceptual Framework: Models of Pedagogy

A preference for inquiry, dialogue, and debate over lecture and memorization has been documented at least since the time of Socrates. He based his educational practices on asking questions, prompting his circle of students to demonstrate critical thinking and ownership of their own learning as he led them to answer those questions for themselves. A direct statement of this philosophy can be found in Xenophon’s *Oeconomicus* when Socrates comments: “Can it be that questioning is a kind of teaching, Ischomachus...You lead me by paths of knowledge familiar to me, point out things like what I know, and bring me to think that I really know things that I thought I had no knowledge of” (1923, pp. 507-509).

Socrates’ emphasis on the interactive nature of education has been supported in the last century or so by others, worldwide. American educational philosopher John Dewey explicitly comments on the importance of social interaction when he states, “The only true education comes through the stimulation of the child’s powers by the demands of social situations in which he finds himself” (1897, p. 77). Similarly, French educational theorist Jean Piaget (1954) asserts that individuals construct new knowledge from their interaction with the environment, and such interaction includes social experiences: “Step by step with the coordination of his intellectual instruments [the child] discovers himself as an active object among other active objects in a universe external to himself” (p. 352). And Brazilian philosopher Paolo Freire (1970/2000) criticizes theories of education that hold “knowledge is a gift bestowed by those who consider themselves knowledgeable upon those whom they consider to know nothing” (1970/2000, p. 72) and that consider students empty buckets waiting to be filled. Instead, he argues, “Education emerges through dialogue between teacher and student: the problem-posing educator constantly re-forms his reflections in the reflection of the students” (p. 80).

Constructivist frameworks such as these that insist on the critical importance of interaction, in particular social interaction, pull away from authoritarian, teacher-centered models of education that envision the instructor as a “sage on the stage” who imparts wisdom on students below (King, 1993). King describes this archetypal persona personifying a traditional model of education as "the one who has the knowledge and transmits that knowledge to the students, who simply memorize the information and later reproduce it on an exam—often without even thinking about it" (p. 30).

She called instead for a move from the one-way sharing of information to a student-centered approach that encourages students to construct knowledge through actively engaging with information, "making meaning for themselves" through discussion and connecting new information to previous experience (p. 30). Such a model calls for the instructor to move from "sage on the stage" to "guide on the side," still responsible for presenting course material but also facilitating "students' interaction with the material and with each other in their knowledge-producing endeavor" (p. 30).

Yoga practitioners of course experience a teacher-student relationship that might begin and end with the instructor at the front of the group, but often includes the instructor moving purposefully among students during the class. In a sense, the yoga instructor is a "mentor in the middle," in a very physical sense providing hands-on direction, adjustments, and support to students as they attempt new poses or try to refine those they have tried before. According to longtime yoga student, instructor, and author Mark Stephens, facilitating yoga in the classroom combines two philosophical concepts: *parinimavada* (the idea that change is a continual and inherent part of life) and *vinyasa karma* (the act of arranging in a particular way, including physical yoga postures, syncopated breath, etc.). Stephens notes, "For a teacher, this means letting go of the preconceptions about students and classes in favor of observing where they are and offering guidance based on that observed reality" (2012, pp. 15-16). This further plays into the idea that teachers must orient themselves among their students in the classroom in order to truly observe and understand students' comprehension at that moment. "The basic idea is to start from where students are and guide them to move consciously – in a special way – as they progress from simpler to more complex practices, gradually refining [their practice]" (Stephens, 2012, p. 329). The successful yoga teacher will have general goals for the design of a class but will also be able to adjust during delivery. As Stephens points out, "It also means crafting and teaching sequences that make sense in terms of the students actually in a class rather than teaching a preconceived sequence that could be too easy, too hard, too complex, or otherwise inappropriate for that particular class on that particular day" (2012, p. 15).

While the practice of yoga does not demand technology, the popularization of the practice in western culture has for many created a deep connection of music to practice. According Derek Beres, longtime yoga instructor, author, and founder of Mosaic Method and Flow Play – an initiative that binds neuroscience, music, and yoga – "nothing, in fact, affects as many regions of your brain as music" (Beres, 2018, para. 2). Beres explains that music is the only non-essential evolutionary tool that has remained a constant element in human life, and that this innate connection lends itself to the use of music during yoga practice. With this, yoga instructors often use technology to amplify music and sound to foster the build of sequencing. This additional element to learning can encourage or enhance momentum (flow) through upbeat syncopation, or to help settle the mind and lower the heartrate with low-tempo rhythm. According to Beres, sitar music – a yoga favorite – is the only tested and proven genre to lower cortisol levels in a listener's blood, which helps to repair tissue in the human body and increase relaxation. Knowing this, instructors can use music to aid their instruction and benefit their students.

Most instructors stream music through apps such as Spotify or Pandora directly from hand-held technologies. The ability to have control over this educational tool as they move around the classroom allows instructors to shift gears based on the needs of their students. When observation of students dictates they need a breath, or stillness instead of movement, a simple thumb click can shift gears musically and invite or encourage students to find a resting posture, like child's pose, based on their needs at that moment. In this way, students are active participants in the sequencing and instruction of their own learning.

We argue here that mobile technology can allow instructors of any discipline to act as "mentor in the middle"; they can "read the room" just as a yoga instructor does by moving among their students, responding to challenges, providing just-in-time adjustments, and encouraging collaboration and sharing. In turn, the physical proximity of an instructor who is not tethered to the front of the classroom can encourage interaction with students shy about asking questions or making comments in front of the whole class. Similarly, opportunities for group work enabled by devices that each student possesses can increase interaction, brainstorming, and creative responses to assignments both during and outside of class time. In addition, the democratizing nature of 1-to-1 access to devices for all students can help avoid perpetuating the digital divide that occurs as a result of unequal access to technology.

The Hiram College Tech and Trek Initiative

Hiram College is a small, private liberal arts institution of higher education in northeast Ohio with a long history of innovation in teaching and learning. A notable graduate is James Garfield, who later became teacher and principal there before becoming President of the United States in 1881. Hiram College includes both a Traditional College, composed of traditional students (18-24), 80% of who live on campus and 40% of who participate on athletic teams, and a Weekend and Evening College, offering education to adult students with careers and families. With a long history of curricular innovation (Miller & Varonis, 2017), the college is currently involved in an academic redesign, updating its curriculum to reflect the "new liberal arts" (Varlotta, 2017, para. 4). This approach affirms the importance of a liberal arts education while cultivating "the 21st-century competencies associated with increasingly global communities and workplaces" (para. 3). The biggest technological piece of that redesign has been the introduction of the "Tech and Trek" initiative, a 1-to-1-iPad initiative introduced in Spring 2017 and funded through a generous donation from a member of the Hiram College Board of Trustees and his wife. By August 2017, all full-time faculty and staff received a new iPad Pro for use in teaching and administrative responsibilities, and all full-time students in the Traditional College were issued an iPad Pro and hiking boots to emphasize the importance of balancing technology with other pursuits. As described in *InsideHigherEd*, the hiking boots became part of the initiative because “the college doesn’t want students to use technology as an excuse to become more engrossed in their phones and computers” (Tate, 2017, para. 8). A previous iPad initiative in 2013, limited to a handful of faculty in the Weekend and Evening College, did not include student adoption, offered limited professional development to faculty, and never gained traction.

The goals of the Tech and Trek initiative are symbolized in its logo, which includes a circle enclosing four key components (Figure 1): at the top, an iPad, representing mobile technology; on the right, a hiker, representing both a physical and intellectual “trek”; at the bottom, a light bulb, representing innovation; and on the left, a drop of water, representing mindfulness. The mindfulness symbol is explained by its creator, graphic designer Giedrius Cibulskis as “like a physical representation of present moment” with the vertical forms representing time, horizontal forms representing space, “And the one is always in the center – being here and now – perfect equanimity” (2017, para. 1). Simultaneously, the image depicts mindfulness as a water drop “which symbolizes time – past and future, both are illusions, no need to spend much time there, stay centered in the present” (para. 2). The four symbols represent four different and integral dimensions of the Tech and Trek program, which can be viewed as utilizing technology on both outward treks leading to creative and innovative interactions with the environment and inward treks leading to personal harmony and balance.

Figure 1. Hiram College Tech and Trek logo.

In early Spring 2017, before committing to adoption of the initiative, teams of Hiram College faculty and staff visited three colleges that had recently implemented 1-to-1 iPad initiatives in order to discuss with them their experiences. Shortly after, seven full-time members of the faculty and staff (including the first author) were invited to serve on an advisory committee known as the Transformers, charged with developing rollouts and professional development for their peers. Full-time faculty and staff were encouraged to apply for a role as an *Early Adopter*, which included receiving an iPad bundle (iPad Pro; keyboard; Apple Pencil) in late Spring 2017. The Early Adopters (EAs) committed to multiple professional development opportunities: completing eight Apple badges in the use of the iPad, participating in “Appy Hour” sessions on iPad apps led by Hiram College faculty and staff, attending professional development sessions led by Apple facilitators, and completing an iTunes U course over the summer that had been designed by the Transformers and included opportunities for EAs to participate in discussion forums, complete assignments, and reflect on the application of mobile technology and universal design for learning (UDL) to their own courses. One measure of the level of engagement can be seen in quantifying interaction in the iTunes U discussion forums: in the UDL section of the course, EA created 103 posts in required discussions and spontaneously initiated six more discussion threads, totaling another 97 posts.

While the faculty and staff were engaged in professional development to prepare them for utilizing the iPads, the IT team was involved in improving the infrastructure by expanding wireless access points and installing Apple TVs in highly-used classrooms. The Apple TVs made it possible for instructors to connect wirelessly with the projector in order to display what was on their screens from anywhere in the classroom. In this way, faculty could take full advantage of the new technology and avoid being tethered to a blackboard or an audio/visual control panel at the front of the classroom, instead moving in the middle of the class and among the students. And students could just as easily display their screens as well.

Though it was originally envisioned that a second round of iPad bundles would be distributed to non-EAs in spring or summer 2018, original donors Dean Scarborough and Janice Bini decided to make additional funds available in summer 2017, so remaining faculty and staff received them at the same time that students did. This provided for an unexpected comparison group for research purposes, since the second round of adopters had not participated in the intensive professional development afforded the EAs. There were additional opportunities offered in Fall 2017, though they were largely attended by the EAs. In total, entering fall semester there were 43 faculty EAs and 38 full-time faculty non-EAs.

Throughout the process of researching and implementing iPad adoption, a key question concerned integration of mindful technology into teaching and learning and the impact of iPad utilization in particular on learning outcomes. The primary aim of Tech and Trek was to teach *mindful technology* – encouraging students to creatively and critically use technology to enhance their learning on and beyond the campus. The “Tech” component promoted technology as an equalizer, as all faculty and students would have the same device. The “Trek” component was envisioned as promoting activity while enhancing experiential learning through off-campus experiences such as international study, internships, clinicals, and visits to the biology field station as well as encouraging “off-the-grid” time. Together, it was hoped that “tech” and “trek” would encourage students to think more critically and creatively and interact more with their environment, thus staying centered and finding balance during their challenging undergraduate years and preparing themselves to be lifelong learners. As articulated by Dean Scarborough (personal communication, July 28, 2017):

> I initially was focused more on learning outcomes, especially on using the technology to help students learn more efficiently and effectively. This dialogue is also focused on the "emotional intelligence" of our students, helping them not only learn, but to communicate and interact more effectively in today's world.

Results of the First Year of Implementation

Analyzing the impact of a technological innovation on learning outcomes is not an easy task. For the first year, both quantitative and qualitative data were collected from faculty, staff, and students in an attempt to document the effect of iPad implementation related to both education and administrative processes.

Fall 2017 Surveys

In the first semester of implementation, Fall 2017, anonymous surveys were administered to all faculty, staff, and students who had been issued iPads at the beginning of the semester, and repeated in the middle and end of the semester. Likert questions focused on iPad use and attitudes but were not formulated to directly ask about changes in classroom practices such as those we focus on in this paper. Only the student and faculty surveys will be considered here.

Student surveys. Students were surveyed on their use of the iPad and their attitudes towards its impact on their learning on a 5-point Likert scale. The highest agreement scores are summarized in Table 1, averaged over the three checkpoints.

Table 1

Student Perceptions of iPad Use in Fall 2017

Student iPad Use	Score out of 5; 5 = “Strongly Agree”
Access entertainment	4.56
Collaborate more effectively	4.40
Study and complete homework	4.36
Be more creative	4.32
Communicate better	4.27
Overall, I feel the iPad helps me learn	4.25

Clearly students were utilizing their iPads to “Access entertainment,” and this was supported by IT reports of Netflix usage during the year. Reassuringly, however, they also affirmed use of the iPad for educational activities. As one student commented at Checkpoint 2 in response to an open-ended question,

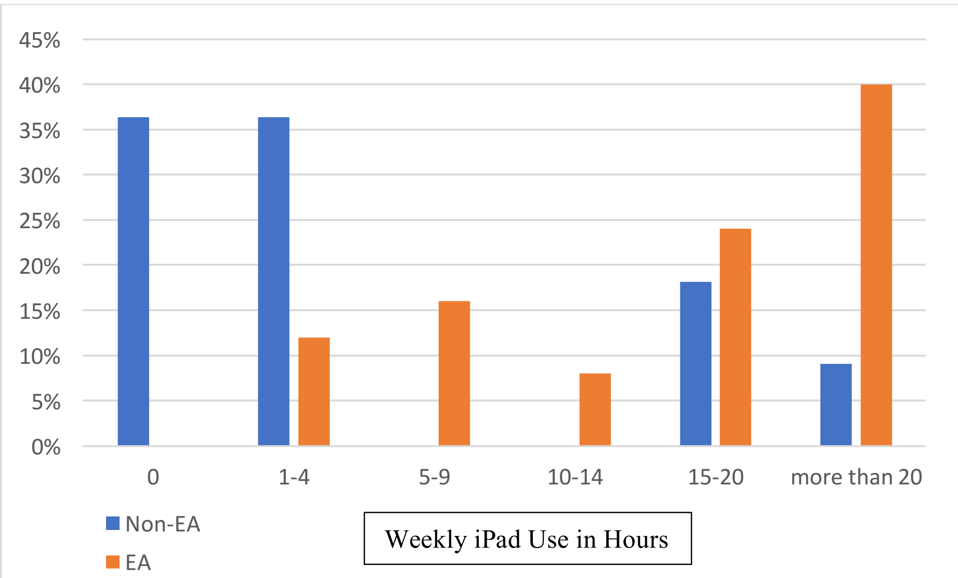
> I enjoy the cooperativity from everyone having the same type of device so there is similar functionality and it helps when working on projects. Also, I enjoy the interactive nature of all students being able to project their information on the projector to share with the class if it is relevant and necessary.

This comment anecdotally supports the concept of "mentor in the middle" that underlies this paper.

Faculty surveys. Faculty surveys were also administered, focusing on amount of usage, types of use, and attitudes towards use. A critical variable was whether the respondents were EAs, though it is difficult to distinguish whether the difference resulted from their desire to be EAs, or their professional development as EAs. The highest response rate was at Checkpoint 1 (36, representing 25 EAs and 11 non-EAs), which is the data summarized in this section. As Table 2 demonstrates, EAs utilized their iPads far more than non-EAs. For example, 40% of the EAs utilized their iPads more than 20 hours a week, but only 9% of the non-EAs did so; this trend continued at Checkpoints 2 and 3.

Table 2

Faculty Non-early Adopters (Non-EA) vs. Early Adopters (EA): Percentage of Weekly iPad Use in Hours at Checkpoint 1



In addition to hours of usage, attitudes towards the impact of the iPad on teaching and learning, as measured by a 5-point Likert scale, differed between the EAs and non-EAs. As Table 3 demonstrates, for every question except one, EAs agreed more strongly with statements about the impact of the iPad. The sole exception was the statement "I feel the iPad distracts me from the task at hand," where non-EAs (2.63) had slightly stronger agreement than EAs (2.56).

Table 3

Faculty Non-early Adopters vs. Early Adopters: Attitudes towards the Impact of iPad Use

	Early Adopters	Non-early Adopters
In general, I feel satisfied with my iPad's ability to help me:		
Access entertainment	3.72	3.38
Be more creative	3.80	3.38
Collaborate more effectively	3.72	3.38
Communicate better	3.48	3.13
Overall, I feel the iPad helps facilitate my intellectual growth.	3.48	2.67
I feel comfortable and proficient using my iPad.	3.84	3.25
I feel my iPad helps me connect with my community.	3.44	2.88
I feel my iPad helps me connect with nature.	2.36	2.25
I feel my iPad helps me to focus on the task at hand.	3.28	3.00
I feel the iPad distracts me from the task at hand.	2.56	2.63
I feel the iPad helps me to be more productive.	3.40	3.25
I feel I get the technical support I need for my iPad.	4.26	3.50

Challenges and barriers. An open-ended survey question explicitly requested faculty to share "challenges and barriers," and they did. Common concerns included unimproved infrastructure in some locations, the lack of an iPad filing system (before the release of iOS11), inability to print (before this was resolved), and the potential of iPads to distract students in the classroom. In addition, a number commented on their own ability to utilize the iPad effectively for teaching and learning. One EA commented, "I am still working on transitioning many of my class topics into formats that make full use of the iPad's capabilities. Time to make those changes is my biggest challenge. Not a barrier, but definitely a challenge." In contrast, a non-EA commented:

> I already know how to do what I need to do on my laptop. While the iPad may do similar things, it is not clear why I should invest the time in learning new ways to do what I'm already doing. The iPad may provide a DIFFERENT way, but so far I haven't seen that it is a BETTER way… I don't understand what they bring that I couldn't do before or what they allow me to do better than I'm already doing.

Best learning experience. A second open-ended question prompted faculty to discuss their "best learning experience" with the iPad. A recurring theme was enhanced participation from students through the technology; one non-EA commented simply, "Sharing screens for in-class group assignment reporting out," while an EA noted, "Students being able to project their work or what they have found on their iPad onto a screen has been awesome. I was also able to circumvent a problem with students uploading video assignments because they could air drop them to me." A number mentioned specific apps that they were successfully using, with a non-EA commenting,

> I love being able to have my students work on problems in Notability, rather than having to print off problems. This saves paper and allows me to generate learning tools on the fly in the classroom that can be immediately accessed by the students.

This same non-EA also applauded the ubiquitous availability of the device and its impact on teaching methods: "It is also wonderful that all students have an iPad – in years past, not all students had a laptop which inhibited use of technology in the classroom."

Personal Interviews with Faculty Early Adopters Fall 2017

All EAs were contacted by staff of the Office of Learning Technologies for personal interviews at the end of the fall semester 12-week session. Although these interviews have not been formally synthesized, there were many commonalities in terms of the impact of the iPad in and outside of class. Instructors commented upon their ability to:

- Display the solution of a problem in real time.
- Display their notes or annotations on instructional materials.
- Return to an image previously displayed (as opposed to writing on a board that had to be erased to make room for more writing).
- Utilize real-time surveys enabled by iPad polling apps to help them adjust their face-to-face lectures "on the fly."
- More easily implement problem-based learning methods.

Faculty also noted that the iPads afforded better opportunities for student-student collaboration; one commented "engagement was probably better because it was easier for them to work together and with me."

Other advantages for students that the faculty pointed out were:

- Note-taking
- Concept-mapping
- Annotating electronic course materials with their Apple Pencils during class
- Engaging in internet research on the fly
- Drafting written work through dictation as a way to avoid writer's block
- Enhancing small group "report back" sessions by projecting group-created documents
- Increased opportunities for students to help each other since they all had the same device.

In addition, the iPad afforded more opportunities for student creation beyond traditional essays or research papers. For example, they could create podcasts or videos to demonstrate achievement of learning objectives or for presentation in class.

The most common challenge that faculty related with respect to iPad use in the classroom was the increased potential for students to be distracted by their devices, e.g., by notifications of e-mail or social media posts. One strategy was to ask the students to shut their iPads before a discussion, but this was "tricky," as one faculty member phrased it, as students were also using their iPads for note-taking. However, faculty noted that student smartphones provided the same distractions before iPad implementation.

Spring 2018 Data Collection

Data collection continued in the spring, with surveys administered to students, faculty, and staff. In addition, Early Adopters were asked to submit a year-end report summarizing their use.

Student Surveys. Short surveys administered to students in Spring 2018 included three open-ended questions about positive and negative outcomes of iPad use and suggestions for the future. There were 115 responses of approximately 800 students who had received iPads by the spring. Results have not been fully coded yet, but individual responses reveal positive attitudes about the iPad as a tool to facilitate student consumption and creation of content. Student iPad use in particular facilitated note-taking, annotating electronic documents made available by the instructor, creation of projects, presentations, collaboration with other students, and on-the-fly research. Many were very appreciative of an instructor who created iBooks with that "beautifully synthesized PowerPoints, readings, and questions."

Relevant to the concept of "mentor in the middle," students commented on their ability during class sessions to view others work, communicate with others, share documents (in particular through air dropping), and work on problems and share solutions. One respondent commented, "It allowed us to transition quickly between presenters." With respect to how they might be used in a future course, many students indicated greater use of "mirroring" to allow student presentations would be beneficial; others asked for greater interaction and collaboration.

At the same time, a number of students pointed out that iPad use could be a distraction during class, just as faculty had previously observed. One admitted, "I sometimes would not pay attention in class and go on social media on my iPad," though another commented, "There were no ways the iPad hindered my learning."

Early Adopter End-of-Year Reports. Early Adopter faculty were required to submit an end-of-year report summarizing their experience utilizing iPads for teaching and learning. Though not compiled yet, the reports provide support for the success of the first year of Tech and Trek. One EA had integrated a "major new and novel course activity," namely, a Protein Structure Scavenger Hunt, and frequently had students share their screens while in class. He reported, "increases in student curiosity and engagement" and "statistical evidence that the iPad integration improved learning" as student performance on the American Chemical Society Biochemistry exam increased by 20 – 25% over the previous year (Romberger, 2018, p. 2).

Conclusion and Next Steps

Some argue that technology can isolate people from each other as they immerse themselves in social media and have less time for those that share a physical space. As Turkle states in *Alone Together*, "These days, insecure in our relationships and anxious about intimacy, we look to technology for ways to be in relationships and protect ourselves from them at the same time" (2011, p. xii). However, technology when utilized mindfully can enhance relationships and liberate users, in particular with respect to teaching and learning. It can provide opportunities for instructors and students to interact in new and powerful ways by breaking down barriers created by traditional classroom architecture and infrastructure, to aid instruction and motivate students, just as music does in teaching yoga. Mobile technologies embrace and advance educational practices grounded in the social construction of knowledge, allowing both the instructor and students to assume the role of "mentor in the middle" in support of student achievement of learning objectives, in particular when all students have access to the same technologies and use them in a mindful way.

For the technology to be effective, however, and lead to improved learning outcomes, faculty and students must be prepared to use devices purposefully and effectively. Professional development for faculty, including formal and informal sessions, can help them become comfortable with new devices and encourage informed risk-taking when trying out new methods. At the same time, conversations about the dangers of technology use – including distraction and isolation – should be included in any orientation to new devices to help ensure they are used mindfully.

Clearly, more research is needed, and there is more to learn from data already collected. Can we find the right balance of professional development for faculty that will prepare them and continue to engage them? Can we isolate best practices that have the greatest impact on enhancing learning outcomes? Are students whose instructors practice "mentor in the middle" for themselves and for their students more engaged and excited about their learning that those who do not have that experience? How do we learn what works best and what we should avoid when implementing new technologies in a teaching/learning environment? We have learned much this year, and hope we can apply it to future implementation and evaluation of our efforts.

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REDESIGNING THE INITIAL TEACHERS' EDUCATION PRACTICES: PROJECT TEL@FTE-LAB

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Abstract

The TEL@FTELab Project was set up assuming that technology enhanced teacher education programs may represent a relevant added value to the quality of prospective teachers' training and therefore of their teaching practices. The project aims to find answers to the question: How does technology in learning spaces offer opportunities to provide innovative ways of designing teacher education for the future.? The project takes the idea that the future will blur the boundaries between living, learning and working. and this will result in the creation of flexible multiuse spaces that can accommodate different activities and serve different learning purposes.

Introduction

The world faces a variety of critical problems and risks namely those related to climate change, sustainability of the planet and social inequality – problems so complex that they exceed the capacity of individual cognition. Education and training have a key role in contributing to create conditions to mitigate the risk of ill formulation of problems as well as to deficient identification of solutions (Matos, Pedro, & Pedro, 2017a). Per Matos, Pedro and Pedro, 2017b, p.7918, "There is an increasingly deep ingenuity gap between the huge practical challenges posed to societies and the rather limited problem-solving skills promoted by the prevailing practices in education."

Project TEL@FTELab (funded by the National Science and Technology Foundation) assumes that there is a need to improve both the competencies for life and work for teachers as well as quality of pupils' learning. Technology enhanced teacher education programs could represent a rather relevant answer to the predictable lack of ability to deal with problems and situations that it is impossible to preview (OECD, 2011). The quality of prospective teachers' education will pass inherently through the competence of teachers to engage students in addressing a variety of inter related problems and issues escaping the strict path of the traditional school disciplines (e.g., mathematics, physics). Thus, the project aims to find answers to the following question: How does digital technology in learning spaces offer opportunities to provide innovative ways of designing teacher education for the future, and to provide research-based resources for teacher education in the areas of Biology, Informatics, Mathematics and Physics? The project also takes the idea that the future will blur the boundaries between living, working and learning and this will result in the creation of flexible multiuse spaces that accommodate different activities and serve different purposes. This leads to the need for rethinking educational spaces and didactic approaches involving a wide range of stakeholders.

TEL@FTELab project articulates the piloting of real experiments in initial teacher education courses and its analysis with the development of a 21st century teacher skills framework. In the empirical field of the project, the implementation of learning scenarios is carried out within courses of the Master Programme on Teaching of the Institute of Education of the University of Lisbon (ULisboa). The initial teacher education programme at ULisboa follows a set of principles that include the requirement of solid knowledge (a) of the subject to be taught, (b) of general topics about education and (c) of specific didactics. It intends to allow the future teacher to develop the ability to cultivate a reflective practice. The introduction to professional practice (within the two years Master Program) is carried throughout the four semesters offering direct contact of the students with the school system and the opportunity to examine, reflect and intervene in real school situations. The competence of the student teacher is shown within the Master programme through the teaching practice on a supervised content unit in a secondary school class under the supervision of a teacher of ULisboa and a local in-service teacher from that school. In cooperation with the local teacher, the student chooses a teaching unit and implements it in a class. A written report of the implementation of the teaching unit by the student is produced and evaluated by a scientific committee. This model of initial teacher education assumes that the early contact of the student teacher with real pupils, under real situations in real schools represents a relevant dimension of inquiry and reflection on professional practice, contributing to integrate students' pedagogic, didactic and content knowledge.

Theorical Background

Although technology is now widely available and cheaper than ever, the scarce use of digital technologies in learning activities in the school context makes clear the resistances that both the education system and the teachers reveal in changing their teaching practices in daily work (Brás, Miranda, & Marôco, 2015). A few years ago, the European report about ICT in Education (European Commission, 2013) analysed the situation in 27 countries. Although it points to significant improvements achieved in schools' ICT infrastructures, there is a set of key conditions still to meet. For example, it is pointed out that (a) the connectivity in the classrooms in most schools is not satisfactory, (b) in general the teachers don't have enough ICT competences and confidence to support engaging teaching and in-depth learning, and (c) students' assessment models need to be reviewed and updated. On the other hand, even if the teachers' competences and attitudes towards the use of ICT in teaching are recurrently recognised as being at the heart of modernization of classroom practices, much professional training is still inadequate, particularly in respect to innovation and teachers' technology supported pedagogical practices. A variety of research articles as well as national and international reports (Barton & Haydn, 2006; BECTA, 2004; Matos, 2004; OECD, 2009) underline that: (a) ICT are not used regularly and systematically in teacher education, (b) ICT-related continuous professional development does not match the demand, and (c) there is still lacking congregate relevant information concerning how teacher education institutions prepare teachers to face today and tomorrow's classrooms.

Teacher education involves both initial teacher education as well as in-service teachers' continuous professional development. However, most of the efforts and programs for technology adoption in schools have mainly focused on basic and secondary education. It seems that it is assumed that university departments of education and graduate schools of education are not seen as stakeholders in the process of developing innovative teaching and learning practices (Wang, 2002). There is evidence that the efforts made to integrate and use digital technologies in teachers' training curriculum in higher education are insufficient (Kay, 2006; Matos & Pedro, 2008; Sutton, 2011; Swain, 2006). For example, Sutton identified the tendencies in the national policies regarding ICT in teacher education in 14 European countries. The conclusions are far from satisfactory. In a large set of countries, the use of digital technologies is not mandatory in the initial teacher education programs. In Portugal, as in many other countries, it is in some way surprising that the law that defines the Professional Qualification for Teaching (DL nº 79/2014) does not address ICT competences in any of the core professional components which are (i) scientific teaching area, (ii) general education area, (iii) specific didactics, (iv) cultural, social and ethical knowledge and (v) professional practice. Thus, consistent research-based recommendations that indicate that initial teacher education programs play a central role in shaping teachers' attitudes towards ICT and innovation are totally ignored: pre-service teachers who have acquired higher level of technological skills possess a stronger sense of efficacy with respect to computer use and are more willing to use technology in classrooms (Brown & Warschauer, 2006; Hammond et al., 2009; Paraskeva, Bouta, & Papagianna, 2008).

Meaningful use of digital technologies in the classroom, with impact on students' learning, requires teachers to take advantage of technological affordances with proper and powerful pedagogical approaches both for the specific subject matter to be taught as well as for the development of cross-discipline skills and societal competencies. But a frequent problem found in pre-service programmes in higher education is that the students do not have enough immersion in the use of digital technologies. Many teacher education institutions offer isolated ICT-related courses in which technical skills are to be promoted (Brown & Warschauer, 2006; Mishra & Koehler, 2006), but this happens in a rather non-contextualized form.

As a theoretical background, the project is using an integrative and contextualized form of addressing teachers' technological knowledge - the TPACK Model (Technological Pedagogical Content Knowledge) (Koehler, Mishra, & Cain, 2013; Wenger, McDermott, & Snyder, 2002). The TPACK framework emphasizes the complex interplay of three bodies of knowledge: content, pedagogy and technology (see Figure1).

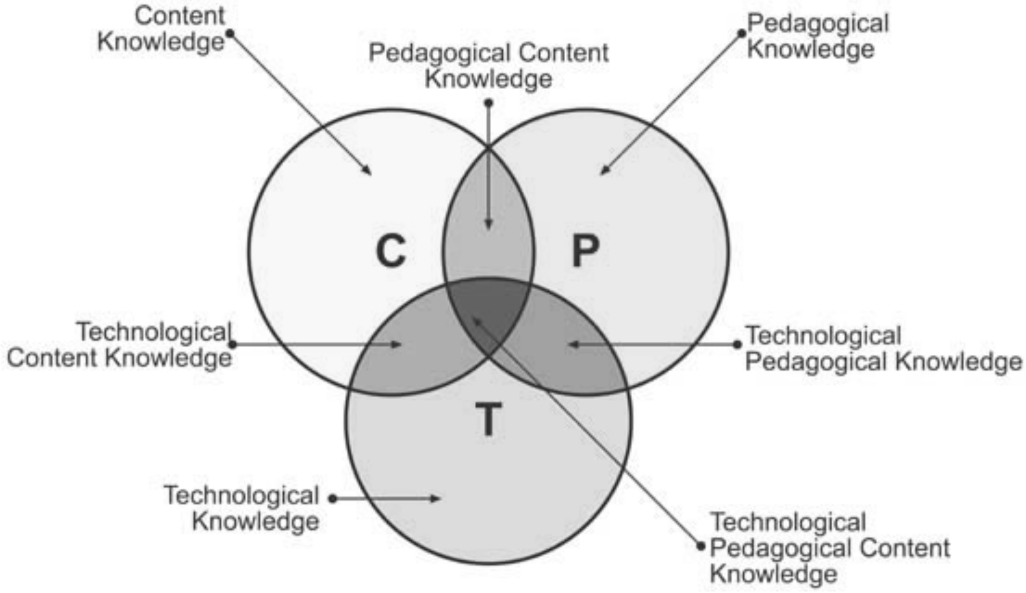

Figure 1: TPACK Model (Koehler, Mishra, & Cain, 2013).

The TEL@FTELab project assumes that quality teaching requires developing a clear understanding of the complex relationships between the three elements of the TPACK Model, its affordances, its constraints and its interactions. The model implicitly criticizes simplistic approaches for developing teacher knowledge, but we go a step forward assuming in the project the intentionality of preserving the complexity of initial teacher education (Matos et al., 2017a). The project also uses the TPACK Model as a form to assist us in developing better learning environments and for supporting a design-based approach for teaching future teachers to use digital technologies to create engaging classrooms (Pedro, Matos, & Pedro, 2014).

Additionally, we also consider that teachers' professional development requires to be continuously considered beyond the initial training they get in higher education, in continuing training sessions. Therefore, it is the responsibility of higher education institutions that run teacher education programmes to provide actions that address training in several areas.

Project TEL@FTE-Lab

The key idea of the project TEL@FTELab (see Figure 2) is that technology enhanced teacher education programs could represent an added value to the quality of prospective teachers' training. It is assumed that immersive use of digital technologies is associated to changes in the way people relate to knowledge. This is true for the way people conceptualize communication and its value in everyday practices as well as for new forms of addressing science and humanities in general. At ULisboa, an effort is being made to study the way we can prepare future teachers in areas such as Biology, Informatics, Mathematics and Physics to act according to the profile of new generations of pupils that will be responsible to create new realities in the future.

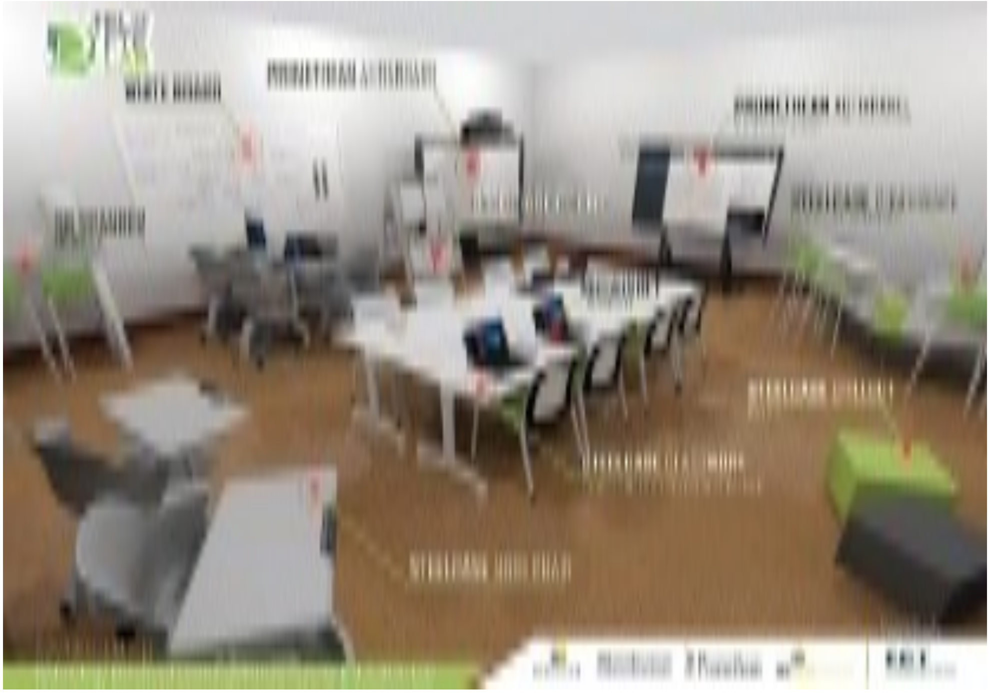

Figure 2. Future Teacher Education Lab at the University of Lisbon.

Beyond the academic research team, project TEL@FTELab includes five commercial partners acting as key participants in two fundamental tasks: the design and setup of the Future Teacher Education Lab (FTELab) and the implementation of strategies for the dissemination and mainstreaming of the results of the project. The project defines the following research questions:

1. What is distinctive about teacher education in technology enhanced learning spaces and how might it change teachers' views about the future of schooling?
2. What key competences should be part of teachers' repertoire for the future school?
3. How does technology enhanced teacher education can improve the quality of Initial Teacher Education programs?

The project is organized in three phases:

Phase I was concerned with the design and setup of FTELab and training modules of design of learning scenarios and the development of a first draft of a three dimension 21st century teacher skills framework (3D-21TSF).

Phase II consists of piloting the modules and the learning scenarios, in two consecutive cycles of implementation, within the Master Programs on Teaching. Each cycle of piloting includes the co-design of learning scenarios involving teacher educators and students and its experimentation in real secondary school classes.

Phase III takes the data collected and analysed and produces a set of video cases, training modules and learning scenarios that together with the 3D 21st century teacher skills framework compose the Teacher Education Toolkit delivered at the end of the project.

Thus, the research problem of the project is addressed through the articulation of piloting of experiments in initial teacher education courses together with an analysis and development of theoretical accounts combining the empirical field (through a two steps piloting with student teachers) with the theoretical field, which draws on Activity Theory and Situated Learning perspectives.

Implementation of TEL@FTELab Project

The project goes through a desk research in continuity with previous work of members of the research team in the domain of 21st century teachers' skills, study of communities of practice and design of learning scenarios using digital technologies, and the iterative participatory co-design (by the teacher educator and student), implementation and analysis of a set of learning scenarios with pupils in schools.

It has adopted a design-based research approach blending empirical educational research with theory-driven design of learning environments, as it proves to be a relevant methodology for understanding how, when, and why educational innovations work in practice (Anderson & Shattuck, 2012). Design is also central in the effort to foster learning, create usable knowledge, and advance theories of learning and teaching in a complex setting such as initial teacher education courses exploring possibilities to novel learning and teaching environments and increasing human capacity for subsequent innovation in education (Matos et al., 2017b).

Evidence on how student teachers learn in a technology enriched learning space is being produced through data collection and analysis and will inform the dimensions and indicators of the 21st century teachers' skills framework. Two kinds of instruments are being used: questionnaires (based on: the TPACK Model and ICT competences) to provide data on acceptance of technology and a focus group interview protocol (to get access to participants' views and understandings). The results of the analysis both feed the revision of the modules and learning scenarios for the next cycle of piloting and provide evidence to get answers to the research problem, the impact of technology enhanced learning spaces in teacher education.

During the last semester of the three years project, data will be collected (subject to social network analysis procedures) from the platform setup for the teacher educators' community of practice, to understand specific forms and strategies for cultivating the community. The project adopts the powerful idea of learning scenario as a key structuring resource for teacher education and produces a set of video cases for dissemination and training as part of the Initial Teacher Education Toolkit (http://ftelab.ie.ulisboa.pt/tel/gbook).The learning scenarios are structured through trajectories using interactive tools. Those trajectories are constituted by activity proposals to explore, in a stimulating and challenging form, key ideas in teaching of the disciplinary areas of piloting. Currently, the project is the 2nd cycle of piloting the learning scenarios – in BIMP area – having as a result a set of learning scenarios available for use for all academic community. It's expected that the project outcomes will show how digital technologies can create an open culture that transforms the teacher.

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A GUIDEBOOK TOOL FOR LEARNING SCENARIOS DESIGN IN INITIAL TEACHER EDUCATION

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Abstract

This paper describes the design process of a guidebook tool for teachers about the topic of learning scenarios design in initial teacher education. This online tool was developed under the scope of the Project Technology Enhanced Learning @ Future Teacher Education Lab (TEL@FTELab) of the Institute of Education of University of Lisbon. The guidebook (http://ftelab.ie.ulisboa.pt/tel/gbook) was organized in four dimensions: (a) planning, (b) production, (c) implementation, and (d) assessment. For each dimension the guidebook organizes many resources (e.g., texts, books, videos, articles, links) and examples of digital technologies that can be mobilized in that dimension. At the end of the project, the expectation is to have a powerful tool to support teachers who want to adopt the learning scenarios approach in their classes.

Keywords: learning scenarios, initial teacher education, technology enhanced learning, Tel@ftelab

Introduction

TEL@FTELab Project

We live in a technology- enhanced society where technologies are in almost all activities and things. The Internet of things and artificial intelligence systems are emerging strongly in society and the economy and briefly in our daily lives. Thus, a technology-enhanced school with emergent technologies and enhanced learning activities should be a priority to improve the development of 21st century skills in students.

Nowadays, it is quite clear that school and education need to change. New learning spaces, new methodologies and pedagogical approaches, new forms of interaction between teachers and students and new forms of organization need to be implemented and adopted. Accordingly, new approaches need to be implemented and tested in initial teacher education. Taking this idea, the Institute of Education of Lisbon University (IEUL) – one of the educational institutions with responsibilities for initial teacher training in Portugal – designed the TEL@FTElab Project in 2015 to be implemented in the initial teacher education Master programs. In the last two decades, IEUL has participated in several projects, both national and European, in the field of educational technologies, particularly to promote the use of technology in teachers' practice (e.g., iTEC, Living School Lab, Future Classroom Lab, Learn, Plano Tecnológico da Educação, Programação e Robótica, Internet na Escola). The TEL@FTElab Project, funded by the National Science and Technology Foundation, assumes that technology enhanced teacher education programs may represent a relevant added value to the quality of prospective teachers' training and therefore of their teaching practices.

The project takes the idea that the future will blur the boundaries between living, learning and working and this will result in the creation of flexible multiuse spaces that can accommodate a variety of activities and serve different learning purposes. This leads to the need for rethinking educational spaces and didactic approaches, involving a wide range of stakeholders. Accordingly, the project aims to find answers to the question: How does technology enhanced learning spaces offer the opportunities to provide ways of designing initial teacher education, and to provide research-based resources for teacher education in the areas of biology, informatics, mathematics, physics and economics?

Project TEL@FTElab aims to develop knowledge that fills the need for powerful engaging strategies to deliver teacher education courses for the future. It is organized in three phases. One of them is about piloting training modules, in two consecutive cycles of implementation, within the Master Programs on Teaching. Each cycle of piloting includes the co-design of learning scenarios by teacher educators and student teachers and its experimentation in real secondary school classes of biology, informatics, mathematics, physics and economics. The initial teacher education program at IEUL follows a set of principles that include the requirement of solid knowledge (a) of the subject to be taught (e.g., biology content), (b) of education and (c) of specific didactics (e.g., of biology teaching). The introduction to professional practice within the two years Master Program is carried throughout its four semesters, offering direct contact with the students within the school system and the opportunity to observe, reflect and intervene in real school situations. The student teacher's competence is shown through the teaching practice on a specific content unit in a secondary school class under the supervision of a teacher of IEUL and a local in-service teacher from that school. In cooperation with the local teacher, the student chooses a teaching unit and implements it in a class. A written report of the implementation of the teaching unit by the student is produced and evaluated by a scientific committee. Project TEL@FTELab aims to understand the impact of the immersion of student teachers in preparing and implementing learning activities at technology enhanced spaces in their professional development. This is accomplished through the design and implementation of learning scenarios.

Learning Scenarios Design: Principles, Characteristics and Structural Elements

Design scenarios have been used in many areas (e.g., marketing, software development, medicine, games design, economy and many others) as a way to think about the future, anticipating problems and predicting solutions to those problems. The use of scenarios in education can promote the development of competences required for 21st century citizens related to problem solving, communication, collaboration, critical thinking and creativity. The TEL@FTELab project adopts the idea of learning scenarios as key to planning teaching activities in technology enhanced learning spaces. Matos (2010) defines the learning scenario concept as “a hypothetical situation of teaching-learning (purely imagined or with real substrate, widely changeable) composed of a set of elements that (i) describes the context in which learning takes place, and (ii) the environment in which learning happens” (p.3). Wollenberg, Edmunds and Bucke (2000) define learning scenarios as

> … stories of what might be. Unlike projections, scenarios do not necessarily portray what we expect the future to actually look like. Instead scenarios aim to stimulate creative ways of thinking that help people break out of established ways of looking at situations and planning their action (p.66).

According to Tetchueng, Garlatti and Laube (2008) scenarios are a powerful tool to plan and “describe the learning activities to acquire knowledge domain and know-how to solve a particular problem” (p.71). Along the same lines, Misfeldt (2015) defines scenario based education as a “newly developed framework or approach to understanding educational situations building on scenarios, understood as real or artificial situations that are used to create context, experience of relevance and immersion, in educational situations” (p. 3).

Clark (2009) defines scenario-based learning as an instructional environment in which participants solve carefully constructed, authentic job tasks or problems. For example, Carroll (2000) pointed out five reasons to adopt a scenario-based design in the design of new technological applications: (1) scenarios evoke reflection, (2) scenarios are at once concrete and flexible, (3) scenarios afford multiple views of an interaction, (4) scenarios can also be abstracted and categorized, and (5) scenarios promote work-oriented communication. Based in those reasons Matos (2010) pointed to a set of structuring elements of a scenario: (a) the organizational environment design, (b) roles and actors, (c) plot line, strategies, actions and activities, and (d) reflection and regulation.

The design and implementation of a learning scenario is conditioned by numerous factors: subject area, knowledge domain, roles played by the different agents (students and teachers) and sequences of learning activities. Matos (2014) defines a set of six guiding principles for learning scenarios design. These principles are represented in Figure 1.

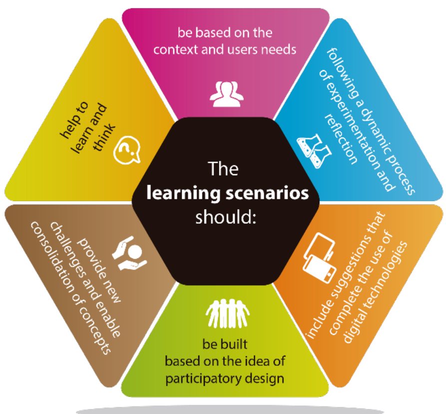

Figure 1. Guiding principles of learning scenarios design (Matos, 2014).

A learning scenario must assume a set of characteristics (Matos, 2010):

- **Innovation** – A scenario should demonstrate possible innovative activities and not provide prescriptive plans to teachers.
- **Transformation** – A scenario should encourage teachers to experiment with changes in their pedagogical practices of teaching and assessment methods and to bring about transformative educational experiences with success.
- **Foresight** – A scenario should be considered as a planning tool used to think on innovative ways of looking ahead and making appropriate decisions regarding uncertain conditions.
- **Imagination** – A scenario should always be a source of inspiration and nurturing the creativity of the teacher.
- **Adaptability** – A scenario should not be presented in a rigid way. It is up to the teachers to adapt it to their objectives and the characteristics of their students.
- **Flexibility** – A scenario should provide options targeting different learning styles and individual teaching styles. Teachers can use it at an elementary level or make it more complex.
- **Amplitude** – A scenario must be constructed to have a greater or lesser extent. The actors' role may be confined only to the level of operations and actions or intended to be active participants in the entire activity system. Scenarios may include multidisciplinary projects to be worked on by students over extended periods of time.
- **Collaboration**– A scenario may contain elements to the accomplishment of collaborative activities (synchronous and asynchronous), including technological tools that facilitate sharing and collaborative construction of objects.

Learning scenarios in the TEL@FTELab project are structured through trajectories using interactive tools mostly based on mobile technology. Those trajectories are constituted by activity proposals to explore, in a stimulating and challenging form, key ideas in teaching of the disciplinary areas of piloting (e.g., biology, mathematic, informatic, physic and economic).

Description of *Learning Scenarios Guidebook*

The *Learning Scenarios Guidebook* is an online tool to support the learning scenarios design and is organized in four dimensions based on the design and implementation process. A brief description of the guidebook's objectives, the concept of learning scenarios, and a set of resources about their design are presented. In a specific menu a set of examples of leaning scenarios developed in various subject areas are available for download. There are also two video case examples developed in the first cycle of piloting (http://ftelab.ie.ulisboa.pt/tel/gbook/cenarios-de-aprendizagem/). A video case example consists of a learning scenario description and presentation (in video animation), a set of metadata (e.g., school, students, topic, subject, student teacher and supervisor), a full and short version of scenario for download and a set of participants' testimonials (see Figure 2).

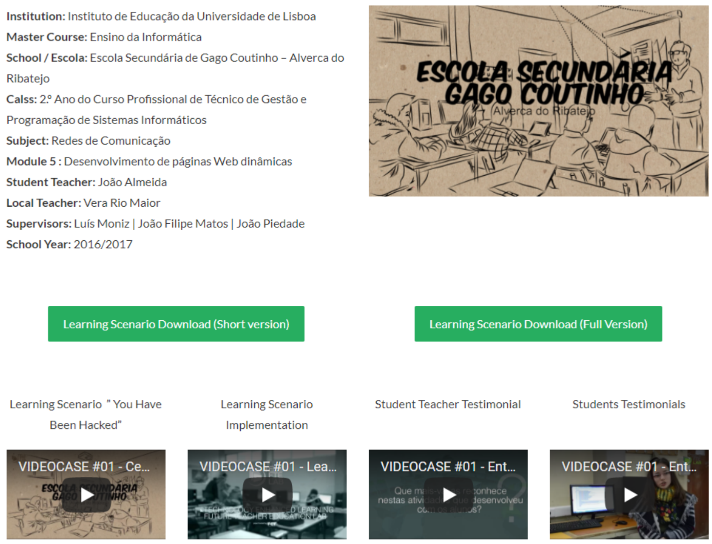

Figure 2. Video case example of Learning Scenario "You Have Been Hacked."

The learning scenario design process should be organized in the phases shown of Figure 3. The guidebook tool was organized according to those phases.

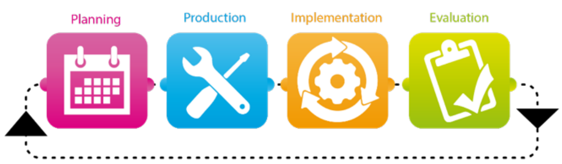

Figure 3. Phases of learning scenarios cycle.

Planning Phase

The design of a *learning scenario* is an activity that should include the reflection by the teacher or the team of teachers involved in the process. Typically, the process of learning scenario design or adaptation to a specific class of students involves the clear identification of the idea, the subject to be addressed or the problem to be solved. It is necessary to clarify the specific domain of knowledge, not necessarily linked to a single subject, and to identify the goals (e.g., learning objectives), contexts, curricular links and the requirements' analysis to the activities' implementation. Taking into account the specificities of this phase, a set of digital resources and applications is organized to support the planning activities. There is a wide range of applications and digital tools that can be mobilized in each of the various stages of the process. For example, collaborative and brainstorming tools (e.g., Paddlet, Stormboard, Glogster), mind maps creation (e.g., Popplet, Mindtools, Mindmeister), presentation apps (e.g., Prezi, Emaze, Sway), and many others.

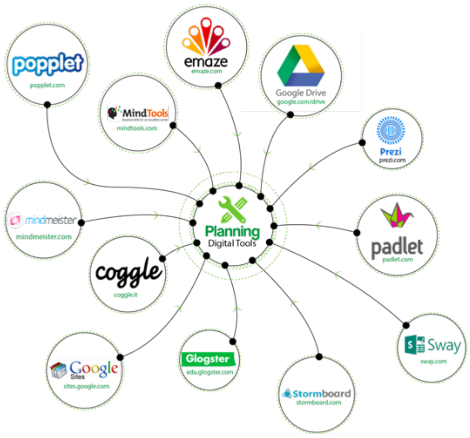

Figure 4. Example of digital technologies that can be used in the planning process.

Production Phase

In the learning scenario's production phase the teacher organizes the main ideas outlined in the planning phase in a specific template. Thus, considering the principles previously mentioned for learning scenario design, as well as their structuring elements, the teacher defines the narrative, learning objectives, methodologies and learning strategies, activities proposals, resources, actors and roles and the forms of learning regulation and self-regulation.

After the scenario design, the teacher can proceed to its licensing by using the creative commons rules defining the conditions for possible use in other educational contexts. The online guidebook provides a set of templates and resources to support the design of a learning scenario.

Implementation Phase

After the scenario design and production, the next phase is its implementation in a real class. Together with the students the teacher orchestrates a set of learning activities and develops a set of learning products outlined in the scenario, using active methodologies and strategies supported by digital technologies.

To support the design of those technology enhanced activities and to help implementation in the classroom, the guidebook offers a set of resources about some active learning strategies: (a) project-based learning, (b) problem-based learning, (c) inquiry-based learning, (d) flipped classroom, (e) gamification, and (f) pair programming (see Figure 5). These resources include an explanation about each strategy, its main characteristics, ways of implementing it, potentialities and constrains and forms of assessment and self-assessment.

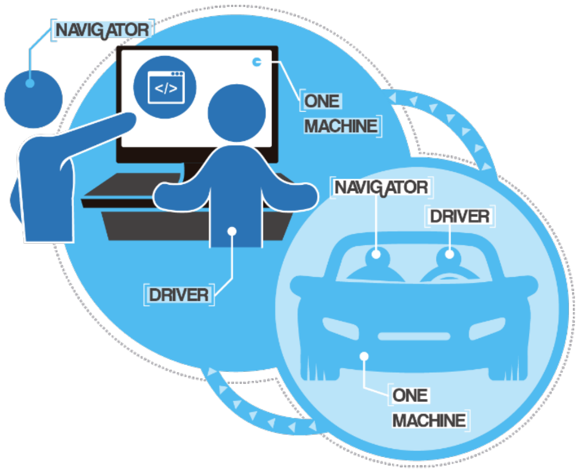

Figure 5. Example of pair programming based activity organization.

Evaluation Phase

The evaluation purpose corresponds to a careful analysis of the actual learning achieved in relation to the planned learning. It will inform teachers and students about the objectives reached and those where difficulties have arisen. The evaluation is an essential process to support the decision-making of the teaching and learning process contributing to effective learning and, consequently, to better results.

In the learning scenarios' implementation, assessment mechanisms and feedback should be present, throughout the process, contributing to critical reflection and self-regulation of learning. In the process different purposes of evaluation should be considered: diagnostic, formative and summative. According to the purpose of evaluation, some digital applications can be mobilized to support and achieve the assessment, results and feedback. Therefore, as for the previous phases the guidebook suggests a set of digital tools that can be used in evaluation and self-evaluation activities. Figure 6 shows some of those digital tools.

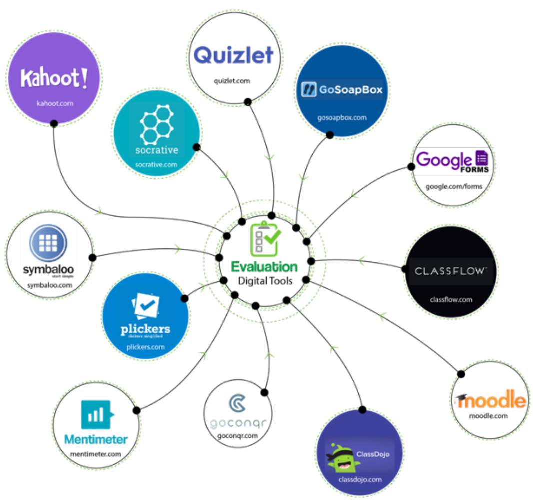

Figure 6. Example of digital technologies that can be used in the evaluation phase.

Implementation Plan and Expected Results

The TEL@FTELab project has two cycles of learning scenarios design and implementation. The first cycle was implemented in the 2016-2017 academic year and the second cycle in the 2017-2018 academic year. This online tool was designed to be used by student teachers in the second cycle during the 2017-2018 academic year. At this moment student teachers are using the guidebook to support the design and implementation of their learning scenarios in secondary schools. In the first semester (from September to January) of the scholar year, student teachers of biology, informatics, mathematics, physics and economics areas designed the learning scenarios to be implemented with a classes of students in secondary schools in the second semester. During the second semester (from February to June) the student teachers will implement the learning scenario in their class in 5 or more lessons. After the implementation process, a written report of the implementation of the teaching-learning scenario by each student teacher is produced and evaluated by a scientific committee.

At the end of this cycle, a set of video cases about each learning scenario implementation will be produced to report the process.

For the production of these video cases, interviews will be carried out with the student teacher, the class students and the supervisors, as well as the analysis of the reports and products developed by the student teacher. One of the dimensions under analysis is the guidebook tool utilization, and it is expected to produce knowledge about the impact of this online tool in the support of the work of student teachers in learning scenarios design and implementation.

Final Remarks

This paper presented the guidebook developed to support the design and implementation of learning scenarios enriched with digital technologies in initial teacher education. An online tool was organized in four dimensions and a set of digital resources made available according the specificities of each dimension.

In the current academic year, the students of the initial teacher education courses are using the tool to support the development of learning scenarios (e.g., informatics, biology, mathematics and economics contents) to be implemented in a secondary school under the scope of a course of introduction to professional practice. At the end of each learning scenario implementation, a video case is produced for dissemination; it includes a detailed description of the learning scenario as well as testimonials of the supervisor, of the in-service teacher and, when appropriate, of the pupils involved.

This guidebook is in continuous improvement process considering the inputs of the implementation cycles and analysis. It is expected that by the end of the project in 2019 a powerful tool will be available to support teachers who are willing to adopt the learning scenarios approach in their classes or educational contexts.

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GLOBAL LEARNING AS A CHALLENGE FOR THE INSTRUCTIONAL TECHNOLOGY UNITS IN HIGHER EDUCATION

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Abstract

Instructional technology units (ITU) in different higher education institutions have different names not necessarily reflecting the mission and mandate of the unit. In addition, the tasks performed cover a wide range of technological, managerial and pedagogical activities. In addition, the existing literature shows more than one definition of global learning, where each reflects a different pedagogical philosophy or a distinct level of technology integration.

This study aims at assessing the magnitude of challenge imposed by global learning on the instructional technology units at higher education institutions. An examination of the jobs performed by these units cross-examined against the set of common features of global learning specifies the tasks clearly challenged. In addition, the subset of features that are not addressed by any of these tasks has an indicative weight in assessing the challenge. Qualitative assessment is employed to judge the magnitude.

Instructional Technology Units

A variety of names is used in higher education (HE) institutions to point to instructional technology, with the most popular being educational technology. The two names are used interchangeably although there exists a general agreement on the differences between instruction and education. These differences do not affect this research as the emphasis is on the managerial aspects of the operation of the units, sections, or departments that provide the instructional technology service. In other words, what matters to this research is the functions performed regardless of the name used.

An overview was conducted of the mission and goals of 9 units handling instructional/educational technology (ITU) in different ecosystems and reflecting different educational visions (See Table 1 for the names and addresses). The goal of the overview is to extract the set of the common functions performed by these units.

Table 1

Units Handling Instructional Technology Consulted in This Study

Unit	URL	University
Academic core processes and systems	http://website.aub.edu.lb/it/acps/services/Pages/home.aspx	American University of Beirut, Lebanon
Educational technology Center	https://www.albany.edu/its/82184.php	University of Albany, USA
Educational Technology center	http://www.ust.edu.ph/academics/educational-technology-center/	University of Santo Tomas, USA
Elearning center	https://www.tlu.ee/en/E-learning-Centre	Tallinn University, Estonia
Educational technology	https://itss.d.umn.edu/services/educational-technology/educator-tools	University of Minnesota Duluth, USA
Instructional technology support	https://www.nyu.edu/life/information-technology/instructional-technology-support.html	New York University
Center of excellence in teaching and learning	https://www.ccny.cuny.edu/cetl	City college of New York, USA
The center for instructional technology	https://www1.villanova.edu/villanova/unit/instructionaltech.html	Villanova University, USA
Instructional technology Unit	http://www.uobitu.org/	University of Balamand, Lebanon

The overview showed that:

1. Instructional technology units focus on facilitating student learning using a wide and varied range of tools.
2. The tasks of instructional technology differ from one university to another.

The set of the most common functions performed by ITUs includes:

1. Training instructors on the design and development of innovative educational technology solutions to enhance teaching and learning.
2. Promoting mobile and e-learning environments and implementing solutions.
3. Assisting in course preparation using building tools and learning management systems.
4. Assuring the availability of classrooms tools, like Clickers, Polling Response Systems and interactive whiteboards
5. Supporting video conferencing.
6. Assisting in the production of high quality multimedia content such as recordings of classroom sessions or video conference sessions.
7. Managing quality assurance including complying with policies and standards and the use of tools for originality checking and anti-plagiarism.

Global Learning

Global learning is becoming one of the buzzwords in the educational technology field. An increase of 24 % in the size of the global learning management system market is expected through 2020 (Technavio, 2016). Global learning is counted among the hottest trends in education technology, according to more than one source (Connell, 2016). Despite this, there is not one final agreed upon definition of the concept (Dlamini, 2017). Some of the definitions approach the concept from a student perspective (Agnew & Kahn, 2015), while others approach it from a faculty member perspective (Hilliard, 2015), and very few make their approach through an ecosystem view (Landorf, Kahn, & Whitehead, 2016).

An examination of the different definitions in the literature reflected a massive dissimilarity between higher education views of global learning. The different approaches reflected concentration on global content, internationalization, and global citizenship (Connell, 2016). All the definitions highlighted the role of technology in achieving the goals. Some definitions oversimplified the issue to describe global learning as the simple use of ICT to collect and utilize global content (Bourn, 2014; Gibson, Watters, Alargic, Rogers, & Haack, 2003; Global Learning Programme, n. d.)

Studying these variations is not our goal, but a definition is needed on which to build our assessment of the challenges of global learning on the instructional technology units; the definition of the Association of American College and Universities was adopted (Hovland, 2014).

According to the Association of American College and Universities, "Global learning is a critical analysis of and an engagement with complex, interdependent global systems and legacies (such as natural, physical, social, cultural, economic, and political) and their implications for people's lives and the earth's sustainability" (Association of American Colleges and Universities, 2009). Through global learning, students should:

a) "Become informed, open-minded, and responsible people who are attentive to diversity across the spectrum of differences
b) Seek to understand how their actions affect both local and global communities
c) Address the world's most pressing and enduring issues collaboratively and equitably" (Association of American Colleges and Universities, 2009).

Methodology

The functions described above were validated against the Metaari's Learning Technology Research Taxonomy. This taxonomy is described in *The 2016 Global Learning Technology Investment Patterns* published by Metaari in 2017. This taxonomy classifies 8 digital learning products for global learning and is used as the backbone of Metaari's quantitative data repository and the foundation of its classification system that enables the identification, cataloguing, and indexing of addressable opportunities for revenue when suppliers market specific products to distinct segments of buyers in different globally. Metaari claims that the purpose of the taxonomy is "to provide tactical precision to suppliers competing in a complex global market" (Adkins, 2017, p. 6). The classified products are: (a) self-paced eLearning (courseware), (b) collaboration-based learning (live online tutoring), (c) digital reference-ware (digital audio, digital video, and text), (d) simulation-based learning, (e) game-based learning, (f) mobile learning, (g) cognitive learning, and (h) a new type of learning product, robotic tutors (Adkins, 2017, p. 23).

Table 2 shows a matching of the functions claimed by the ITUs and the digital learning products classified by the taxonomy to assure the readiness of the ITUs to manage these products and produce service using them.

Table 2

Claimed Functions vs. Metaari's Global Learning Products

	Self-paced eLearning	Collaboration-based learning	Digital reference-ware	Simulation-based learning	Game-based learning	Mobile learning	Cognitive learning	Robotic tutors
Training instructors	✓	✓	✓	✓	✓	✓	✓	
Advising on e-learning environments and implementing solutions	✓	✓				✓		
Assisting in course preparation and building tools for LMS	✓	✓	✓	✓	✓	✓	✓	
Assuring the availability of classrooms tools		✓	✓	✓	✓	✓		
Supporting video conferencing systems	✓	✓	✓	✓	✓	✓	✓	
Assisting in the production multimedia content	✓	✓	✓	✓	✓	✓	✓	
Managing quality assurance	✓	✓	✓	✓	✓	✓	✓	

Table 2 shows that ITUs manage all the global learning products fully or partially. The robotics tutors is not yet mentioned by any ITU although it is expected to have a major effect (MacIntosh, 2018).

It should be noted here, concerning the validity of the matching, that to assure an exact matching, the study should have dealt with the task level, where differences among ITUs will show. Dealing with the general task is satisfactory since the aim of this study is to explore the range and nature of the challenge more than the steps to meet it.

A *challenge* is something new and difficult that requires great effort and determination (*Collins English Dictionary*, 2018). In the case under study, challenges are seen as the occurrence of an arbitrary phenomenon.

To come out with a clear assessment, a clear tool should be devised. To report the findings of the research and make the assessment clearer, a matrix is used as a visual representation. In this matrix, information is organized to show the value of the severity of the challenge brought by global learning products. Since the concern is evaluating the association between the functions of the ITUs as perceived and declared by them and the global learning products that form the variable determining the rows of the table, scoring is the method used (Trochim, 2006). Challenges are scored by a set of 10 experts. These experts are directors and managers of ITUs in 10 different Lebanese universities.

These experts who provided their scoring were contacted by email. The scores filled in the table are the averages of the assessment made by the 10 experts. These are intended to reflect how severe is the challenge created by each global learning product on the ITUs based on the functions claimed to be performed by them. Directors and managers were asked to grade the difficulty of each function on a scale of 1-10 where 1 is the easiest and 10 the most difficult (Alberts, 2013).

Results and Analysis

Table 3

Scores of Challenges Created by Global Learning Products

Products	Score
Digital reference-ware	2
Self-paced eLearning	3
Collaboration-based learning	4
Simulation-based learning	5
Mobile learning	5
Cognitive learning	6
Game-based learning	7
Robotic tutors	9
Average	5.12

The overall difficulty is above average. This means that going global is a difficult challenge for ITUs. This result can be understood since both instructors and students need to bring learning experiences from the world into classrooms, to share their experience and problems, and to collaborate on projects with international partners and colleagues.

Conclusion: The Set of Challenges

The result of the above analysis necessitates a clearer presentation of the challenges an ITU faces in adopting global learning. A revisit of the literature was necessary to better formulate the challenges. The result is the following list of the most important common challenges:

1. Social media utilization challenges include:
   - Global learning generates to a growth of use in social media and collaboration tools such as Facebook, Twitter, Google Hangouts, Skype, and many others.
   - The selection of the right social media for a course challenges the instructional technology unit as it is expected to cross the course needs against the functionality of each social media tool and make a decision on which to use.
   - The utilization of multiple social media tools might lead to chaos (Beseghi, 2017).
2. Video Conferencing challenges include:
   - An increase in the demand for video conferences is another challenge especially if dedicated rooms are requested.
   - The type of video conferencing, the real presence requirement.
   - The increase in the number of sessions requires an increase in budget.
   - The bandwidth and quality of conference is another concern (Sinay, 2014).
3. Training challenges include:
   - A higher learning curve should be adopted by the unit in order to support the new tools and products. Adopting new technologies requires professional mastery before handing them to instructors and students in class.
   - Studies show that in many cases, instructors avoid workshops and training sessions. This requires a higher level of support from the unit's side (Hovland, 2014).
4. Global issues challenges include:
   - The learning management system support of multilingualism or content translation. This is a challenge for the unit that manages this system.
   - The differences in the regulations on privacy and intellectual property from one country to another.
   - The difference between time zones as it affects due dates and exams scheduling (Gillett-Swan, 2017).
5. Emerging trends and technologies' challenges include:
   - New trends in education like blended courses whose approach is to integrate components of face-to-face and online learning.
   - A higher demand on videos and presentations for class use, assuring a considerable quality (Adkins, 2017, p. 28).

Recommendations

Since global learning is not just connecting a classroom to the Internet, every new demand for a product or service creates a different challenge for the ITUs for which the ITU should be ready, technically and organizationally. Accordingly, it is recommended that:

- An ITU should ensure that the university has the best conceivable infrastructure to provide instructors with the best technology resources to better serve and prepare students to global learning
- Professional development of the ITUs staff should be at the top of the management concerns to assure access to relevant and rigorous professional training that guarantees the proficiency in integrating learning technologies in the HE ecosystem (Passut, 2018).

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BACK TO CONTENTS

APPLYING LEARNING ANALYTICS TO CURRICULUM REVIEW: EXAMPLES FROM PROGRAMS

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Abstract

Learning analytics (LA) are used in higher education for predicting student grades or identifying students at risk (Gašević, Dawson, Rogers & Gasevic, 2016). However, there is little research on its use for curriculum evaluation (Méndez, Ochoa, & Chiluiza, 2014). This paper describes a LA-based curriculum review that includes assessment of subject grades, student satisfaction and cohort comparisons. Our results show that using LA as part of curriculum review can provide insights not possible with traditional curriculum review methods and can yield useful and actionable insights. But the challenge remains to develop tools that can assist teachers to conduct LA independently.

Background

This paper reports on how using learning analytics (LA) for curriculum review at the program level can provide insights not possible with traditional curriculum review methods. Most research applying LA in higher education has focused on academic success and retention (Siemens, Dawson & Lynch, 2014), rather than it as an approach to program[1] curriculum review. Historically, curriculum review in higher education has taken a fairly standard approach—stakeholders, usually students and faculty, are surveyed and/or interviewed, standard course and subject performance data are collected, an evaluator (often external to the program under evaluation) is appointed to undertake the review, analyse the data and generate a report with recommendations for improvement. A review of the literature on curriculum review and the current status of the use of LA in higher education shows that LA specifically for curriculum review purposes is under-explored but has considerable potential (Komenda et al., 2015; Méndez et al., 2014; Toetenel & Rienties, 2016). This paper presents applications for LA as part of curriculum review at the program level that clearly demonstrate its usefulness in providing actionable insights that are either not easily obtained or not possible with traditional curriculum review approaches. The progress we have made towards formalizing our approach so that it can be applied to curriculum review of programs more generally and work we have done addressing the challenge of making LA-based curriculum review accessible to teachers through tools that analyse and visualize program or subject data is also briefly discussed.

Curriculum Review and Learning Analytics

Curriculum Review

A curriculum consists of the proposed aims, objectives, learning outcomes and disciplinary content of an educational program. It should be designed considering characteristics of the students entering the program, and have learning outcomes, performance outcomes or competencies that are clear, measurable and reflect the disciplinary requirements of graduates. There also need to be descriptions of the intended pedagogical or teaching and learning approaches (such as active learning strategies, supervision, work-integrated learning, laboratory teaching, e-learning, etc.) and of the substantive curriculum content, along with a robust assessment approach that directs learning and measures intended performance and learning outcomes. There should also be transparent program-wide continuous improvement and evaluation processes.

Internationally, rapid changes in technology and increasing employer demands have come to influence curriculum development and evaluation processes (Cleaver et al., 2017). In higher education, standard approaches to curriculum design generally include those key considerations noted above. Further, curriculum review as a quality improvement strategy has generally included what has been referred to as "the usual incremental and risk-based continuous enhancement processes" (Cleaver et al., 2017, p. 146). Such 'enhancement processes' generally seek evidence from stakeholders, principally students and faculty, about their experience of the curriculum and evidence *from* and *about* stakeholders of their learning development against the intended outcomes of the curriculum. At our university, curriculum review approaches include student and faculty surveys of satisfaction with subjects, programs and teaching practices, surveys of the first-year experience and student perceptions of their program after graduation, as well as performance data such as subject and program-level pass rates, progression and program completion data. Quantitative data such as this is normally complemented with qualitative data from documentary analyses and student and faculty interviews.

Creswell and Clark (2017) suggest that the addition of mixed-methods research to review approaches offers strong outcomes-focused evaluation options. Furthermore, the application of LA for curriculum review should not only complement existing methods, but can also add considerable power through its predictive capabilities. While the field is changing, curriculum review in university settings is almost always post-hoc, in that review data are collected at the completion of units of study and programs. Recommendations from the review are then implemented for the next iteration.

Universities collect considerable and varied data about their students across the course of their studies. For example, data relevant to students' learning behavior are held in student administration records, the learning management system, the library, IT services and other sources. Unfortunately, data often exists in silos and are rarely aggregated, analysed and applied to specific curriculum questions. However, when data are available for analysis as part of curriculum review, the potential exists to provide valuable insights for action.

By using LA for curriculum review, data from multiple sources can be aggregated and analysed and complex and unstructured data can be turned into actionable information about what is happening in the curriculum and how to address performance challenges (Daniel, 2015).

Learning Analytics
A commonly accepted definition of LA is "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs" (Siemens, 2013, p. 1382). LA can be used to predict student performance, to understand the causes of at-risk learning behaviors and student attrition and for assessing institutional performance (Greller & Drachsler, 2012). Student characteristics, grades, behavior and effort have been found to be highly predictive of past students' success. Furthermore, using this information to help current students with their studies has been shown to improve student grades significantly and decrease fail rates (Mattingly, Rice, & Berge, 2012).

About the Current Work
Our Centre supports academic departments in the implementation of outcome-based education and program review. As part of this work, we have been exploring the application of LA to a range of different data, including institutional survey data and student performance data. Since the graduation of the first cohort of a new four-year curriculum introduced in the 2012-13 academic year, there has been considerable interest in program review to ensure that the curriculum is achieving the intended learning outcomes. There has also been a focus on how to improve programs from a structural (e.g., timetabling) and learning design perspective. Our Centre has worked with program and subject leaders to assist them with curriculum review, adopting an LA approach to complement and extend traditional methods. Through this work, we have developed and tested analytics to address questions raised as part of subject and program review. As discussed next, these analyses can provide insight into program and subject difficulty, relationships between subjects in a program, assessment mix and differences between student groups.

Analytics for Curriculum Review

The approach we have adopted to curriculum review has been to look for analyses that address specific questions that the curriculum review wishes to address. In addition, we have also looked at the data available for analysis as part of the review to determine what insight could be provided relevant to the curriculum review. In the next sections we present a selection of analyses that address important questions about the curriculum that are not easily answered using traditional approaches to curriculum review. At the program level, these questions relate to defining and measuring how difficult a program is as a whole, how student grades are related to student satisfaction, whether the learning outcomes and assessment mix are appropriate and if there are differences on variables of interest, such as grades or satisfaction with the program, between identified student groups. The examples provided are from actual program reviews; however, data is anonymized.

Assessing Program Difficulty
A question of interest in one program review we conducted related to the appropriateness of the level of challenge across all subjects, which we interpreted as the difficulty of the program. While student grades or grade

point average could be used to address this question, our approach was to conduct Rasch analysis to compare subject difficulty against students' ability to determine the overall difficulty of the program. A full explanation of Rasch measurement is beyond the scope of this paper. However, one of its advantages is that Rasch analysis can calibrate the person estimates (ability) and the item estimates (difficulty) on the same unidimensional scale (Bond & Fox, 2015). In our case, an "item" represents a subject. For Rasch analysis, the difficulty of a subject was estimated from all of the grades that students who took the subject received, while student ability was determined from their performance in all subjects. Another benefit of conducting Rasch analysis to determine students' ability and subject difficulty is that both use the same scale units, logits (log odds units), which are linear and can be compared on the one scale. When a student's location (ability) on the unidimensional scale is equal to the difficulty of getting a certain grade in the subject, the student has a 50% probability of obtaining that grade. Figure 1 shows the item-person map for Rasch analysis for one program we reviewed. As this figure shows, for this program the mean student ability is above the mean subject difficulty, which indicates that, overall, the program could be more challenging as the average difficulty level of subjects is below the ability of the average student.

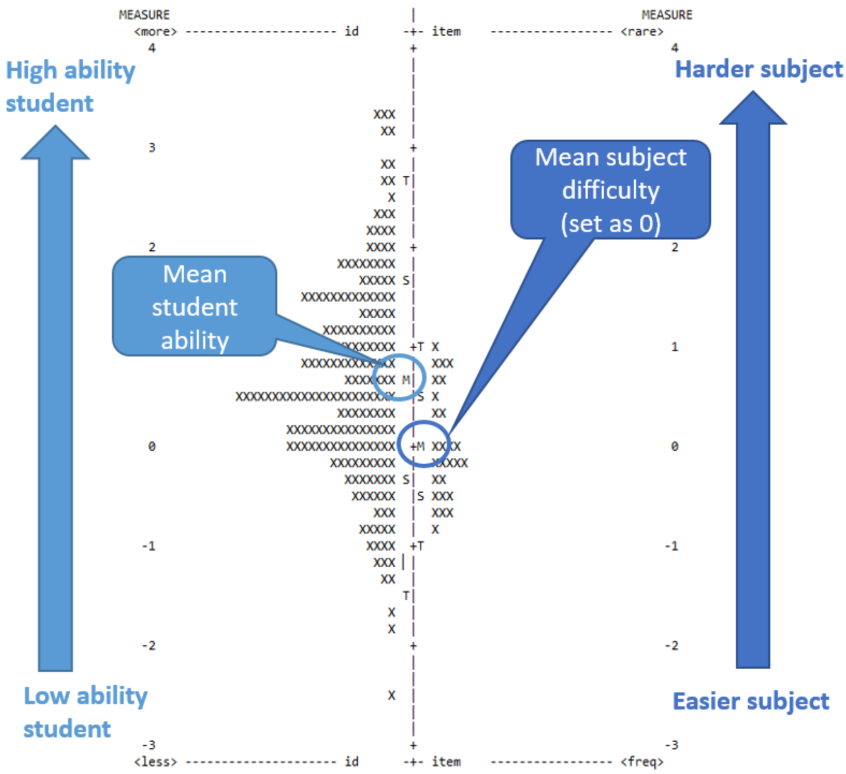

Figure 1. Item-person map showing student ability against subject difficulty. On the right hand side, one x equals one subject (*N*=27), while on the left hand side; one x equals three students (*N*=300).

The subject difficulties determined by Rasch can also be used in other statistical tests. An example of once such application is provided next.

Identifying Subjects That Need Revision

Programs have a large number of subjects that students take. Thus, decisions about what subjects need revision can be difficult. Figure 2 shows subject difficulty scores plotted against the subject's mean evaluation score on the end of semester evaluation of teaching survey. In the figure, the lower the subject number, the earlier in the program the subject is taken by students. As shown in the figure, subjects 1, 2 and 4, which are taken by students in the first semester of their first year, receive quite low subject satisfaction scores and are relatively more difficult. Furthermore, subjects 7, 14 and 16 are relatively easier but also have lower satisfaction scores. This analysis and visualization suggest that review of these subjects (i.e., subjects 1, 2, 4, 7, 14 and 16) to determine how to improve satisfaction and/or student performance is needed. In this way, the analysis provides the curriculum review team with information to identify and prioritize subjects for revision as part of the review.

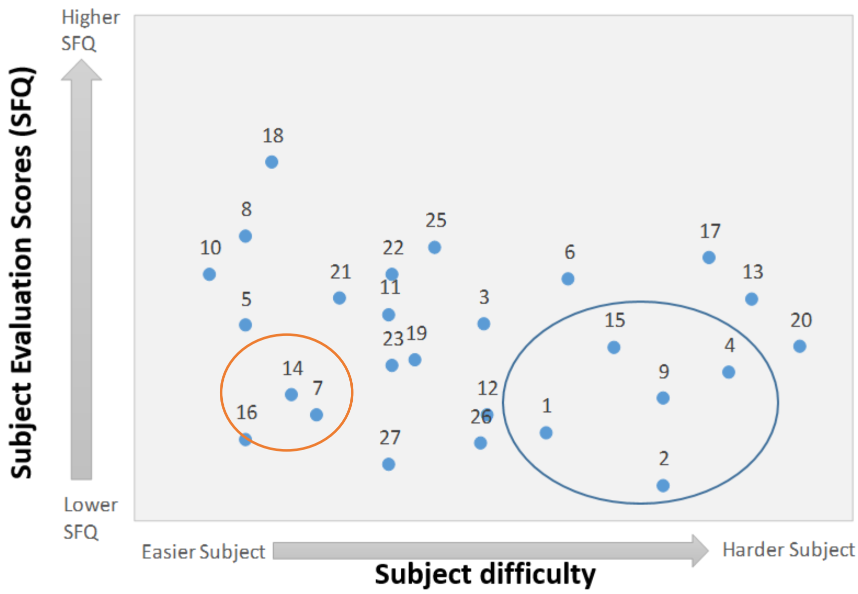

Figure 2. The relationship between subject difficulty and student satisfaction with the subject. Subjects are numbered according to the order in which students complete them in the program.

A second analysis and visualization that provides information about subjects in the program is shown in Figure 3. In this figure the thickness of the line joining nodes in the diagram indicates the strength of the correlation between subjects – the thicker the line the stronger the correlation. From the figure, students' performance in ABC2006 and ABC3001 is strongly correlated with their performance in ABC4001. Similarly, performance in ABC3004 is strongly correlated with both ABC2004 and ABC4006, the latter being low on student satisfaction and low on subject difficulty. Based on this analysis, revision of the lower level subjects (i.e., ABC3004 and ABC2004) to increase their difficulty could be undertaken to better prepare students for the upper level subject ABC4006. What revisions need to be made to achieve this would be determined by further analysis and review of the subjects themselves.

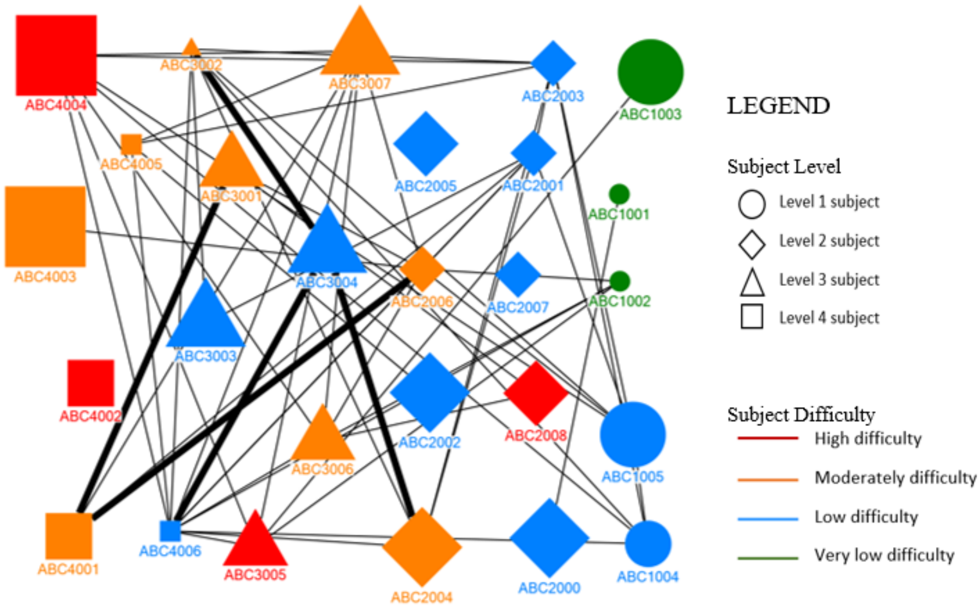

Figure 3. Visualisation of the relationship between subjects together with subject level (indicated by node shape), average student satisfaction with the subject (indicated by node size – the larger the node, the higher the average satisfaction rating for the subject) and subject difficulty (indicated by node colour – see legend for details).

Classifying Learning Outcome Levels and Identifying Assessment Mix

Another consideration in curriculum review relates to learning outcomes and assessment tasks. Figure 4 shows the distribution of learning outcomes for each year level of a program, which have been classified according to Bloom's Taxonomy (Krathwohl, 2002) on the basis of the adjectives in the learning outcome statement. Categories are arranged starting with lower order skills (Remembering) and progressing through to higher order skills (Creating). As Figure 4 shows, for this program, there is a heavy focus on remembering in the first year subjects, but this decreases in both the second and third years of the program. Furthermore, higher level learning outcomes such as Creating and Applying increase from Year 1 to Year 3.

This visualization is useful for checking that the different levels of learning outcomes are distributed appropriately across the program thereby demonstrating a developmental progression. As Figure 5 shows, it is also useful to do this for the different sections of a program (e.g., core, elective, discipline streams, etc.) – for the program shown in Figure 5, that learning outcomes relating to 'Analysing' do not appear in subjects in either of the themes and the core subjects do not have learning outcomes classified as 'Applying' is something that a curriculum review team might wish to address.

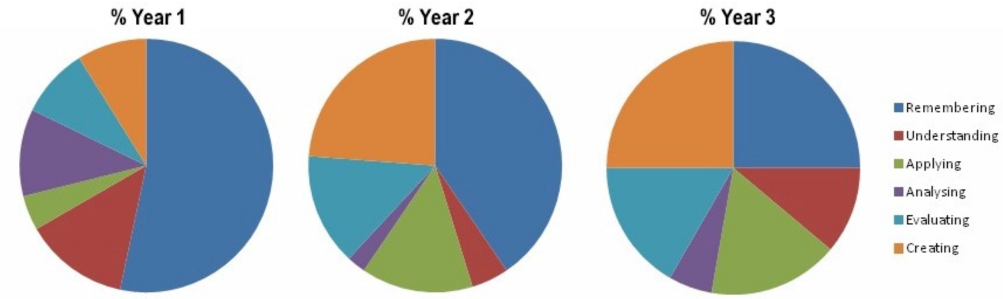

Figure 4. Relative proportions of different levels of learning outcomes classified according to the six levels of Blooms Taxonomy (Krathwohl, 2002) across a program.

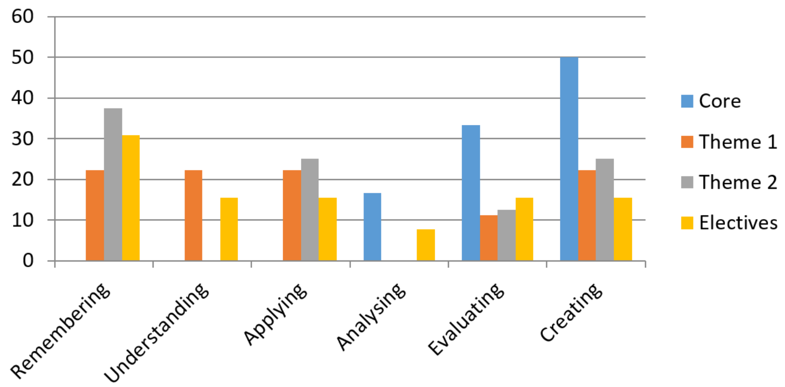

Figure 5. Distribution of learning outcomes by level across different sections of the program.

As well as ensuring that the learning outcomes for the program are appropriate, it is also useful to look at the mix of assessment tasks. Figure 6 exemplifies an assessment mix across a program. Depending on the program or learning approach, some assessment types may need to feature more prominently than others – for example with problem-based learning, a higher proportion of assessment that is project-based might be appropriate. This analysis helps visualize the assessment mix to ensure it is appropriate for the program. Similarly, analysis of the proportion of group versus individual assessment tasks could be used to check the accuracy of feedback from students or staff suggesting there is too much group assessment. A similar analysis and visualization can be produced to check that the relative contribution each assessment type makes towards the student's overall performance on the course is appropriate and that one assessment type (e.g., examinations) does not contribute disproportionately to students' grades in the program.

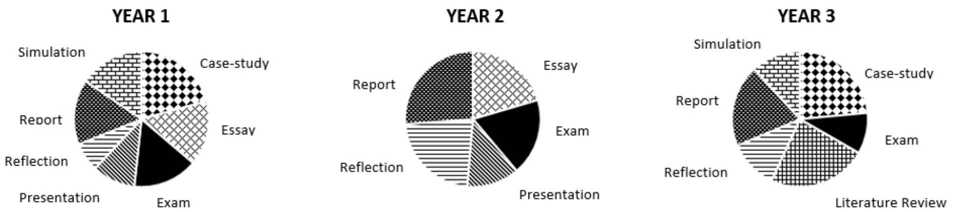

Figure 6. Frequency of assessment types across the program.

Comparing Groups of Students

At our university, programs often have two defined cohorts. The first consists of students who start the program in first year and complete all four years of the program (FY). The second is a group of students who enter the course in third year having received credit based on prior learning. This second group of students, who are referred to as 'senior year admitted students' (SY), often experience challenges because of their entry point to the program and the workload they need to take on to complete the degree in two years.

Our program review approach includes analyses comparing SY students with those admitted to the first year of the program. Figure 7 shows the comparison of these two groups of students in one program on the difficulty of achieving grades for subjects at different levels across the course. As can be seen from Figure 7, the SY students tend to outperform FY students, particularly in those subjects that are typically taken in the first two years of the program. However, by the end of the program, the FY students have caught up and are performing at similar levels. This analysis is useful because it can tell program leaders where students are likely to be struggling so they can provide appropriate support. It also provides reassurance that all students reach a similar level by graduation.

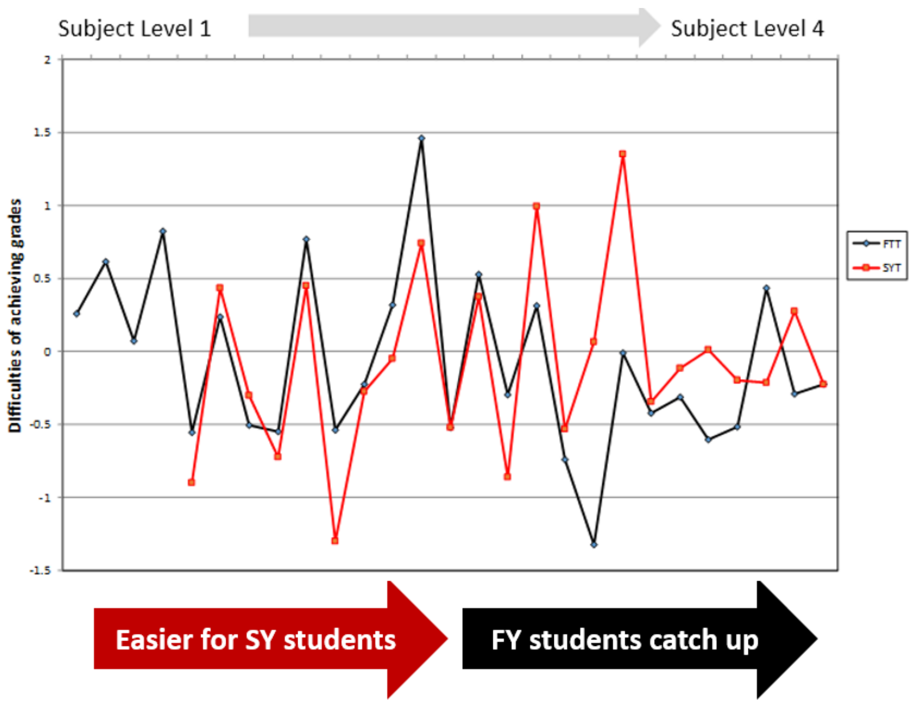

Figure 7. Average subject difficulty across the program for students admitted in the first year of the program compared to those admitted in the third year (senior admitted students). Each data point is the difficulty rating for a subject in the program, with subjects ordered according to when they are typically taken in the program, with Level 1 subjects appearing to the left of the figure and Level 4 subjects to the right.

Discussion

The examples provided above show the usefulness of adopting an LA approach to program review. In each example, the analysis provided insight into the program above that obtained with traditional curriculum review methods. Importantly, the analyses provided findings that were actionable. In our experience, program leaders have found actionable insights most useful; they have commented to us that our analyses provide concrete evidence for their 'hunches' so they can implement strategies for improvement. Our analyses have also told them things about the program that they would not have otherwise known. While feedback from our colleagues has been positive and supportive, we want to formalise our approach. To do this we intend to map data types to analyses that address specific curriculum review questions and detail related strategies for analysis, visualization, interpretation and reporting when conducting LA-based program review.

We have now gained sufficient experience to formalize our LA approach and to test it by conducting further program reviews. However, a key challenge to using LA is having access to relevant institutional and program-level data. Sometimes this is because the data exists in silos and bringing it together for analysis is difficult due to institutional constraints, such as data "ownership." In our situation, data that would be useful for program (and subject) review has not been collected consistently or is not available to our Centre. One of the review recommendations then becomes creating a data collection plan that maps to a curriculum review framework and ensuring that the data is collected for future evaluation exercises.

A second challenge is empowering academics to conduct LA curriculum reviews independently. Many of the analyses we have conducted as part of program review require specialist skills and knowledge that many academics do not have. To address this, we are developing and piloting tools that do the analysis and visualization automatically and include interpretation guides and reporting templates. To date we have a prototype tool that can be used for predicting student performance, visualizing the relationships between variables and comparing groups. We are now documenting our LA approach to program review and refining the tool, with a view to evaluating its usefulness for conducting future program reviews.

Notes

1. By program we mean the timespan of an undergraduate degree. In our context, it is four academic years, that is eight academic semesters where a semester is generally 13 weeks.

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DESIGN OF AN ADAPTIVE E-ASSESSMENT SYSTEM FOR FORMATIVE ASSESSMENT: TRAiL

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Abstract

Formative assessment plays a key role in the teaching and learning processes. It informs about the status of students' learning and helps to identify difficulties, promoting students' autonomy and learning self-regulation. At the same time, it enables teachers to evaluate their students' progress. As a result of a study developed between 2014 and 2017 with Portuguese primary and secondary school teachers, this paper presents a proposal to develop a new Adaptive e-Assessment System that can support the implementation of formative tests and, consequently, contribute to the academic success of students.

Keywords: formative assessment, online digital tests, feedback, adaptive e-assessment system

Introduction

Formative assessment has proven to play a key role in enhancing the teaching and learning processes (Marzano, 2007). According to Black and Wiliam (1998), when presented as a systemic and regular practice, it improves student learning and his outcomes. Formative assessment consists of the gathering, analysis and interpretation of systematic evidence to determine how students' learning is matching teacher expectations and curricular objectives. It reports students' progress, where they face problems and how well they are progressing.

Tests, as a formative activity, allow the assessment of several curricular contents as well as the evaluation of many students simultaneously. According to Roediger and Butler (2013), the regular use of tests and the feedback provided by them are factors that enhance student learning. At the same time, relevant and just-in-time feedback promotes student confidence, autonomy, and self-regulation of his/her own learning processes (Gilbert, Whitelock, & Gale, 2011). Tests also allow teachers to reflect and make decisions about the teaching process (Earl, 2003), promoting the adjustment of strategies and methodologies according to the students' achievements and difficulties.

We can consider effective feedback as one that promotes the self-regulation of learning by students, as well as the readjustment of the teaching process by teachers. According to Irving (2007), to be effective, feedback must be individualized, clear, detailed, guiding and as immediate as possible, to allow timely intervention in learning process. However, with the short time teachers have available, it becomes complex to design, apply and evaluate formative tests (pen and paper format) in a systematic way.

This makes the use of online digital tests as a particularly interesting alternative, mainly because of the correction, grading and production of effective feedback, which can be immediate and automatic.

Online digital tests have several advantages over pen and paper tests. An online test enables the integration of multimedia elements and interactive simulations, which can facilitate a better understanding of the questions and feedback. Once the test is created, it can be automatically shared with other teachers and used by students at any time, any place and at their own pace. Students may repeat the test whenever they want, and the system can automatically shuffle the order of questions and answers on each trial. As each student finishes an attempt to solve the test, he/she immediately receives the correction, the grade and complete feedback. As all data is stored, both student and teacher can carefully analyse all the answers and the feedback for each question and in each attempt. In addition to the individual results, the teacher can analyse the overall performance of different classes and act immediately, adjusting his/her teaching strategies.

Through the use online digital tests systems, the feedback can become more immediate and effective, because it can be delivered right away and at the pace of each student, allowing him/her to understand his/hers own learning difficulties and problems and to immediately act in order to solve them (Hattie & Timperley, 2007; Stobart, 2008).

However, in the Portuguese educational context, it is not exactly known how ICTs are integrated into formative assessment activities, especially in tests. Despite the technological evolution at schools, it is considered that formative, as do summative tests, tend to be mainly applied through the traditional format - in paper.

Under these circumstances, a study was developed to identify whether teachers use tests for formative assessment tests, and, if they do not use them, the reasons and constraints they identify. In this study it was also intended to identify the possible benefits of the digital format tests for overcoming the identified constraints.

Research Aims

This work was part of a wider study focused on how online digital test systems can support effective formative assessment practices. The main objective of the study was to present a digital solution that answers to the difficulties experienced by teachers in the regular implementation of formative tests, considering the innovative technologies currently available and characteristics and functionalities that teachers value most for this purpose.

To achieve this aim, the following goals were defined: (i) identify the conceptions and the difficulties in the practices of formative assessment described by teachers, (ii) identify the specific characteristics and functionalities that teachers value most in online digital tests, (iii) identify useful features of adaptive technologies that can be used for formative assessment, and (iv) check the availability of free online platforms that match the previous requirements identified in goals ii and iii and that are available in Portuguese and in accordance with the Portuguese educational system. If no system meets these criteria this research project intends to design a new Adaptive e-Assessment System, an adaptive online digital testing platform (v).

Methodology

Methodologically, the work was structured in three distinct phases. In a first phase, that took place between 2014 and 2015, the intention was to ascertain the concepts and practices of Portuguese primary and secondary school teachers in relation to the formative assessment tests in both paper and digital formats. Following a quantitative methodological approach, data were collected through the application of an online questionnaire. The questionnaire consisted of 14 items in the 5 points Likert scale format, ranging from 1 (totally disagree) to 5 (totally agree). Six items were about teachers' practices and conceptions on formative assessment tests and eight items about the importance given by teachers to the features of online digital tests. The discordant frequency was constituted by the congregation of the answers of levels 1 and 2 of the scale. The concordant frequency was constituted by the congregation of the answers of levels 4 and 5 of the scale. The results of level 3 of the scale were assumed as neutral opinions. Once the constraints of the paper format tests, as well as the most relevant characteristics of the digital format tests were identified, the second phase of this work was started by reviewing the literature on innovative particularities resulting from technological developments in the field of adaptive technologies for learning assessment. This process took place between 2015 and 2016. After some characteristics and functionalities of adaptive technologies had been identified, we checked and analysed the availability of free online systems that incorporate them. In a third phase, that took place between 2016 and 2017, and due to the impossibility of finding a free and appropriate platform for the purposes of this study, it was considered necessary to conceptually create and develop a new platform. This system would implement the characteristics and functionalities pointed out by teachers as more relevant and, through its adaptive particularities, should adjust to the needs of each student and teachers. The results of these three phases are described next.

Results

Phase 1

At this phase of the study a questionnaire was distributed to 793 teachers from middle and secondary Portuguese public schools. About 2% of the respondents had less than 8 years of teaching, 17% between 8 and 15 years, 45% between 16 and 25 years and 36% more than 25 years of teaching. In examining what constitutes teachers' practices regarding the use of tests in formative assessment, the results revealed that 83% of teachers apply formative assessment tests; 78% of these only use the paper format. Concerning the feedback, 34% of the teachers who apply online digital tests use tools that don't trigger it. Regarding the frequency of application of formative tests, only 18% use formative tests regularly (weekly or once every two weeks), the remaining respondents conducted them monthly or even less frequently.

Table 1

Teachers' Practices and Conceptions on Formative Assessment Tests (*n*=793).

	Agree	*Disagree*	*Neutral*
Grading and correction of tests is time consuming.	66%	12%	22%
Application of tests disrupts the teaching process and take time away that is precious to cover all the topics of the curriculum.	30%	47%	23%
Tests correction and feedback are only made orally and for all students simultaneously.	62%	20%	18%
Elaborate feedback is given to students for each question.	45%	33%	22%
The processing and analysis of tests requires too much time.	59%	18%	23%
If the correction, grading and feedback were quickly given to the students the result of applying formative tests would be more beneficial.	70%	14%	16%

As Table 1 indicates, the results reveal that teachers consider the activities of test correction and grading, as well as the provision of elaborate feedback, to be very time consuming. Surprisingly 30% of teachers consider that tests disrupt the teaching process, taking away time that is very important to cover all the topics of the curriculum. The feedback provided to students is neither immediate nor effective as it tends to be based only on the identification of the correct and the wrong answers. Most of the teachers consider that if the correction, grading and feedback were more quickly given to the students, the result of applying formative tests would be much more positive.

Table 2 presents the characteristics and functionalities teachers value most in online digital tests. These results suggest that, in teachers' opinion, the key features of online digital tests that indeed are important for formative assessment are not only the automatic presentation of feedback to the students but also the possibility of integrating multimedia elements, as it can be seen in the following table. They support the study's relevance, suggesting that online digital tests are, indeed, seen as a valid and advantageous alternative compared with the paper format, presently used by most of the teachers.

Table 2

Importance Given by Teachers to the Features of Online Digital Tests (n=793)

	Agree	*Disagree*	*Neutral*
Automatic correction and classification.	85%	4%	11%
Feedback is automatic and immediate.	89%	2%	9%
Allows effective feedback.	81%	5%	14%
Students may repeat the test how often they want.	76%	8%	16%
Allows the integration of multimedia elements.	87%	2%	11%
The integration of multimedia elements improves learning.	85%	3%	12%
Tests can be used by students at any time and any place.	82%	4%	14%
Tests and questions can be automatically shared with other teachers.	84%	3%	13%

Phase 2

Initially in this phase, and in agreement with a literature review on this topic, some characteristics of the adaptive technologies considered important to e-Assessment Systems were identified. In learning assessment, these technologies have had many benefits, especially the possibility of allowing students to use these systems autonomously and meaningfully. Among other features, the system can adapt in real time the activities and the resources provided to the students considering their needs. Based on the student's difficulties and on their answers to previous questions, the system decides what activities will be presented next. Automatically, and without human intervention, the system analyzes the student difficulties, his/her interaction with the system and the previously obtained results to suggest new learning activities adapted to his/her abilities and difficulties.

Identifying some key features of adaptive technologies, we checked and analysed the availability of free online systems that already incorporate those features. The process of searching for existing systems was based on the application of a search equation in the Google search engine, using the following keywords *adaptive learning* or *adaptive computerized testing* or *adaptive computer testing* or *adaptive e-assessment* or *adaptive computer assessment.* These were organized in a conjunctive logic with the keywords *platform, software* and *system*. For each search in Google the results of the first 15 pages were analyzed. The data extracted from the online search pointed out to a total of 25 platforms that fulfilled the defined requirements: first, to be at least partially free of cost and, second, not to be only an LMS. The 25 systems analyzed were the following: acrobatiq, Aleks, aNewSpring, area9 Learning, Cerego, CK-12, CogBooks, Concerto, Desire2Learn, DreamBox, FastTest, Fishtree, Formative, Khan Academy, Knewton, Learnetic, Learnosity, OWL, Realizeit, ScootPad, Smart Sparrow, Socrative, Surpass, TAO Community Ed., Testive.

For the analysis of these platforms, the following characteristics were considered: (i) it is an adaptive system, (ii) it has free licensing, (iii) the interface is configurable for the Portuguese language, (iv) it is simple to use, (v) it allows the integration of teacher authoring resources and questions, (vi) it provides an elaborated feedback to the student (immediate, descriptive and guiding), (vii) it allows the definition of difficulty levels for questions and tests, (viii) it provides automatic activities to students, (ix) it is possible to align it with new curriculum structures (Portuguese), (x) it is multidisciplinary, and (xi) it provides reports of difficulty and performance.

The analysis, presented in Table 3, was based on the information provided on the product websites, on white papers published by the authors of the systems and on some tests that were carried out (when allowed by the platforms).

Table 3

Analysis of the Platforms (x Means the Characteristic is Verified; N.O. Means the Characteristics is Non-Observable)

	i	ii	iii	iv	v	vi	vii	viii	ix	x	xi
acrobatiq http://acrobatiq.com	x			x	x	x				x	x
Aleks www.aleks.com	x			x	x	x		x		x	x
aNewSpring www.anewspring.com	x			x	x					x	x
area9 Learning http://area9learning.com	x			n.o.	x	x				x	x
Cerego www.cerego.com				n.o.	x					x	x
CK-12 www.ck12.org		x		x	x					x	x
CogBooks www.cogbooks.com	x			x	x	x				x	x
Concerto http://concertoplatform.com	x	x			x	x				x	x
Desire2Learn www.d2l.com				x	x					x	x
DreamBox www.dreambox.com	x			x		x				x	x
FastTest www.assess.com	x			n.o.	x	n.o.				x	x
Fishtree www.fishtree.com	x			x	x	n.o.		x		x	x
Formative http://goformative.com				x	x					x	x
Khan Academy https://pt-pt.khanacademy.org	x	x	x	x				x		x	x
Knewton www.knewton.com	x	x						x		x	x
Learnetic www.learnetic.com	x			x	x					x	x
Learnosity www.learnosity.com				x	x					x	x
OWL www.owlts.com				x	x						x
Realizeit http://realizeitlearning.com	x			n.o.	x				x	x	x
ScootPad www.scootpad.com	x			x	x			x		x	x
Smart Sparrow www.smartsparrow.com	x				x					x	x
Socrative www.socrative.com		x		x	x					x	x
Surpass www.btl.com/surpass				x	x					x	x
TAO Community Ed. www.taotesting.com	x	x		x	x	x				x	x
Testive www.testive.com				x	x					x	x

The analysis led to the following conclusions: (i) from the 25 platforms that were analyzed about two-thirds weren't adaptive; (ii) only four had a totally free license, and only two allowed implementation of assessment activities;

(iii) only one presented a native interface in Portuguese, but it was a closed system with proprietary content; (iv) most systems didn't allow the sharing of resources created by the users; (v) only seven platforms enabled elaborated feedback, but none of them enabled the definition of difficulty levels for the questions; (vi) only one allowed the alignment with new curricular structures; (vii) all systems were multidisciplinary; and (viii) none of the systems allowed the autonomous recommendation of assessment activities.

Therefore, it was considered that none of the platforms analyzed fully satisfied the functionalities and the adaptive features that are considered to be essential for an Adaptive e-Assessment System. Due to the impossibility of finding a free platform that could be adapted to the Portuguese educational system, and that suited the purposes of this work, the study evolved to its third phase.

Phase 3

As no system had been found that meets the requirements defined in the previous phase, the conceptual design of a new Adaptive e-Assessment System started to be developed. For this process the first step was to design the framework that supported the system. The basis of the framework is presented in Figure 1: (i) Learner, (ii) Teacher, (iii) Adaptive Engine, (iv) Test, (v) Instructional Resource, (vi) Question and (vii) Curriculum. The Learner and the Teacher dimensions represent the users who will interact with the system. These as well as the other dimensions are described below.

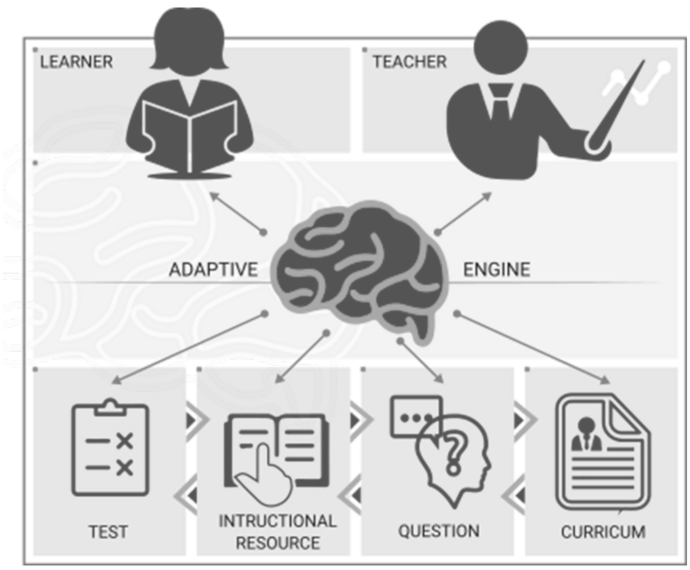

Figure 1. Framework for Adaptive e-Assessment System.

Dimension learner. This dimension represents the model composed by detailed information of the academic data and profile of each student, namely: learning style and preferences; level of general difficulty; level of difficulty per curricular topic; activities carried out and results; progress and trends; proficiency regarding each topic of the different subjects of the curriculum; interactions and telemetry; temporary records of system use; among others. This dimension allows the Adaptive Engine (AE) to make more assertive activities recommendations according to the knowledge got from the student overall activities.

Dimension teacher. The teacher plays a crucial role in system, for his or her knowledge on pedagogy, curriculum, evaluation processes and adequacy of learning approach to the characteristics of his/her students. This dimension represents the information that the system should record about the teacher-type user, particularly with respect to teachers' profiles, subjects, classes and students they teach, activities developed and assigned to each of their students, and all the interactions with the system. The greater the interaction with the system, the better the AE can help teachers in the design and management of their activities.

Dimension question. Questions are the key element of any adaptive assessment system. It is through the answers to specific questions that the system analyzes and decides what resources to recommend in order to help students to overcome difficulties and promote their learning. For instance, in a typical adaptive assessment system, if the student misses a question then an easier question should be presented next. This dimension represents the information about each question available in the system. This information goes through its description, formulation, typology (multiple choice, true/false, etc.), response options, its corresponding correction, feedback, difficulty level, author, among others. The model also defines the articulation between the *question* dimension and the remaining ones. For instance, with the dimension *curriculum* it allows categorizing each question with the topics of the curriculum to which it refers; with the dimension *test* it permits registering in which test each question is integrated; and with the dimension *instructional resource* it allows defining what resources are presented to the student together with a given question.

Dimension instructional resource. This represents each learning object available in the system, which is composed by information that relates it to a specific subject matter. This model represents the set of information that integrates each learning object, which can be made up of different formats (text, image, audio, video, interactive simulations), and is related to a certain topic of the curriculum. For example, a text, a video, a simulation that describes the respiratory system. It can be used as part of a test, articulating with the dimension *test,* or it can precede a certain question, or even be integrated in feedback.

Dimension test. A test consists of a set of questions, with a well-defined organization and structure with specific objectives in knowledge assessment and promotion of learning. It can also be supplemented with instructional resources that help to contextualize questions. This structure represents the information related to each of the tests available in the system, such as the questions and instructional resources that form it, i.e., the sequence, the level of difficulty, the total amount of time required, who was it appointed to and who solved it, as many other information.

Dimension curriculum. This represents the content of each subject, which is modelled as a hierarchical and sequential structure of knowledge items. Each item represents atomic knowledge about a particular topic. This dimension represents the detailed information of the curriculum of each subject, such as the description of each topic, its sequence and hierarchy. To have mastery over a certain subject, the student must dominate all its elementary parcels - the items. It is with these items that the questions and instructional resources are articulated. Thus, the AE can understand what questions and resources are available for each curricular topic. The curriculum dimension represents this information in detail and also structures the interdependency of the topics.

Dimension adaptive engine. This dimension represents the model responsible for the interconnection of all components of the system. It is the central element of connection and communication among all other dimensions and has the function of learning with and about the users, the questions, the instructional resources and the curriculum. It represents the characteristics, functionalities and adaptive algorithmic mechanisms that the system must implement to accomplish its functions efficiently and effectively. It must discover and adapt the activities to be carried according to the profile, behaviour and difficulties of each student, assuring him or her an individualized learning process. It manages all processes, interactions and presents the right information at the right time and place. It ensures that the registration, updating and analysis of all the information flow in the system in real time, at the same time that keeps the entire system functioning.

Figure 2 presents a diagram of the articulation between these dimensions.

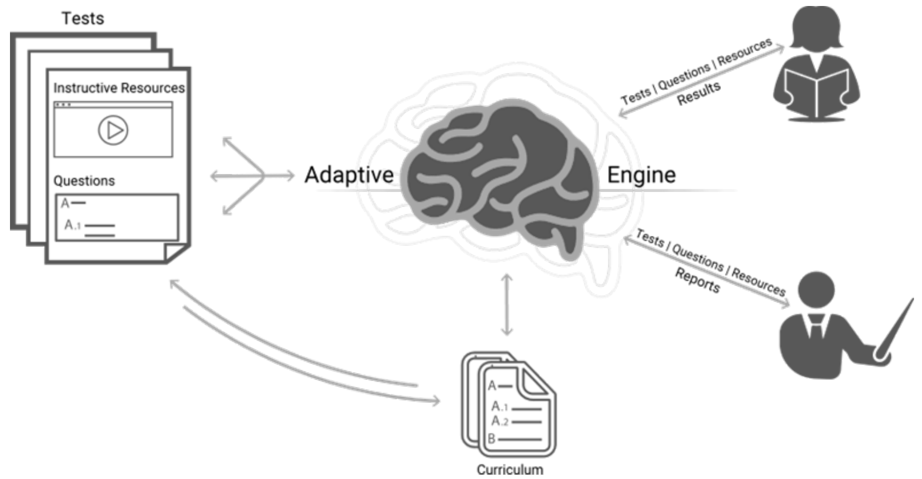

Figure 2. Articulation between the framework dimensions.

Conclusion

Therefore, the next stage of research, currently under development, consists of the conceptual design of a new Adaptive e-Assessment System that responds to the needs of the teachers and contributes to the students' learning. The system, which we named *TRAiL-Transforming Assessment into Learning*, will be based on the framework previously presented.

It is considered that the instructional model "one-size-fits-all" is not suitable to the diversity of learning profiles, needs and motivations of todays' students.

Thereby, the system allows all assessment activities to be adjusted to the characteristics, difficulties and capacities of each student.

In general, it is assumed that TRAiL will include the following particularities:

- Available and suitable for all subjects and years of schooling
- Availability to be used at any time, place and device
- Allows the student to perform the same activity as often as he/she wishes
- Allows the teacher to characterize the profile, capacities and difficulties of each student in the system
- Allows the teacher to create resources, questions and tests, that will be automatically shared with other teachers
- Allows the possibility of student to perform activities even without the intervention of the teacher, either on his/her own initiative or by suggestion of the system
- Guarantees access by the teacher to the data of his students, and the access of students to their own data, enabling the monitoring of the results obtained by them in all activities
- Has a diversity of types of questions with the possibility of integrating multimedia elements in their formulation and response options
- Allows feedback in multiple media formats (e.g., audio or video)
- Includes elaborated feedback mechanisms (immediate, descriptive and guiding) for each response option, and provides the student with content which he wouldn't probably have contact with on his/her own studying activities
- Has the possibility of creating and suggesting autonomous tests to the students, considering the resources and questions available on the system and according to different levels of difficulty and performance
- Analyzes in real time the difficulties and performances of the students, as well as the results and performances available for each of the questions and tests
- Allows a systematic analysis of the levels of difficulty and results in each topic of the curriculum
- Enables the creation of automatic tests either by teacher or student in a reduced number of steps, through the reuse of questions and resources available in the system
- Has the flexibility to support the development of other types of assessment (diagnostic and summative) and to be used in classroom activities (e.g., classroom questioning and discussion)
- Has the ability to learn from their own analysis, decisions and actions

Thus, we consider that the future development of TRAiL for the Portuguese educational system will contribute to a regular use of formative assessment tests that develop students' selfregulation and academic success.

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HOME-SCHOOL COMMUNICATION THROUGH A WEB-BASED LEARNING MANAGEMENT SYSTEM – EXPERIENCES AND LESSONS

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Abstract

The purpose of this paper is to explore teachers' (N=454) experiences and perceptions with regard to the use of a new web-based learning management system (LS) in home-school communication in Swedish schools. The results indicated a great dissatisfaction with its functional features among the teachers, which negatively impacted the attitudes and beliefs towards the usefulness and ease of use of LS for communication. This in turn prevented teachers' and parents' use of the LS and caused a general decrease in home-school communication in daily practices, especially for those disadvantaged parents.

Keywords: Learning Management System (LMS), Learning Space (LS), implementation process, home-school communication, teacher survey

Introduction

Traditionally, face-to-face, telephone and email contacts between teachers and parents have been the main pathways for home-school communication. Nowadays, almost all K-12 schools in Sweden have an integrated so-called learning management system (LMS) that enables the systematic management of school administration, teaching and learning, as well as internal and external information and communication (Swedish National Agency for Education, 2013). It is argued that the integration of LMS does not only have economic, administrative and pedagogical advantages, but also opens new opportunities for online communication and interaction among school leaders, teachers, students, and parents (Blau & Hameiri, 2010; Cameron & Mahoney, 2008). Previous research in this field mainly emphasised integration of LMS in higher education and provided evidence of advantages and disadvantages of adopting LMS in online learning environments (e.g., Naveh, Pliskin, & Tubin, 2010; Xu, Sakthi, & Kenton, 2014). Research on the application of LMS in compulsory education, especially on the use of LMS in home-school communication and interaction by different stakeholders, is insufficient.

In Sweden, it is up to each municipality to decide on which LMS to use, depending on their economic and infrastructural conditions and other political demands. The implementation processes could also vary from municipality to municipality, and from school to school. In spring 2015, one municipality in Sweden started to implement a new web-based LMS called Learning Space (LS) in all public schools, including all compulsory and upper secondary schools, and in adult education. The goal of this initiative was to provide a single LMS for all public schools in the municipality in order to facilitate the management and communication between schools, as well as to reduce teachers' workload in accordance with policies and regulations for communication and documentation (Municipality XXX, 2014). To evaluate its implementation process with regard to the teachers' experiences, an online questionnaire was sent to all grade 1-12 teachers in the municipality in March 2016. This study is part of the evaluation project with a special focus on LS use for communication between home and school. The specific research questions are:

1. How do teachers experience and perceive theirs and parents' use of LS for communication between schools and families?
2. What critical variables for integrating LS in home-school communication can be identified and understood?

Literature Review

Parents' access to meaningful and effective communication with schools and teachers is one of the crucial prerequisites for enhancing the home-school relationship and parental involvement. It is the responsibility of schools and teachers to strategically establish, design and carry out communication with families in order to disseminate information, create home-school links and provide opportunities for dialogue (Epstein, 2001; Erikson, 2009). Stringer and Blaik Hourani (2013) found three patterns of home-school communication in their study. *One-way school-to-home communication* disseminates general information to parents on matters of education and school events. *Two-way school-to-home and home-to-school communication* encourages the giving and sharing of information from school and home that is child centered and related to academic and/or behaviour needs. *Three-way school-to-home and home-to-school communication* involves the school, parents and students in decision-making and planning to address individual needs. It calls for a parent-teacher-student interaction model that involves all stakeholders.

Web-based School Management System and Online Interaction with Parents

The utilisation of technology through the use of web-based communication with parents is growing rapidly as an additional link for the home-school relationship. The concept of e-communication is adopted to stress the advantages of using modern technology to increase a school's effectiveness through databased decision-making and instant interactions among different stakeholders (Blau & Presser, 2013). During the last few decades, using emails to send information about school and class activities, teaching and learning resources and management, and students' behaviour and outcomes has been the dominate means to communicate with families. Recently, the integration of a web-based LMS in K-12 schools has become an important tool for facilitating instruction, assessment, administration, and to provide new possibilities for online interaction among school leaders, teachers, students, and parents (Blau & Hameiri, 2010; Xu et al., 2014). Some studies provide evidence of significant positive correlations between the use of LMS and pedagogical effectiveness, school cultural change, and parental involvement (Blau & Presser, 2013; Davidovitch & Yavich, 2015). Other research, however, indicates that the presence of LMS in schools does not automatically ensure its effective use by staff, students and parents, and that the application of this system must be explored and examined, as Wayman, Jimerson and Cho

(2010) argue. Moreover, LMS also includes functions for parental use. Parents are a heterogeneous group with different language, socioeconomic and educational backgrounds that influences the levels of their accessibility to web-based information and communication, and their ability to utilise technical and digital resources (Gu, 2017). With regard to the implementation of LMS, this challenge could lead to the exclusion of disadvantaged families in home-school communication.

Implementing Technological Change in Schools

The adoption of technology in education is a complex issue related to different levels of implementation such as at the system and policy levels, organisational level, and individual level. It also includes technical and human aspects. Strategic and operational policies at the national and municipal levels allow for a common vision with regard to significant expenditures, which are required for employing technological change in educational settings, and may enable these visions to be realised through action plans, programmes or projects (Gu, 2011). At the organisational level, new culture and e-leadership are regarded as necessary for implementing technological changes at schools (Avidov-Unger & Eshet-Alkalai, 2011; Chamakiotis & Pantell, 2011).

Research indicates that teachers' perceptions of their school as a learning organisation that emphasises cooperation and collaborative learning among staff affects their readiness to be active actors in integrating innovative technologies (Levin & Fullan, 2008; Zimmerman, 2006). At the individual level, teachers' digital competence differs and is crucial for the uptake and use of technology in teaching. However, despite teachers' proficiency in using information technology, it does not mean that they believe it is a valuable tool when used in educational settings (Steel, 2009).

Studies indicate that teachers' attitudes towards change, their contextual pedagogical and technological knowledge, and their perceptions of school as a learning organisation are three of the most important factors affecting successful implementation of change in general and innovative technologies in particular (Kontoghiorghes, Awbre, & Feurig, 2005; Sandy, 2010). According to Halverson and Smith (2009) and Harris and Hofer (2009), teachers' resistance to change with regard to technology is mainly because it does not fit their pedagogical practices and beliefs.

Approach for Analysis

To evaluate and analyse the implementation and use of LMS in schools, the Utilization of LMS framework developed by Asiri, Mahmud, Abu-Bakar and Ayub (2012), which is based on the Theory of Reasoned Action (TRA) (Ajzen & Madden, 1986) and Technology Acceptance Model (TAM) (Davis, 1986), has been adapted, developed and applied. This framework aims to identify and explain critical factors that influence the utilisation of instructional technology. According to the framework, the utilisation level of LMS depends on some important internal, external and demographical variables. There are three components in the category of internal variables. Firstly, implementation of technology in an educational setting depends strongly upon the users' attitudes towards the new technology. If the users have a positive attitude towards LMS, they are more likely to be motivated to use it (Lochner, Conrad, & Graham, 2015; Yang & Yoo, 2004). Secondly, educators' beliefs and predictions towards the usefulness and ease of use of technology influence their specific technology integration in educational practices (Cheok & Wong, 2015; Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010). Thirdly, teachers' technological experiences, skills and competencies are crucial elements that affect their integration of technology in educational practices (Ball & Levy, 2008). External variables refer to the environments and conditions that play a key role in the adoption of technology in educational settings. Organisational factors refer to different aspects such as leadership, collective expectations, visions, philosophy, and values (Perrotta, 2013) that determine the strategies and arrangements for technology integration. Technological features regard the functional aspects of LMS that influence the user in terms of accessibility, usability and relevance (Althobaiti & Mayhew, 2016). Pedagogical, administrational and technological support, training and professional development contribute significantly to the success of technology implementation (Kampylis & Punie, 2013). Social circumstance is an extensive concept. In this study, the focus is on social conditions relevant to the teachers' work, as well as political contexts for technology implementation. Demographic features such as gender, age and professional background and computer experiences may also serve as antecedents that determine the technology use (Vekiri & Chronaki, 2008)[1].

Research Design

In spring 2015, the web-based LMS Learning Space was implemented in all public schools in one municipality in Sweden. To evaluate the implementation process, and to investigate teachers' experiences of the application of LS, an online questionnaire was sent to grades 1-12 teachers in all public schools in the municipality in March 2016.

Participants and Attrition

During 2015 and 2016, the total population of teachers in all 1-12 public schools in that municipality was around 800[2] (Swedish National Agency for Education, 2017). Four hundred sixty-eight teachers responded to the questionnaire, in which 14 questionnaires were not completed (internal attrition). Four hundred fifty-four teachers (N=454) participated in this study with an approximate response rate of 57%. While participation in the web-based survey was voluntary and anonymous, and there were no incentives to participate, the response rate was quite high (Lefever, Dal, & Matthíasdóttir, 2007).

Instrument

The online questionnaire consisted of three main categories and 15 sub-categories with a total of 71 items in forms of questions or statements. The three main categories include teachers' background information, teachers' perceptions on generic LMS-related experiences and capability, and teachers' perceptions on the use of LS. In the last mentioned category, three sub-categories were applied: 1) LS use for school administration; 2) LS use for teaching/learning and; and 3) LS use for contact/communication with school leaders, colleagues, students, and parents. The questionnaire also provided free text fields where participants could provide comments. The questionnaire combined single/multiple choice, rating scales, and free text fields for teachers' comments.

Data Collection and Analysis

This paper aims to describe and discuss the teachers' experiences and perceptions on the use of LS in communicating and interacting with parents. Thus, data used in this paper were selected according to the relevance to the topic, in other words teachers' perceptions with regard to if LS facilitates communication with parents and their perception of the outcomes of parental contact and communication through LS. In order to provide context information, teachers' background information in terms of their professional experiences and their LMS-related experiences and capability, including information about the duration of their LS use, are included. Both quantitative and qualitative data were represented. Descriptive statistics were adopted to present the quantitative data in the form of bar graphs showing the numbers of teachers in the different defined groups.

In order to forge a deeper understanding of teachers' perspectives, teachers' comments on their use of LS in communication with parents and their perceptions of parental use were used as part of the empirical data. After the first reading of all comments (N=617), the comments from general experience of LMS use and school-related communication through LS were regarded as relevant (N=302) for further reading and selection. At the next stage, after a more careful reading, 34 comments from general experiences of LMS use, and 77 comments from contact/communication through LS were selected as the qualitative database for analysis (N=111 totally). The length of comments varies from a few words to longer paragraphs; for instance the longest comment consisted of 263 words. Data from free text comments in the questionnaire were analysed by adapting the systematic process of developing codes and themes in relation to the research objectives that involved an integrated process of reading, understanding, interpreting, and reflecting as Hjerm and Lindgren (2011) suggested. The teachers' comments provided us with richer and more contextual information that supported identifying, illustrating and understanding the tendencies emerging in the quantitative data (Kvale & Brinkmann, 2009).

Data was analysed according to the Utilization of LMS framework (Asiri et al., 2012). Three themes relevant for internal variables and four themes dealing with external variables were identified. Internal variables included attitudes towards the use of LS, beliefs towards the usefulness and ease of use of LS, and experiences and generic competence of using technology. External features referred to technical functions, organisational culture, instructions and support, and social and political circumstances for implementation. The demographic variables described in this study intended to provide background information of the teachers' group in general. In other words, no specific measurement of correlations between demographic variables and the utilisation of LS were carried out.

Findings

This section presents the main findings related to the research questions. Firstly, teachers' background in terms of their self-reports on levels of ability of using LMS, as well as duration of LS use, are presented. Secondly, teachers' experiences of their own use of LS in communicating with parents and their perceptions of parental use of LMS in communicattion with the school are outlined. Thirdly, critical factors for integrating LS in home-school communication are highlighted.

Teachers' Backgrounds

The following graphs show the demographic features of teachers' backgrounds with regard to professional experiences and self-assessment of technological competence. Figure 1 indicates that most of the participants were experienced professional teachers: 73% of the participants had worked as teachers for more than 10 years. Almost 96% of teachers reported that their ability to use LMS (such as First Class, Fronter, and LS) was at average or above average levels, in which 58% even had a high or very high level capability in handling LMS (see Figure 2).

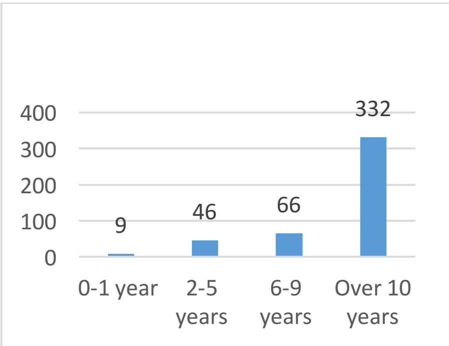

Figure 1. Professional experience (N=453).

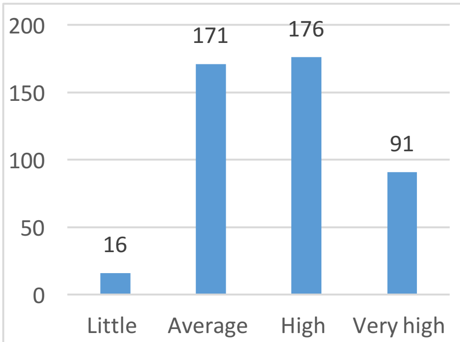

Figure 2. Self-assessment of the ability to use LMS (N=454).

In the teacher group, only about 47 % of the teachers had experience using LS for more than six months (see Figure 3).

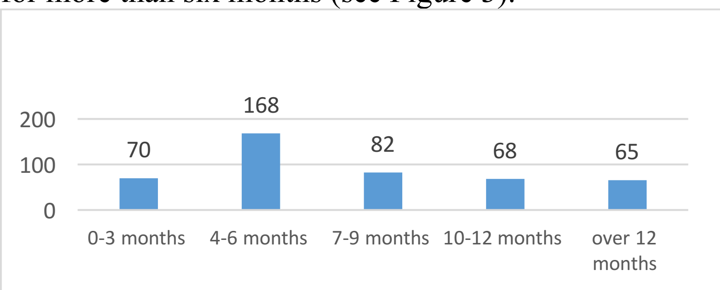

Figure 3. Duration of the use of LS (N=453).

LS Use in Communication between Home and School

Implementation of LS was to provide teachers with a unified and structured system that benefits the effectiveness of their work in terms of teaching, learning, administration, and communication. In the field of communication with home through LS, the focus has been on teachers' experiences of their own use and their perceptions of parental use.

Teachers' use of LS in communication with parents. The teachers reported that LS was used mainly in sharing teaching materials and documents in some shared spaces/rooms for classes, school and staff. Many teachers also used LS for reporting students' ratings and other assessment documents. However, it had been more difficult to find a logical communication solution with others through LS, including parents. A number of teachers pointed out that even school principals seldom used LS, ultimately preferring to send information and messages to teachers through Microsoft Outlook.

Information sharing and message exchange are two important features in communication with parents. However, the communicative functions in LS did not work as well as expected: "There are many who are not happy with the message function in LS. Missing, for example, is the possibility to get an overview of the messages, send messages to multiple recipients, as well as attach files." Some teachers pointed out that parents complained that they could not get any messages sent by the teacher via LS. Thus, for many teachers the dominate manner to communicate with colleagues and parents was still by Outlook.

When answering the question if they perceive that LS facilitates communication with parents, the majority of the teachers gave negative responses, in which 68% of them disagreed with the statement or agreed with the statement at a low level. Only 11% agreed with this statement at a high or very high level (see Figure 4). Teachers' dissatisfaction with LS use in contacting with parents was obvious.

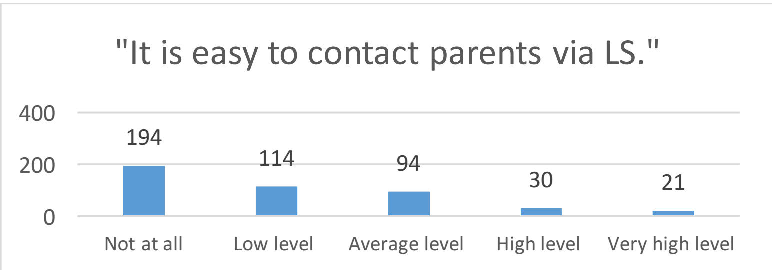

Figure 4. Levels of agreement with the statement, "It is easy to contact parents via LS" (N=453).

Perceived parental use of LS in home-school communication. Parents' possibility to access the system is even more important. A number of teachers reported that they were supposed to post weekly letters to parents on LS, but they were very unsure that all parents had access to LS and read the letters. This was mainly because the system required a bank ID to log in, but not all parents had this ID, and they might not know how to apply for and use an e-ID, especially those with other language and cultural backgrounds. One teacher said: "Parents generally find that LS is decent, messy and complicated. The fact that you have to log in with e-ID to get information was a mistake. This barrier causes significantly fewer parents to read the weekly letter compared to when emailing the information."

Difficulties accessing LS and lack of information and knowledge on how to use the system seemed to be the main barriers for parents to communicate with teachers via LS. Some teachers also felt responsible to teach parents about the system so that they would not miss information from the school. One explained:

> Many students and parents are unsure how to handle/use LS. It contributes to an increased workload for me when I am expected to teach LS to students and parents. It has made me stressed. I wonder where in my profession I will be responsible for parents understanding and using LS? … I get angry that I need to take time off my teaching to keep up with LS.

Critical Variables for Integrating LS in Home-School Communication
Accessibility and ease of use are the most important features when integrating a new technology into educational practice. However, as one person noted, "This program requires so many button clicks to complete simple things that you almost forget what you intended to do from the beginning." Another example was the login system, as it first asks for an ID to log in to LS, and then different rooms within LS may require additional login processes. For a number of teachers, the implementation of LS increased their workload in terms of time consumption when dealing with technical difficulties, and they were forced to use two systems due to the message function problem in LS, which was the opposite intention of the municipality when it implemented the project. Some comments even had a very negative tone, which to some degree reflected the disappointment of not only the technical weakness of LS but also the top-down implementation process:

> … LS is a disaster in its harshness and inexcusability and in its lack of intuitiveness. That since the IT office in its wisdom forced us to change the website to only contact outward (who has the use of a school website????), no children or parents get updates on homework and examinations anymore. There is no single forum for a parent to go in and see a compilation of homework and tests in a week. All parents have said they miss the old system of homework on the website. XXX usually defends LS in the media about the fact that it was developed by the "30 most knowledgeable teachers in the municipality." What she NEVER says is that they got three wretched systems to choose from, of which LS was the least bad. Talk about putting your head in the sand!

Lack of instruction and training to apply LS, both for staff and parents, were also mentioned by some teachers:

> [I] have not learned to use all functions of LS. There have been too few learning opportunities and that the instructions on how to use LS are still just headlines. There is no content. Would look at an instructional video that the municipality refers to but it was so bad quality that it could not be heard or see the instruction. Have missed some of our hits when it comes to learning LS. Is hard to take again. Colleagues are busy with their own work. Need more support to get started properly.

Table 1 outlines a summary of teachers' descriptions that deal with external variables affecting their own and parental use of LS.

Table 1

Teachers' Perceptions of External Factors that Prevent Their Own and Parental Use of LS

External Variables	Teacher Use	Parent Use
Organisational factors	• Principals and colleagues do not prefer to use LS to communicate with each other • Lack of encouragement and challenge from school leaders • Using different LMS in parallel, which resulted in heavier workload	• Lack of information about LS implementation
Technical features	• Demands many clicks and many log in steps to reach the place they want • No function to attach documents in the mail system in LS • No function to send a message to both parents at the same time	• No other options but bank e-ID to log in • Problem to log in to LS via cell phones • No notice when a new message in LS is received • Cannot receive messages if they have not linked their email addresses to LS • Unable to reply to messages via LS
Support and training	• Lack of knowledge on how to use LS and all of its functions • Lack of introduction and further training • Responsibility to handle the difficulties at individual teachers' level	• Lack of knowledge on how to use LS • No organised training and introduction to LS
Social circumstances	• Social pressure • Top-down initiative and implementation process	• Some parents have difficulty with the Swedish language that prevented them from using LS, which is only in Swedish • Not all parents have access to computers, Internet, smart phones, and e-ID

Logically, these difficulties could have prevented home-school communication from both sides. Teachers gave very negative answers to the question on whether communication with parents had increased after the implementation of LS. Almost 87% disagreed with the statement or agreed with it at a low level. Only 4% of teachers gave positive responses, as displayed in Figure 5.

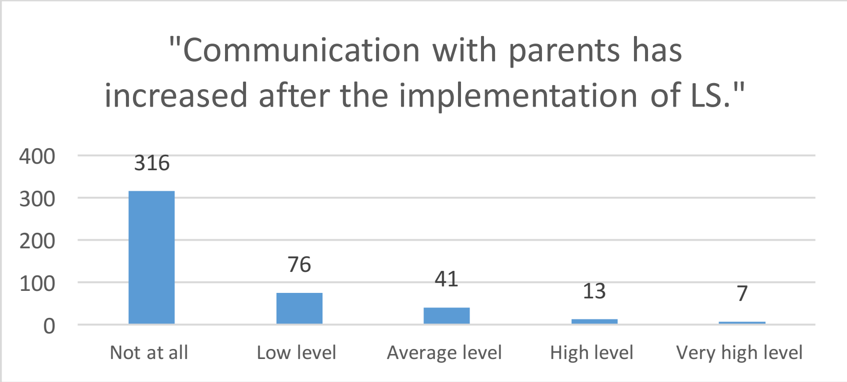

Figure 5. Levels of agreement with the statement, "Communication with parents has increased after implementation of LS" (N=453).

More ironically, some teachers reported that contact with parents increased, but the reason was due to "improper absences reports entered in LS [by parents], which must be retrospectively corrected," and therefore "[parents] contact the school in frustration at how difficult LS is to use. The contact does not occur via LS."

Discussion and Conclusions

By adopting the Utilization of LMS framework (Asiri et al., 2012) to analyse the results, we are able to identify and understand some critical internal and external variables that influence the actual and perceived use of instructional technology by teachers and parents for home-school communication and how these variables relate to and affect each other.

The findings reveal that the majority of teachers are experienced professionals and have a high level of self-confidence in IT-related abilities and capabilities, including LMS experience (internal factors). Although there are new functions within LS that teachers need to learn and become familiar with, their existing generic content and pedagogical knowledge, and their digital competence would have benefited them in adopting the new LMS (Harris, Mishra, & Koehler, 2009). In this respect, the teachers' more negative perceptions and attitudes towards LS use might be related to the technical and functional shortcomings of the system (external factors) that do not fit their educational beliefs in terms of pedagogical effectiveness, parental involvement and school cultural change (Blau & Presser, 2013; Davidovitch & Yavich, 2015; Halverson & Smith, 2009; Harris & Hofer, 2009). This could have influenced their attitudes and educational practice in a negative way, which prevented their engagement and opportunities to quickly update relevant information in the system. All of which deteriorated the information flow to parents and weakened the one-way school-to-home communication (Stringer & Balik Hourani, 2013). With regard to parents' use of LS, the problem with access and other difficulties have also prevented their use when contacting and communicating with schools. According to Stringer and Balik Hourani, for parents who were unable to join the system in order to receive information and to provide direct feedback and comments, their effective involvement in their children's schooling through two-way or three-way communication was challenged. Contact between home and school therefore decreased since the implementation of LS. This indicates that the LS implementation project's intention — which aimed to effectively involve all stakeholders in schools through a single learning platform — has not reached the expected result.

There could be other factors that affect the level of teachers' satisfaction and the effective use of the system. For instance, teachers' attitude towards change plays an important role in the implementation process (internal factors). According to Del Val and Fuentes (2003), attitude towards change can be divided into two aspects: behavioural/cognitive and emotional. The result of this study supports their assumption. In the teachers' responses we are able to identify these two groups of attitudes, both of which are a form of resistance. Some teachers focused on comparing the new system with the older systems they previously used and tried to identify and describe the weakness of the new LS and even provide suggestions for improvement (behavioural/cognitive attitudes). Another group of teachers mainly expressed their anger and dissatisfaction (emotional attitudes).

Implementation of a new educational technology is a complex process, and it needs time. Georgouli, Skalkidis and Guerreiro (2008) suggest that the use of new technologies is similar to the application of new educational models that need to be supported by systematic redesign of the processes at both the institutional and individual educator levels. Implementing a new technology in an organisation requires developing an organisational learning culture that helps to maintain transfer of knowledge, creativity, flexibility, and support, in which cooperation and collaborative learning within the organisation are regarded as the characteristic elements (Collinson, 2010; Weldy & Gillis, 2010). Teachers' negative experiences of the use of LS could be related to the top-down implementation process they experienced, which left little room for their input and negotiation in the decision-making process (Selwyn, Banaji, Hadjithoma-Garstka, & Clark, 2011). At the organisational level, lack of positive attitudes and collective approaches towards integrating LS in school management was evidenced by teachers' descriptions of the similar negative experiences of principals and other colleagues who chose not to use LS but rather Microsoft Outlook to communicate with each other. Teachers also expressed that even with the lack of information and introduction on LS use, schools and the municipality did not seem to intend to provide further training opportunities and support for teachers and parents' effective use of LS. These provided some evidence of external barriers at social/political and organisational levels to the integration of LS (Asiri et al., 2012).

Another external barrier for parental use perceived by teachers was the fact that LS did not benefit disadvantaged parents who had no or little access to and knowledge about hardware and software that the system demanded. In other words, they were excluded from the system, which, it could be said, is based on the norms and conditions of well-educated middle-class families and parents. Parents who are more comfortable speaking with teachers, and have the time, education, knowledge of school culture, and competence in dealing with technology, can take advantage of the use of LS. Consequently, their cultural dominance (habitus) through access and use of communication with schools in many ways provides privilege for their children. The gap between children from middle- and lower-class families could thus be extended (Reay, Crozier, & James, 2011). This is a challenge for the system developer and the municipality to work out other alternative solutions. Parents, especially those who are disadvantaged, should have the opportunities and support to receive necessary instruction and training to learn more about the system and to have easier access to it.

This study provides evidence of some critical prerequisites for successful implementation of innovative technologies in schools. Implementation involves far more than a mechanical application of goals and initiatives into routine procedures and actions. A successful implementation of technology in schools calls for policy commitment, quality features in technical design, sufficient organisational support, and positive personal attitudes and efforts. As we have learnt that central policies or reforms do not automatically lead to practical changes in schools, the top-down initiatives should follow a greater attention to local conditions to ensure a successful implementation of policies (Gu, 2011). School policies and plans, resources, leadership, and a collaborative team of teachers could positively relate to the implementation of new technologies in schools. In the technical respect, the compatibility of the system, transparency/information, interactivity, accessibility, and usability are crucial (Gu, 2017; Parajuli, 2007). LMS must be evaluated and developed in order for different stakeholders to easily use it. The municipality and its schools should provide technology-related training and support to help teachers and parents develop their digital competencies and skills for integrating technology in education and in home-school cooperation. The design and functions of LMS should consider disadvantaged users such as parents from other cultures with limited knowledge of the language and computers. Individual teachers' understandings, interpretations, attitudes, and efforts also play important roles in this process.

Notes

1. It must be noted that this study is based on teachers' self-reports and perceived parental use of LS, which means that it could differ from their actual use or the actual level of utilisation of LS.
2. This number was not exactly the number stated in the Swedish Agency for Education's database (2016) in order to protect the identity of the municipality.

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DIGITAL CREATIVITY: ENABLING LEARNING OF GENDER ROLES IN SOCIETY IN PRIMARY SCHOOL BY STORY DRIVEN DIGITAL PRODUCTION

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Abstract

To achieve knowledge and understanding in social science, students' ability to discuss and reflect is important. However, the goal to stimulate perspective taking and inference making upon social phenomena has proven to be difficult in general and in particular for primary school students. Thus, there is a need to develop models and concepts for learning that provide guidance that address these challenges. This study reports on how 6th grade students in a Swedish school successfully worked with gender roles in society with a story driven didactical design linked to digital competence development and creativity in a cross-border setting.

Introduction

To achieve knowledge and understanding in social science, students' ability to discuss and reflect is important. Although many subjects have this ambition, social studies is particularly connected to creating lessons that inspire and stimulate discussion and reflection (Lödén, 2012; Parham, 2014). The core of the subject area is to interpret present times and to understand the human condition in different societies (National Agency for Education 2018,).

To become a competent citizen in the increasingly digitalized society (Castells, 2010; Voogt, Erstad, Dede, & Mishra, 2013), competent use of digital technologies is highlighted in various policy documents, signaling political ambition for citizens in general as well as teachers and students in particular (Digitaliseringskommissionen, 2013; EU-Commission of the European Communities, 2008). Teachers as well as students are expected to develop their ability to use digital tools in school to learn (Hatlevik, Gudmundsdóttir & Loi, 2015; Røkenes & Krumsvik, 2014; Säljö, 2012; Selander, 2013).

Given the subject, answers are seldom unambiguous, which means that discussion and reflection are especially important in social science, and teachers need to arrange for the possibility to do so. Lund and Hauge (2011) emphasize how important it is for teachers to "design themselves in" the different activities that students must do. They emphasize the importance of being aware of when the plans for teaching and learning are in danger of tipping over to be either too rigid, which hinders students' own reflections, or become too unsupervised, leaving students adrift, preventing students from being both challenged and guided in their discussions and reflections. The goal is to stimulate perspective taking and inference making upon social phenomena, proven difficult in general and in particular for primary school students (Peterson & Portier, 2014). Therefore, it becomes essential to study teaching activities *in-situ* as well as capturing teachers' own reflections of their own teaching activities in social science in primary school.

Aim and Research Questions

The aim of this study is to examine how primary school in-service social science teachers work with their planning and execution of teaching activities in cross-border cooperative situations with special reference to supporting student discussion and reflection abilities using digital technologies. This exploratory study is driven by the following questions: When designing a cooperative learning situation to stimulate meaningful discussion and reflection in social science, how do teachers plan for and execute their teaching activities to support student learning in cross-border cooperative practice? What type of practices becomes supportive for learning and what factors needs to be prioritized for goal achievement?

Didactic Design in Social Science - Dialogue and Digital Technology Intertwined

Teachers need to understand how digital tools play a role in learning. The choice of digital technology, and how it is used, has a bearing on the design process (Lund & Hauge, 2011). The selection of the digital tools becomes particularly important when discussion and reflection is central to the learning of social phenomena, since the digital tools play an important role in the learning situation as a mediator of symbols, signs and interpretations crucial for mutual understanding, communication and cooperation (Lund & Hauge, 2011; Selander, 2013). Consequently, digital technology is useful for learning, and the way in which technology should be used to achieve desired learning is a critical aspect for teachers to become explicitly aware of in order to support student learning.

Boundary Object and Cross - Border Digital Didactic

In situations when the teaching happens in cross-border settings, in this case cooperation between schools in Sweden, Norway and Denmark, digital technology becomes a prerequisite for the cross-border cooperation. Previous scholars have emphasized that a well-thought-out idea and a guided process for how and why to use digitals tools in general are crucial (Grönlund, Andersson, & Wiklund, 2013). To use digital tools inconsiderately could even hinder student learning (Grönlund, 2014).

In relation to crossing borders, previous research has enhanced the learning potential of crossing various boundaries by the resulting discontinuities in action and interaction (Akkerman & Bakker, 2011). The main argument here is that when people are involved in unfamiliar setting, then there is a learning potential involved. However, if such a potential is to be reached, the crossing of boundaries need to be handled as resources for development of intersecting identities and practices (see Kumpulainen and Mikkola (2014) for primary school setting).

One identified way to handle the crossing of borders as resources for development and learning is to identify and use a so-called boundary object. According to the theory of boundary object, what to gather around might be something tangible like a tool or something more abstract like a work process. *Boundary object* was originally defined as a "key process in developing and maintaining coherence across intersecting social worlds" (Star & Griesemer, 1989, p. 393).

The main point of the boundary object theory is that a boundary object unites people rather than separates them from each other, and creates understanding and meaning rather than confusion and pointlessness (Star & Griesemer, 1989; Star, 2010). The literature has repeatedly shown that the same type of IT systems or digital artifacts can lead to different outcomes when being used (Hasu & Engeström 2000; Rehm & Goel, 2015). In other words, it is not enough to find a system or tool to create a common shared work process but rather one that is perceived as meaningful and understandable in order to create meaning (Star, 2010).

Efforts have been made to distinguish between various types of boundary objects, to classify them in accordance to their syntactic, semantic and pragmatic features and to deal with varying information complexity (Carlile, 2004). Such theoretical classifications however, do not incorporate the more dynamic and context specific practice when intended boundary objects are used and how they are experienced (Marheineke, Velamuri, & Möslein, 2016).

The concept of boundary object has gained increased attention in educational contexts investigating how boundary objects influences adult learning (Caruso, Cattaneo, & Gurtner, 2016; Lofthouse & Wright, 2012; Schaap, Baartman, & de Bruijn, 2012) and teacher education (Nolen, Horn, Ward, & Childers, 2011). Interest has also been shown in how subject specific learning can be improved in mathematics (Kynigos & Kalogeria, 2012; Venkat & Winter, 2015), language (Elf, Hangøj, Skaar, & Erixon, 2015) and science (Rahm, 2014) by identified boundary objects.

The concept of boundary object has also been incorporated into research about institutional change in education (Banner, Donnely, & Ryder, 2012; Emand & Roth, 2009; Snoek, 2013) but is still understudied within primary school settings (Akkerman & Bakker, 2011) as well as in social science education. This is unfortunate since the concept has been shown to be fruitful in both illuminating how meaningful processes are organized, as well as in what way digital technologies might have a sense making opportunity for humans involved in cooperative work. In schools, we increasingly have such cooperative processes that span over both groups of student and institutional borders, made possible by digital technology. This article therefore suggests that the concept is suitable as an analytical lens for determining if teaching cooperative practice across borders in primary school social science is supported or hindered.

Case Study Methodology

The methodological approach in this study is a case study (Merriam, 1998; Seawright & Gerring, 2010). In particular, the case study methodology suggested by Merriam was used, focusing on rich and various data where data collection is driven by an interpretative approach. Case studies should, according to Merriam, (a) focus on a particular phenomenon, in this case social science primary school teacher teaching activities in cross-border cooperation; (b) present rich, thick description of the phenomenon under study; in this study the teaching and learning situation was the focus; and (c) facilitate the reader's understanding of phenomenon under study with the two aforementioned strategies.

The Bounded Phenomenon within the Larger Project

Within a larger action research project related to cross-border cooperation between Danish, Norwegian and Swedish schools for educational purposes supported by information and communication technologies (http://projektgnu.eu/), it was possible to define *bounded phenomenon* (Merriam 1998, p. xiii) Merriam deems essential for case studies. Bounded phenomena require clearly defined surrounding boundaries and a specific focus. The bounded phenomenon analyzed here was cross-border teaching sessions in social science that aim to stimulate discussion and reflection, essential features in social science. The session lasted from January to February. The didactical setup was planned for and executed by teachers and students in Sweden in a primary school, in cooperation with a primary school in Denmark. This article focuses specifically on the Swedish context perspective.

The School Context

The school in Sweden is a primary school for 340 students with students from age 6 to 12. The school has a vision and ambition to be open and flexible in supporting the use of digital tools for learning. It is architectonically supported with technology such as stable broadband connections and educational technologies, planned from the outset in 2001 when the school was built. It is equipped with interactive whiteboards in most classrooms; two-on-one model for surf tablets or laptops for students (two students share one device), teachers with laptops and/or surf tablets; and fast network connections. Teachers in the school are expected to be, and become, skilled users of digital tools for learning in their profession. They have access to a person at the school with a special responsibility for competence development linked to technology-enhanced learning.

Data Collection

Various types of data collection methods and work process documentation provided rich material from both of the cases examined, providing the possibility to present rich descriptions of the situation, necessary for case study methodology (Merriam, 1998). Teachers' online conversations on their wiki page and their email conversations were read through in relation to collegial didactical planning to get an increased understanding of collegial cross-border didactical planning. Classroom observations during lectures were conducted capturing activities and dialogues among teachers and students.

Student online activities in shared documents, a project blog and reflection sheets also were part of the rich empirical material, providing a rich picture of students' experiences of the processes and their learning.

The multi-faceted material was interpreted, with a focus on different pedagogical activities the teachers cooperatively planned for and executed with their students in the cross-border cooperative work. The author was, as often as possible, present in the cross-border planning process among the teachers and involved in the on-site planning with the Swedish teachers in accordance to the overall action research approach. Firsthand experience and access was also possible for the author by doing all the classroom observations, teacher and student interviews and analysis of student performances in Sweden in the social science classes reported in this case study.

The research approach in this article thus applied case study methodology on an action research project in order to analyze the bounded phenomenon, presented below, used to enhance knowledge and understanding of cross-border teaching activities in social sciences in primary school.

Case description

One cross-border teaching session was analyzed in this case study. The teachers gave their students the task of creating an alternative ending to the story of Cinderella in groups. They were to take inspiration from the class discussions about gender roles; also, they were informed that the students from the other country would do the same and that they would look at each other's suggested ending and comment upon them. Figure 1 illustrates the form of cooperation.

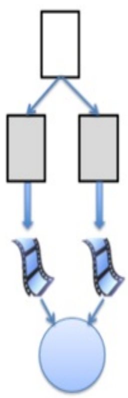
Read Cinderella and talk about gender roles in class. Work in groups at the national school creating alternative ends of the fairy tale of Cinderella. Dramatize the end, decide on requisites and place for shooting the video, make a story-board, film shooting, edit, add subtitles and music. Upload and share the video on the common blog. Look at the videos and use them to talk about gender roles in society.	

Figure 1. Cross-border didactical model, asynchronous cross-border model.

Story Driven Digital Production and Evaluation

Six groups in Denmark and six groups in Sweden made different alternative stories. Table 2 shows the different stories for the six Swedish groups, length of video, digital and dramatic video features, and teachers' evaluation of the story linked to gender roles.

Table 2

Gender Role Videos and Teacher's Interpretation

Group	New End	Video Length	Digital Practice and Drama Features	Teacher Evaluation of Gender Role Types
1	Prince punishes stepmother and gets married to Cinderella	1:51	Video with text Props as clothing Indoor video shooting Video editing	Unequal gender roles Male dominance Female submission
2	No one gets to marry the prince	4:04	Video with text Props as clothing Indoor and outdoor video shooting Video editing Inserted sound effects and music	Unequal gender roles Female dominance
3	Both Cinderella and her step sister get to marry a prince	2:49	Video with text Props as clothing Indoor and outdoor video shooting Video editing Inserted text to clarify the story	Unequal gender roles where the females need to marry, and preferably with a prince.
4	Cinderella kills the prince after the marriage to get his money	3:16	Video with text Props as clothing Indoor video shooting Video editing Inserted slow motion effects and music	Unequal gender roles but a violent Cinderella
5	The prince marry a man	2:18	Video with text Props as clothing Indoor video shooting Video editing Inserted text to clarify the story Inserted music	Equal gender roles, and norm critical thinking
6	Cinderella becomes empowered and perhaps she will marry a man	3:55	Video with text Props as clothing Indoor and outdoor video shooting Video editing Inserted sound effects and music	Equal gender roles

The initial teacher-led discussions on gender roles brought enthusiasm and interest. Students were able to give their own examples of situations where they had experienced differences between boys and girls at school and expectations that they considered to be present for boys or girls. Furthermore, they discussed the differences between men and women. The teachers interpreted that the students' discussion were spring boarding from their own thoughts and experiences, which they later actively used in the scripts for alternative endings to the Cinderella story, and were tightly connected to the curriculum of gender roles in society.

Student engagement for the task was striking. The students' work to dramatize the ending was also discussed so that students could divide roles that suited everyone. For example, those who did not want to be in front of the camera got roles as filmmaker and editor, and those who were good at running group work became producers. Teachers continuously went around in groups and helped with what was needed for the moment. They supported the learning situation and the students' understanding of gender roles in parallel as they supported the work process.

In this particular example, a large part of the benefits of working in cross-border settings was to be found in the collegial cooperation where the initial discussions and agreed arrangement gave added value to the teaching that occurred at each school. The teachers were particularly focused upon how to secure a common understanding of the task for the students. They used several meetings and wrote down their meeting minutes on a shared wiki page. Together, they clarified the task and reduced a lot of complexity. Task clarification was finally obtained with the very specific task of figuring out a new ending for the Cinderella story. Complexity reduction was obtained by not using real time interaction due to scheduling difficulties and also by using digital tools that they were familiar with and had easy access to in each school. The cross-border collaboration effect was obtained by the requirement for the students to upload and share their videos on a common blog and also to provide comments on each other's work. Due to the asynchronous model of communication, these requirements were possible to perform within the normal schedule at each school rather than rearrange the schedule in order to meet in real time settings.

The teachers had collaborated before during the GNU project, and the time perspective is not trivial since policy regarding implementation of technology innovations in school might happen at the expense of teachers' professional practice (Convery, 2009). Collegial cooperation needed time to develop. Time was also essential to become affected by the collegial cooperation (Leitch & Day, 2000). A social studies teacher, involved in the project over three years said: "If the project had only lasted a year, it would have felt like a failure. It took a long time before we really felt that we 'owned' the problem and could work with it accordingly."

Analysis

The teachers worked hard to come up with an approach that reduced the risks of fragmentation and confusion while keeping the ambition to create a focused, yet open task to support discussion and reflection This ambition was accomplished by the fairy tale about Cinderella where students were given completely free rein to create alternative endings, while still within the borders of their understanding of gender roles (see Table 3).

Table 3

Didactic Questions and Answers

Didactic Questions	Answers
What	Gender roles in society
When	During January and February in the spring
Where	In class and on the common blog.
How	In groups in class. Creating story and video. Uploading videos on common blog. Commenting on each other's videos in a video conference. Asynchronous model domination.
Why	To discuss gender roles in society in relation to their own video productions to support discussion and reflection to learn about gender roles in society
Didactic evaluation	Success due to common understanding of task, no scheduling problems, well-functioning technology and joy.

As presented above, the students created both varied endings and digital creations through their own written and dramatized ending that they videotaped, edited and uploaded on the mutual blog. The active choice not to make use of real-time communication promoted learning in this particular situation. The task fit the students. Teachers could actively guide students in their work when they collaborated on the creation of an alternative story. Both teachers and students used their surf tablets and software that they were already familiar with, while using some additional functions such as implementation of sound and music in their videos. The technology fitted well to the task, thus supporting the activities they would undertake, i.e., filming the dramatized ending and sharing these films on the common blog with the Danish students.

The ongoing discussions about male and female gender roles and notions of gender roles in society were interwoven in a meaningful way in the activities from start to end. According to the teachers' comments when evaluating the students' work, "They really have the courage to get involved and engaged in their roles," and "Thanks to the drama driven task, they clearly can talk about things that they seldom talk about."

On the whole, this collegially developed task provided knowledge, joy and learning, although it did not work exactly as wished. The Swedish teachers and students felt disappointment by the feedback they got from the students in Denmark according to reflection talks and comments with the students. The Swedish students would have liked to hear more specific comments than "the videos were good." Likewise, they had required that Danish films made use of subtitled dialogue for them to understand the Danish films better. Danish continued to be difficult for the 11- and 12 - year old Swedish students.

Despite this criticism, the study was evaluated as a topic-focused learning situation with relevant support of technology. The arrangements of the task and the chosen digital tools created a meaningful creative situation that all students vividly engaged in over time, thus showing features of a boundary object driven activity (Star, 2010). The students understood the task at hand and could use available technology appropriate for the task in a cooperative way becoming engaged in discussions and reflections about gender roles. Still, the creative group work was present in physical classrooms, whereas the feedback sessions were linked to cross-border actions in the mutual blog.

The boundary object was thus found in the structure and content of the task as well as in the integration of the actual use of familiar digital tools for task completion. It might be tempting to address the digital tool as the boundary object (Gajek, 2016; Prinsloo & Sasman, 2015), but that has proven not to be enough guidance (Hasu & Engeström, 2000; Rehm & Goel, 2015). Boundary objects can be both physical and abstract (Star & Griesemer, 1989). Therefore, it might be a concept that can be used as a “mental design device” when involved in complex learning situations, such as cross-border settings in social science in primary school that aim to stimulate discussion and reflection among students through social interaction across schools contexts. In order to incorporate subject specific learning goals with actual situation complexity aligned with institutional constraints, this paper suggests that *boundary object* as a concept might provide support and guidance in the complex planning of cross-border digital didactic.

Discussion and Conclusion

In social science, where discussion and reflection is a necessary part of the subject itself (Lödén, 2012; Parham, 2014), it becomes particularly important to insightfully plan for opportunities to support students to have a clear understanding of what should be done and discussed. However, there is a risk that the task becomes too rigid or too loose (Lund & Hauge, 2011) therefore not supporting discussion and reflections of the content to be dealt with, essential abilities to develop in social sciences in primary schools (National Agency for Education, 2018)

When such cross-border cooperation is a prerequisite in social science, teachers need to consult the curricula very actively to identify common ambitions that are present in the cooperative nations. They also need to spend considerable time to find time to coordinate the cross-border activities between the teachers as well as the students given the schedule constraints at each participating school, as each school has its own institutional constraints (Hauge, 2014). Support may be created through the understanding of the restrictions and possibilities linked to curricula, schedules and technological resources when finding ways how to deal with these issues, addressing the institutional requirements in their work practices. Since in-service teachers already have tight schedules, added activities to arrange for cross-border cooperation and communication becomes yet another demand to handle. Cross-border didactics in social science for primary schools can be supported by insights of the complexity that are added by cross-border cooperation. Naïve implementations of such complex practice should be avoided (Convery, 2009).

Here it is argued that such planning can be facilitated by the use of a boundary object-guided work process (Star, 2010). Adding the framework of boundary object driven design helps to improve the process by its focus on a shared understanding, common practice and sense making, making possible explicit evaluation after each activity in a cross-border setting. In such processes the choice of digital tools has an important supporting role, as the technology itself and how it is used can either divide or unite activities that drive discussion and reflection forward for both teachers and students, thus calling for teacher digital competence in learning situations (e.g., Hatlevik et al., 2015; Petterson, 2017).

For primary school teachers in social science it becomes essential to have competence in how to design and execute cross-border teaching sessions. Science is strongly connected to the general societal development of increasing digitalization as well as cross-border cooperation due to increased globalization, which are core issues in social science as a subject. However, such a design process is far from straightforward and simple, as exemplified by the cross-border setting presented and discussed above. To enhance such competence, it is suggested that boundary object driven design might be a helpful approach in digital design processes.

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A VIRTUAL REALITY ENVIRONMENT SIMULATING DRUG USE IN SCHOOLS: EFFECT ON EMOTIONS AND MOOD STATES

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Abstract

Virtual Reality (VR) can be exploited as a teacher-training tool promoting understanding of students' problematic situations. This paper aims to investigate the potential of using VR for teacher training related to substance use by students. During the experiment participants were exposed to a virtual environment showing drug addicted students. Changes in participants' emotional states before and after the exposure to the virtual environment were recorded using EEG measurements, heart rate recordings and self-reported data. The results indicate significant changes to participants' negative emotional and mood states, suggesting that the VR experience had a strong impact on them.

***Keywords**:* Virtual reality, emotions, substance use, teacher education, empathy

Introduction

Substance use is not only a major societal concern, but also a serious problem within the school environment. Research results concerning drug use in schools, indicate cause for concern as there are many cases recorded, even in primary education. Thus, substance use in schools is a fact and a real problem and not a possibility and as such should be treated. However, this specific type of problem has always been a taboo subject, and neglect has been an ongoing challenge as the school and the teachers are afraid to deal with it. It is essential that educational staff is in the position to realize that students dealing with drug use disorders are not the problem, but they are facing a problem. Additionally, it is of paramount importance that teachers are not only open to accept this type of student disorder that might occur in their school or classroom, but also be able to detect possible symptoms of students associated with such disorders (such as aggression towards teachers or classmates, indolence, sleepiness, etc.), as their role is significant to the promotion of preventive actions and raising students' awareness. However, preventive actions by teachers are unclear and teacher training in issues concerning substance use in school is missing. As a result, teachers face similar situations with embarrassment, weakness and fear to face them, while at the school level when such an incident occurs, the usual solution is the transfer of students to another school so as to transfer the problem elsewhere.

Considering all the above, substance use issues in schools is an enormous and challenging problem and it is everyone's duty, especially teachers', to act instead of being idle waiting for things to change or by transmitting the problem elsewhere. Teachers need to act, become more sensitive and deal responsively with students experiencing these disorders. The first step for changing teachers' attitude towards the problem and at the same time cultivating their care, compassion and empathy towards problematic students, is to put them in the position of the student facing the problem, in an effort to make them understand and change their behavior for the well-being of the student. Thus, we propose a novel Virtual Reality (VR) application that could be used to support the cultivation of teachers' empathy skills regarding substance use in schools, which, to the best of our knowledge, has not been done before. Literature regarding the use of VR in teacher education is extremely limited, while substance use related training scenarios have not been used as part of teacher preparation. Using VR based methodology will allow teachers to put themselves in the position of a student that faces substance use problems, in order to understand in depth, the problem raising their awareness. Another significant point is that the proposed VR approach addresses a real problem of inadequate practical training in teacher education, while the scenario is based on real-life incidents and real teachers' needs. In the long-term we aim to develop a VR tool that could be implemented as part of teacher education within universities or other organizations.

The paper describes an experiment that aims to investigate the possibility of cultivating empathy skills to in-service and potential teachers using VR methodology. Moreover, the experiment aimed to investigate participants' emotional states before and after the use of VR. This was essential, as Virtual Reality Environments (VREs) can represent real-life situations, and thus emotions have an integral part to play during the experience of the users. Additionally, investigating participants' emotional experiences is essential to further investigate whether those states affect presence levels within the VR environment and whether some of the states might be used as parameters in order to design the scenario within a VR system for training purposes related to the specific group of teachers. Although presence was also an integral part of the current experiment along with the cultivation of empathy, the results are still under analysis. Therefore, only the results regarding participants' emotional states will be presented in this paper.

Related Work: Emotions and VR

Over the years, emotions have caught the interest of the scientific community. Nevertheless, there is a wide range of scientific opinions regarding the role of emotions. There are scientists who argue that people are always experiencing some emotions. Others claim that emotions do not play a significant role to the behavior of human, and still others claim that emotions are the primary motivational system of humans and that emotions play a key role in motivation (Izard, 1991). There is a need to investigate emotional experiences in VR environments as there is a lack of research regarding the emotional experiences of users (Felnhofer et al., 2015). The question that arises is why to investigate emotional experiences in VREs. This derives from the fact that emotions “are implicated in our phenomenological understanding of the physical world” (Morie, Williams, Dozois, & Luigi, 2005, p. 1). Media such as books or television can provoke emotions (Reiners et al., 2014). Thus, as VREs can represent real-life situations, emotions have an integral part to play during the experience of the users. Moreover, as Morie et al. (2005, p.2) argue “emotions cannot be easily dismissed when focusing on pedagogical goals.”

Despite the fact the VR environments “provide the unique possibility of creating rich and interactive true-to-life replications of emotionally charged scenarios and stimuli,” the manipulation of the data regarding emotions from researchers is problematic (Felnhofer et al., 2015, p. 48). Felnhofer et al. argue that limited emotional experiences have been investigated in VR use including relaxation, joy, sadness, anxiety, anger and boredom. Anxiety is one emotion that has been addressed by many researchers in the context of using VR for mental health problems and psychological treatment (Bouchard, 2010). Thus, as the goal of the proposed VR system is to train teachers, their emotional state within the VRE during their training cannot be ignored.

There are several methods for the recognition of the emotions in VR. First of all, skin conductance has been used, as well as heart rate variability (HRV) in order to capture the responses of autonomic nervous system (Baumgartner, Valko, Esslen, & Jäncke, 2006; Kim, Rosenthal, Zielinski, & Brady, 2014). Moreover, electrodermal activity (EDA) has recently been tested as a reflection of the sympathetic activation of the autonomic nervous system (Felnhofer et al., 2015). Lastly, EEG has been used in order to capture the brain signal and its possible alterations as well as self-reports (Menezes et al., 2017; Rodríguez, Rey, Clemente, Wrzesien, & Alcañiz, 2015). For the purpose of the current research a multimodal approach was used, combining HRV, EEG, self-reports and head movement detection in order to be able to determine the intention of the user. The use of this multimodal approach was decided in order to achieve higher reliability of the results based on the outcomes of each instrument.

Methodology

The Scenario

The scenario was inspired by the real incident that took place in 2017 in a school in Cyprus which had to do with the use of substances given to a 12-year-old student by his classmates, in the form of pills and after threats (Kounnou, 2017). The substance that is portrayed in the scenario is cannabis (also mentioned as marijuana in the scenario) and it was chosen because according to the 2017 Country Drug Report of Cyprus and Greece, cannabis was the most commonly used illicit substance in these two countries, and its use was concentrated among young adults aged 15-34 years (EMCDDA, 2017). The scenario that was designed takes place in the school outdoor space during break time. A female student (named Anna) is watching her classmate (Nikos), who is sitting on a bench, having done substance use and is experiencing the so-called bad trip (all hallucinogenic, psychedelic drugs including others like marijuana and cocaine can produce intense and distressing effects like frightening hallucinations and delusions) (Hartney & Gans, 2017). Anna is asking another classmate (Kostas) for explanations and after admitting substance use by the student (Nikos), he is trying to pressure her to smoke a cannabis cigarette. Anna refuses and being threatened by Kostas and because of fear she remains indifferent when finally, the teacher approaches asking questions about the student drug user.

The Virtual Environment
The VR system that was used for the experiment included the Head Mounted Display (HMD) Oculus Rift CV. The VR application was developed with the Unity© game engine. The 3D avatars (teachers and students) were created using the online software Autodesk® Character Generator. The VR school environment is presented in Figure 1.

Figure 1. The virtual school in unity and the student's avatars.

The Research Tools
A combination of tools was used for the current research. Two questionnaires were used pre- and post- the experiment, including closed-ended Likert-scale questions. The questionnaire consisted of questions regarding participants' demographic data, participants' empathy skills and participants' mood states. The empathy scale used was based on already existing and validated scales with many modifications so as to meet the needs of the current research and in close collaboration with an expert psychologist on drug issues. The mood states scale was based on the Positive and Negative Affect Schedule (PANAS), which comprises of two mood scales, one measuring positive affect and the other measuring negative affect. Moreover, the fitness wristband Fitbit Charge 2 was used for the measurement of the participants' heart rate, and the 14-channel wireless EEG EMOTIV EPOC+ for the recording of the brain signals. Furthermore, user statistics, recorded from users' head movement through Oculus, was recorded real time through the VR application and was used to track where the user was looking throughout the procedure.

The Sample
A total number of 25 participants (n=25) took part in the experiment with 88% (n=22) coming from Cyprus, one participant from Greece, one from Serbia and one from Ukraine. Among the 25 participants, 52% experienced within the VR the perspectives of the teacher and the student drug user, and 48% experienced the perspectives teachers and student Anna. Of participants, 72%

(n=18) were female, and 28% (n=7) were male. Most of the respondents were from 18 to 39 years old (84%), 8% were from 40 to 49, and 8% were from 50-59 years old. Of the participants, 64% of the participants were active teachers, while 36% were not currently working as teachers. The results indicated that 36% of the participants had no teaching experience; 20% reported to have teaching experience between 5 to 10 years, 16% reported less than 1 years' experience; 12% reported experience between 11 to 20 years, 12% reported experience between 1 to 4 years and 4% reported over 20 years of experience. The results indicated that 36% of the participants currently serve in secondary education, 36% do not serve as teachers, 24% serve in higher education, and 4% in primary education. Regarding participants' teaching specialty, the results indicate a variety of fields including computer science (20%), multimedia and graphic arts (16%), mathematics (12%), literature (12%), foreign language (8%), primary school teacher, physical education (sports), sociology, speech pathology, and web design. Regarding participants' experience in the use of VR environments, the results indicate that most of the participants were not familiar with the use of virtual reality as 36% claimed to have never used VR in the past, 32% claimed to have 'a little' experience in the use of VR, 12% claimed to have 'moderate' experience, 12 claimed 'much' VR experience, and 8% claimed to be 'very much' familiar with the use of VR.

The Procedure

Initially, the participants were given a consent form with the instructions regarding the experiment. Then, they had to complete the pre-questionnaire and after the completion of the questionnaire, there were preparations for the use of EMOTIV EPOC+, Oculus Rift and wristband to record the necessary data. The experiment then began within the virtual world. The exposure of the participants in the virtual environment lasted approximately 5 minutes, depending on the pace with which they were advancing the dialogues of the two scenes. After the end of the experiment, the participants were asked to complete the post-questionnaire.

Results

Positive and Negative Affect Scale Results

Reliability analysis was conducted on the variables of the positive and negative affect scale for both the pre- and post- questionnaires. According to the results, the overall alpha for the pre-test scale is 0.841>0.7 indicating high reliability of the variables. According to the results the overall alpha for the post-test scale is 0.864>0.7 indicating high reliability of the variables. The results from the tests of normality (namely the Kolmogorov-Smirnov Test and the Shapiro-Wilk Test) both in pre- and post- questionnaires, revealed that most of the items are below 0.05; therefore, the data significantly deviate from a normal distribution, and non-parametric tests were used for the analysis.

A Wilcoxon test was used to understand whether there was a difference in participants' positive and negative mood states before and after the use of VR. The response continuum for each positive and negative mood state scale is a 6-point scale (not at all-low-a little-moderately-very-extremely) indicating the extent respondents agree or disagree with each mood state. For the problem above the null and alternative hypothesis were:

> H_{null}: There will be no difference in the rankings of participants regarding their positive and negative mood states before and after the use of VR.
>
> H_{alt}: There will be a difference in the rankings of participants regarding their positive and negative mood states before and after the use of VR.

A Wilcoxon signed ranks-test indicated that some post-test scores were statistically significantly different than pre-test scores. Thus, some of participants' mood states were statistically significant different after the use of the VR (see Figure 2). More specifically, the use of VR elicited a statistically significant change in participants' state of fear (Z=-3.51, p=0.000). Indeed, median score rating for the state afraid was Mdn=6.0 (SD=1.05) before the use of VR and Mdn=4.0 (SD=2.05) after the use of VR. Thus, we reject the null hypothesis for the mood state of fear. The results indicate a change in participants' mood state of interest before and after the use of VR Z=-2.14, p=0.035. However, median score rating for the mood interest does not indicate a significant difference before (Mdn=5.0, SD=1.19) and after the use of VR (Mdn=5.0, SD=1.53). Participants tended to be more active before the use of VR (Mdn=5.0, SD=1.22), than after (Mdn=4.0, SD=1.50), Z=-2.43, p=0.015.

Moreover, the results indicate a statistically significant difference in participants' state of fear before and after the use of VR, Z=-2.31, p=0.21. Indeed, median score rating for the state nervous was Mdn=5.0 (SD=1.73) before the use of the VR and Mdn=3.0 (SD=1.99) after the use of VR. Thus, we reject the null hypothesis for the mood state nervous. Moreover, the results indicate that the use of VR elicited a statistically significant change in participants' state of sadness, Z=-2.94, p=0.003. The median score rating for the state sad was Mdn=6.0 (SD=1.55) before the use of the VR and Mdn=2.0 (SD=1.96) after the use of VR. Hence, we reject the null hypothesis for the mood state of sad. Furthermore, the results indicated a statistically significant change in participants' state upset, Z=-3.91, p=0.000. Indeed, the median score rating for the state upset was Mdn=6.0 (SD=0.91) before the use of the VR and Mdn=2.0 (SD=1.96) after the use of VR. Thus, we also reject the null hypothesis for the mood state of upset.

A Wilcoxon signed-rank test showed that the use of VR elicited a statistically significant change regarding participants' state of feeling ashamed before (Mdn=1.0, SD=1.11) and after (Mdn=2.0, SD=1.80) the use of VR, Z=-2.72, p=0.006. Additionally, there are indications for participants' fatigue after the use of the VR, since the median score rating for the state sleepy was Mdn=5.0 (SD=1.19) before the use of the VR and Mdn=3.0 (SD=1.80) after the use of VR. Moreover, according to the results the participants were more downhearted after the use of VR, Z=-3.19, p=0.001. Indeed, the median score rating for the state downhearted was Mdn=6.0 (SD=1.12) before the use of the VR and Mdn=3.0 (SD=1.89) after the use of VR. Hence, we reject the null hypothesis for the mood states ashamed, sleepy and downhearted.

A Wilcoxon signed-rank test showed that the use of VR did not elicit a statistically significant change in participants' inspiration (Z=-0.25, p=0.79). Moreover, a Wilcoxon signed-rank test showed that the use of VR did not elicit a statistically significant change in the states of calm (Z =-0.83, p=0.41), confidence (Z=-1.22, p=0.22), tired (Z=-0.47, p=0.64), alert (Z=-0.09, p=0.92), relaxed (Z=-0.64, p=0.52), determined (Z=-1.40, p=0.16) and concentrating (Z=-1.89, p=0.59).

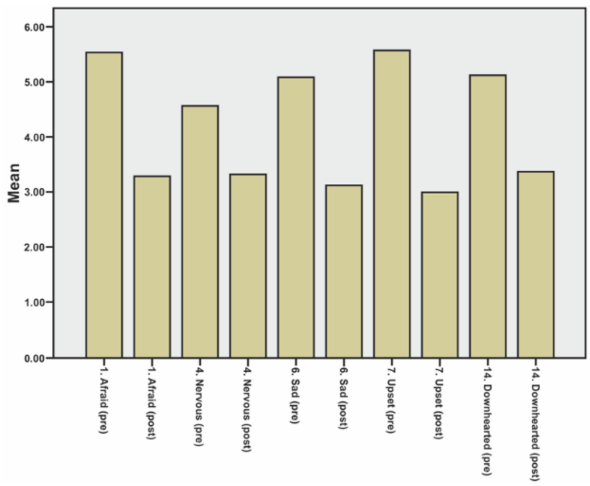

Figure 2. Participant's mood states before and after the use of VR that were mostly affected.

Head Movements

Data was collected regarding the head movements of the participants, and more specifically the objects/people they were looking at more. As mentioned before, all the participants in both groups experienced Perspective I (teacher), in which, 18 out the 25 participants, turned their gaze more times towards Kostas (the student/bully). In Perspective II (Student-drug user), 9 out of 12 participants also turned their gaze more times towards Kostas. In Perspective III (healthy female student) 8 out of 13 again turned their gaze more times towards Kostas. This can be explained by the fact that as observed by the video footage of the participants, they weren't moving their head or their body as much (or at all), and in all three perspectives in front of them was Kostas, so they were looking at him all the time.

Heart Rate and EEG Data

During the VR experience, the heart rate of the participants was measured. The results indicate a significant difference before and after the VR experience. HB1 represents the heart rate before the experiment (M=80.92 bpm, SD=10.59 bpm), while HB2 shows the heart rate after the experiment, (M=87.21 bpm, SD=10.97 bpm (see Figure 3).

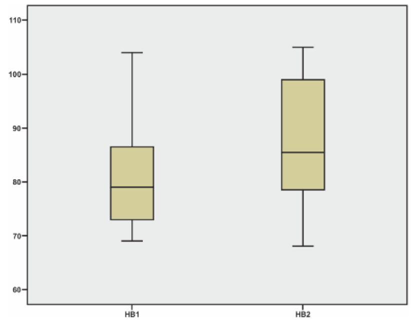

Figure 3. Participant's heart rate before and after the use of VR.

The EEG data are under analysis in EEGLab and NBT toolboxes of MATLAB. The results so far indicate a predominance of the alpha state in frontal and parietal areas for the perspective of the student (healthy or drug user), verifying the results of the questionnaire and the increase in the heart rate. Moreover, there seems to be a difference in the occipital lobe between the three perspectives that can possibly be explained by the intensity of the recruited visual attention.

Discussion

The aim of the current paper was to present the initial results of an investigation regarding the use of VR in teacher education regarding substance use related problems in the school environment. The results are still under analysis; however, the first results indicate that the use of VR elicited a statistically significant change in participants' negative mood states. It seems that the context of the scenario had a strong impact on participants' mood states. Before the use of VR participants did not feel fear, nervousness, sadness, upset, ashamed or downhearted. However, after the use of VR, the results indicate a significant change of those states. Regarding the positive states no statistically significant changes were found after the use of VR. Thus, the scenario affected only the negative states that were absent before the experiment.

Further research is required to investigate participants' mood state changes with a different scenario, because it is possible that the context of the scenario with the drug use was indeed a taboo problem for the participants. Indeed, in-service and experienced teachers after the end of the experiment expressed strongly the opinion that it is not their responsibility to deal with students facing drug problems and their main concern must be to report the situation to the principal's office to transfer the responsibilities. What is interesting is that those teachers reported to have encountered such an incident within their classrooms but refused to act and preferred to ignore the student during the lesson. Thus, raising teachers' awareness and sensitizing them towards serious problematic conditions including substance use should become a priority in teacher training and VR can provide a training tool for this cause.

Nevertheless, this first preliminary investigation provided significant insights regarding the use of a VR based approach to teacher training in relation to substance use problems in the school setting and useful feedback was received for future changes in the application. Moreover, regarding the effects of cannabis on a user, further research is required, and interviews will be conducted with ex-cannabis users, so that the virtual effects depicted are as close to reality as possible. Additionally, after feedback from some of the teachers/participants, the drug incident would be more likely to take place in the bathrooms of the school and not in an open space like the schoolyard in the future version of the application.

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TACIT KNOWING: IMPLICATIONS FOR THE DESIGN OF COMPUTER SIMULATION TRAINING IN POLICE EDUCATION

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Abstract

This paper focuses on the practical knowing that is central in police education. Drawing on perspectives about tacit knowledge and embodied learning (e.g., Argyris & Schön, 1974; Merleau-Ponty, 1945/1997; Polanyi, 1966) as well as empirical examples, this paper will discuss the design of and what can be expected from computer simulation training for the development of police students' professional knowing. Based on the the lessons learned from working with computer simulations in police education we argue that computer simulations can be a useful aid for practical training, but they cannot replace exercises in scenario training or drill exercises.

Keywords: adult learning, tacit knowledge, reflection, professional knowledge, vocational education

Introduction

This paper concerns the development of professional knowing in police education and computer simulation training. More specifically, the focus of this paper is on the practical knowing that is central in police education and essential in many professions. This knowing consists of "quiet,"experience-based knowledge and skills – an embodied practical knowing (cf. Polanyi, 1966). In this sense, knowing is about more than just isolated technical skills and procedures; rather, it involves both specific practical techniques and the thinking and decision-making required to use these techniques effectively (cf. Söderström, Åström, Anderson, & Bowles, 2014a). Extensive resources are spent during police education on a variety of practical exercises, such as drill exercises and scenario training, to teach students how to deal with complex and risky situations where collaboration, decision making and assessment are crucial for a safe and professional practice (e.g., Gonczi, 2013; Reader, Flin, Lauche, & Cuthbertson, 2006). Exercises include, for example, handling weapons (firearm, baton, pepper spray, etc.) and shooting, but also more complex skills where the performance may vary depending on the environment and the set of circumstances. Police education like many other vocational educations has limited opportunities and resources for students to practice sufficiently for developing professional knowing. Thus, computer simulation training is used to support the development of professional knowing (e.g., Dorn & Baker, 2005; Mooney et al., 2012). However, the primary focus of computer training appears to be largely on specific skill acquisition (e.g., shooting, driving).

Despite their increased use, there are many questions surrounding whether computer simulation training can support professional knowing. In this paper, we examine the link between computer-based training and the development of professional knowing. Drawing on perspectives about tacit knowledge and embodied learning (e.g., Argyris & Schön, 1974; Merleau-Ponty, 1945/1997; Polanyi, 1966) as well as empirical examples, this paper will discuss the design of, and what can be expected from computer simulation training for the development of police students' professional knowing. The field of computer simulation training consists of many different types of computer-based training methodologies (e.g., desktop simulation, motion-based video gaming, and high-fidelity simulation). This paper and the empirical examples used will focus on desktop computer simulation, but since the argumentation presented does not specifically build upon any one type of technology the reasoning should be relevant for any computer simulation training designed to develop professional knowing.

Research on Professional Knowing and Computer Simulation Training

Professional knowing has been investigated in a wide variety of contexts, such as medical education (Dieckmann, 2009: Hopwood, Rooney, Boud, & Kelly, 2016), crisis management (Berlin & Carlström, 2013; Moats, Chermack, & Dooley, 2008), firefighting education (Blondin, 2014, Holmgren, 2015), and in police education (Alison & Crego, 2008; Sjöberg, 2016; Stokoe, 2013). There is a general agreement among researchers in the field that developing professional knowing requires extensive training within a particular domain (Ericsson, Krampe, & Tesch-Römer, 1993) and acquiring the professional skills necessary for effective performance normally takes many years of training. Although extensive research on scenario training and other physical training situations has been conducted, there is still limited knowledge on how professional knowing is developed and learned. Additionally, knowledge on how different situations with varying degrees of complexity can be handled is limited (see Sjöberg, 2016). From a theoretical point of view, the development of professional knowing is to learn to acquire the embodied knowledge (know how) to handle the different practical situations an individual can face in real life (knowing-in-action) (Argyris & Schön, 1974, Schön, 1983). This knowing incorporates tacit, experiential knowledge and skills that are gradually acquired by practice (cf. Kinsella, 2009; Polanyi, 1966). How the body feels and perceives the environment is central to the understanding of practical knowledge (Merleau-Ponty, 1945/1997; Polanyi, 1966). Although scenario training does involve embodiment, an observation one can make from previous research is that this theoretical stance, embodiment and body techniques acquired through training and teaching and how it is learned (see Crossley, 2006), has largely not been specifically addressed.

One possible reason for why research on professional knowing has neglected embodiment may be due to its complexity. For example, when a building is being searched in order to locate a suspect, a threatening situation may arise where the police student has to adapt his or her actions and weapons to solve the situation in both legal and effective terms – a situation that often creates physiological stress reactions (Armstrong, Clare, & Plecas, 2014).

In conjunction with an intervention an officer must integrate sensory, motor, emotional and cognitive factors in order to deal with and solve the situation. This example illustrates a complexity that can occur in embodiment that is difficult to capture for researchers in typical laboratory or scenario test. In addition, the theoretical frameworks used in the research have not to any major extent taken into account embodiment. Without a theoretical framework that can provide interpretations in relation to tacit embodied knowledge, it is even more complex to pay attention to aspects of embodiment when applying it to professional knowing.

This lack of attention to embodiment is also true for research on desktop computer simulation training and the development on professional knowing in general, including police education. Typically, research has mostly focused on cognitive aspects of the situation being trained such as complex and integrative reasoning (Huppert, Lomask, & Lazarowitz, 2002; Ingerman, Linder, & Marshall, 2009; Silén Wirell, Kvist, Nylander, & Smedby, 2008) and for police education specific skills training such as shooting) (Li, 2009) or tactical decision making (Hartley & Varley, 2001) has been the focus. Clearly, there is a gap in the knowledge that is relevant to the design of desktop computer simulation training that we elaborate on in the next section.

Embodied Professional Knowing And The Design Of Computer Simulation Training

Evident from the review of research concerning scenario training, one complication that might hinder the designing of effective computer training modules for professional knowing is the fact that little is known about learning professional knowing. We cannot inform the design process with empirical data since no such data appears to exist. Instead, we have to rely on theoretical research that can provide a basis for understanding what factors interact and in particular which factors contribute most to the development of professional knowing. Theories on how practical knowing is acquired put forth that knowing is a consequence of bodily experiences and sensations (Merleu-Ponty, 1945/1997). Thus, desktop simulations have had to focus on cognitive aspects because, as defined by In Merleu-Ponty and Polanyi terms, they cannot accommodate embodied action. Desktop simulations, irrespective of how interactive they are or how much advanced technology is used, involve primarily the training of the cognitive strategy the user employs and even that is constrained by the design limitations of the simulation. In practical scenario training, we rely, in Polanyi's terms (1966), on our awareness of the body's contacts with external things, and we learn to pay attention to these things. For example, in many situations in the field police officers' actions will be dependent on their situational awareness, which smells, tastes, touch, and hearing can influence (cf. Damasio, 1994), and which includes embodiment in terms of selective attention, movement and action in relation to the situation to be solved. Such complexity is very difficult to pack into a simulation.

This is not to say, however, that desktop computer simulation training does not have a role in the development of professional knowing in police education. Drawing on Dewey’s view, “Every experience affects for better or worse the attitudes which help decide the quality of further experiences”

(1938, p. 37), computer simulations need to be anchored to the complex and risky situations that are to be trained in a practical scenario exercise. In other words, the simulation must be relevant for scenario training in order to support the development of professional knowing. The computer simulation training examples in this paper were designed to facilitate the understanding of complex situations, as they should be handled in the physical training situation. However, the effect of computer simulation training is not only a result of the design of the simulation tool, what it allows or limits. The link from practical scenario training to the design and performance of computer-based training is of crucial importance (e.g., Chang, Chen, & Sung, 2008; Söderström, Häll, Nilsson, & Alhqvist, 2014b; Windschitl & Andre, 1998). In the next section, we illustrate the lessons learned from working with computer simulations in police education with help from two different projects.

Lessons Learned From Working With Simulation Training in Police Education

In this section we describe lessons learned from working with computer simulations in police education

The Computer Simulation Training Sessions

The first project was a desktop gaming simulation designed to train peaceful resolution of conflict during local entry clearance search and to prepare the students for a physical search (see Söderström et al., 2014a). Conducting a search involves moving from areas under the control of the police into adjacent areas. Officers must assess the level of risk and evaluate whether or not they will have control before moving into subsequent areas. The simulation was developed using the game engine "Unreal" which provides a 3-D first person game user interface (see Figure 1). The students (n=12) worked about 1 hour with a desktop gaming simulation that trained local entry search. The task was to search through a building using the search tactics and to locate risk areas. The students worked in groups of three. As one student undertook the simulated task, the other two commented and discussed the search strategies. The computer simulation training was followed two weeks later with a practical training situation.

Figure 1. Local entry clearance search simulation.

The other example we use is a virtual case (see Figure 2) where 35 students worked to prepare for a large scenario exercise (see Söderström et al., 2015). The students were presented with a task that required interpretation of the situation and developing strategies for how to solve the situation as well as identify possible actions. The students worked 1.5 hour in their base groups (5-6 students). The computerized material consisted of images, videos, texts and discussion questions. A practical scenario training two weeks later followed the computer simulation training.

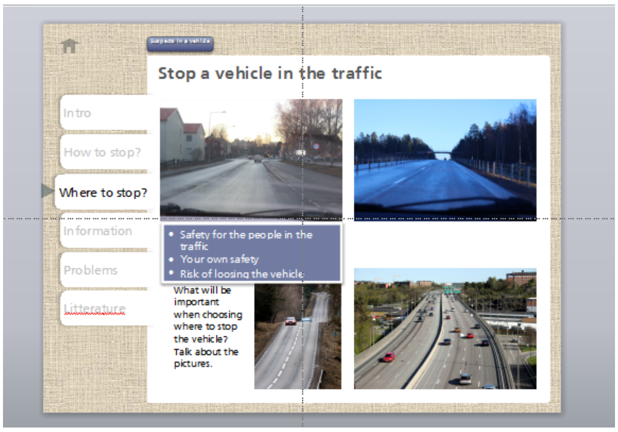

Figure 2. Online virtual case.

Students' Perceptions of Computer Simulation Training

The students' experiences of the computer simulation training were evaluated with questionnaires with items focusing on their experiences of working with the computer simulations as a support for the practical training. Answers were given by grading statements on a five-point scale. The results from the two groups of student were quite different. On one hand, the students that carried out the local entry clearance search simulation (n=12) were only moderately convinced that the simulation training contributed to being prepared for the practical search, discovering risk areas, giving guidance on how to act or contributed to feeling confident about the various possible means of action. The mean value of the students' responses on the items varied from 2.57 – 3.00. On the other hand, the students that worked with the virtual case (n=35) believed that the work with the virtual case clearly helped them to develop their knowledge of police work, contributed to and understanding of different ways to solve a problem, gave guidance of how to act and that they were theoretically prepared for the scenario training (mean value on the items varied from 4.11- 4.54)

Clearly, the students participating in the local entry search did not experience the same amount of support as the students from the virtual case when moving to the practical training. The students in the virtual case thought that to a high degree everyone in the group took responsibility, worked well together, that the group performed well and that the various solutions for the tasks were well discussed (mean values from 4.09 to 4.37). Responses about how well the group functioned from the students who worked with the local entry search were lower (mean values from 3.58 to 3.92). The items concerned their perceptions of how the group assisted their strategies and actions while performing the simulation, how different strategies for solving the task were discussed and how the group performed.

Reflections on the Training Sessions

Although both simulations were influenced by theories on reflection (Dewey, 1938; Schön, 1983,1987) and addressed senses as guides for action in design process (Söderström et al., 2014a), only the virtual case could be said to be of any help in preparing the students for the practical training. The explanations to these differences can be analyzed on several different levels, but here we want to emphasize its link to practical scenario training as well as to how the training is designed and performed. One interpretation of the missing relevance for the local entry search simulation for the practical test is that the different characteristics of the simulations mediated how the training session was performed. The local entry search simulation was built on a gaming platform in a first person perspective. Like a game that is played just to perform the tasks, there is a risk that a gaming simulation for education is performed in the same way. It is possible that the simulation sessions were performed at a pace where the detecting and marking of risk areas turned out to be an unplanned trial and error that, in Schön's (1987) terms, contributed to an "exploratory action undertaken only to see what follows" (p. 70). In this sense how the training was performed is one clue to how we can understand the little relevance the students believed the local entry search had for their practical training. On the other hand, the virtual case is a simulation that did not support or motivate students to perform it in the same way. Therefore, it was easier for the students in the group to remain focused and attentive to the situation that was to be resolved, which contributed to a more concentrated and conscious training.

Another explanation to the differences in students' experiences of the training might be found in the group work. It appears as the simulation sessions mediated the group work differently. In the simulation, the focus should not simply be on performing the task, but also on how the task is performed (e.g., thoughtfully). This will particularly affect and facilitate the discussions within the groups. As the results show, the virtual case students were more positive to the discussions about how to act and appropriate actions in relation to the situation to be solved in the simulation. In one sense, consistent with Argyris and Schön's (1974) perspective, they applied an inquiry process of identifying how a situation may be managed –" the action appropriate in order to achieve an intended consequence" (p. 7), which the local entry search students did not do. The virtual case sessions can be interpreted as the students' collective efforts to testing the theories-in-use, e.g., ways of doing in situations to achieve an intended consequence (Argyris & Schön, 1974; Schön, 1987). Similarly, as Sellberg's (2017) study of a full mission ship simulator showed that bodily conduct and talk by the instructor filled in missing aspects of the real world, it is possible that the students collective work filled in missing aspects of the practical training in the simulation session.

The discussion we have presented demonstrates that action never takes place in a vacuum. The teaching situation and how a situation is understood affects an individual's actions and what goals they are directed against (cf. Goffman, 1974). Although both examples discussed here were designed to challenge the students' theories-in-use in order to avoid the experiences of their actions in the simulation sessions being processed superficially, we have learned that a computer simulation's relevance for practical scenario training is a complex endeavor that needs, in various degrees, to be supported by pedagogical steering. In other words, the need for pedagogical steering differs between computer simulations.

Concluding Thoughts

Learning practical skills is about acquiring skills that can be used both in simple and in complex situations within an ever-changing environment. Computer simulations can be a useful aid in offering many and varying experiences about typical cases and in discovering the prevailing situation in the practical training which is similar (cf. Johnson's [2010] view on transfer). However, computer simulation training cannot replace exercises in scenario training or drill exercises. To fully learn practical knowing in Merleu-Ponty´s (1945/1997) terms is dependent on the body's sensations and perceptions in the development of knowing. By acknowledging this, it becomes clearer what and how computer-based training could contribute to the development of practical skills in training with extensive elements of practical-oriented training such as police education. However, since we cannot fully rely on research on physical scenario training in the design of computer simulation, a user centered design based on students' experiences of practical training may be a more feasible way to carve out aspects that can inform the design process. Scenario training is resource intensive, and it is essential that students be well prepared for the training. Sjöberg's (2016) study demonstrated, for example, that preparation is important for how training is performed and what lessons are learned. He showed that it is both about managing equipment and weapons (wanting to avoid focusing on a radio that does not work or a baton that is stuck) and to quickly read the situation and act expediently (wanting to avoid focusing on peripheral things in the situation).

Simulations offer opportunities to recreate and simulate situations and scenarios that are considered relevant to the profession and the content that the student should learn. However, the design of computer simulation training (both the simulation and how the training is designed and performed) needs to consider the specific aspects that surround tacit knowledge and embodied learning in the "real sense." Through an alternation between simulation and practical training, theories in use can be altered and new theories of action can be tested in the scenario training directed by a process of reflection rather than blindly using a trial and error approach (cf. Argyris & Schön, 1974; Schön, 1987). Students working together can discuss possible solutions to the task and strategies can be tested in a simulated environment before being tested in scenario training. This interplay between discussion and testing in practical scenario training gives the student the possibility to develop theories which in line with Argyris and Schön's (1974) thinking can facilitate knowing what to do in a given situation in order to achieve an intended consequence.

Although, computer simulation training has the potential support the students' development of theories-in-use, it cannot put the theory of action into practice, which is the proof of whether it is learned in the most important sense (Argyris & Schön, 1974, p. 12; cf. Polanyi, 1966).

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DEVELOPING PEDAGOGICAL DISCOURSE FOR EFFECTIVE SIMULATION-BASED LESSONS IN PROGRAMMING

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Abstract

In this study, we explored pedagogical aspects of simulation-based programming lessons using the lens of students' and instructors' perceptions. We followed a qualitative approach using focus groups and semi-structured interviews with the students and instructors of a British university. Findings suggest a number of pedagogical guidelines including measuring prior knowledge of learners, varying instructional approaches, and addressing student learning preferences in pedagogical designs, amongst others. A key contribution of this study has been a rich pedagogical discourse containing effective simulation-based practices transferable among disciplines that can use simulation for learning and teaching.

Key words: simulation, pedagogy, meaningful learning, teaching, programming

The Need for a Simulation-based Pedagogical Discourse

The term simulation refers to the use of a technological device or model that facilitates elements of reality for the purpose of practical experience and learning enhancement (McGaghie, Issenberg, Petrusa, & Scalese, 2010). The utilisation of simulation for formal education has been in existence for more than two hundred years and the approach has been widely applied in medical, aviation and maritime education (Woolley, 2009; Wyatt, Archer, & Fallows, 2015). Presently, simulation is used in various disciplines including engineering, business, computing and education (Chini, Straub, & Thomas, 2016; Isiaq & Jamil, 2018). Consequently, the knowledge of simulation has extended from technological characteristics to a medium of learning and teaching (Harder, 2009). As a result, the need for understanding the pedagogical perspectives and best practices in simulation-based educational activities has been established (Rystedt & Sjoblom, 2012).

Simulation links real actions of future academic and professional work with similar learning environments and actions at formal educational institutions (Kelly, Forber, Conlon, Roche, & Stasa, 2014). In some cases, simulation can be an alternative for industry placement (Rochester et al., 2012). In simulation-based teaching, aspects of curricular content are integrated for providing comprehensive and standardised practical learning experiences to students (Gonczi, 2013). The approach offers a collaborative and supportive learning environment for imitating risky actions in a safe and corrective learning environment (Jeffries, 2012). However, simulation itself cannot lead to effective learning if the design and facilitation are not properly conducted (Dieckmann, 2009).

There are barriers to using simulation for learning and teaching, for example, lack of study resources, inadequate teacher preparation time and professional development, and teachers' lack of simulation experiences (Hayden, 2010). There is also a gap of theoretical understanding about how simulation contributes to learning (Bland, Topping, & Wood, 2011). Therefore, researchers and practitioners consider the need for a broader philosophical understanding of simulation concepts with transparent, systematic application and procedural use of the tool or model in education (Tun, Alinier, Tang, & Kneebone, 2015). In other words, it is important to discuss the theoretical aspects of simulation in relation to associated educational principles. In this regard, a balance between teaching-focused and learning-focused theoretical explanations needs to be explored (Kaakinen & Arwood, 2009). Hence, a rigorous discourse of simulation-based pedagogy, particularly the relevance, challenges and solutions need to be adequately constructed.

The paper explores various pedagogical aspects of simulation-based programming lessons including teaching preparation, content delivery approaches, learning-related challenges and assessment techniques. The findings build a pedagogical discourse by amalgamating diverse experiences and perceptions of students and instructors of a British university.

Aspects of Simulation-based Programming Pedagogy

The teaching and learning of programming are considered difficult because they require concrete understanding of the operational procedures of computational devices and models as well as enhanced code manipulation competence (Ma, Ferguson, Roper, & Wood, 2011). Additionally, a programmer is expected to be creative, problem solver and critical thinker (Bergin, Reilly, &Traynor, 2005). Moreover, high student engagement and meaningful learning experiences are essential for achieving programming-related competencies (Kujansuu & Tapio, 2004). These conditions may exacerbate the difficulty of designing and delivering programming lessons when simulation is involved.

According to learning theories such as behaviourism, cognitivism and constructivism, simulation is effective for acquiring knowledge and skills. For example, it involves 'learning by doing', the approach that follows the experiential learning model (Kolb, 1984). Simulation also allows conscious and repetitive practice that supports gaining mastery of certain skills (Sawyer et al., 2011). Moreover, simulation allows the creation of a self-directed learning environment, which presents relevance of the learning contents and their applications (Bryan, Kreuter, & Brownson, 2009). Although simulation-based programming lessons involve distinctive subject matters and unique educational approaches; a detailed discussion, particularly the pedagogical discourses of this field, has not been significantly developed in the literature. Yet, several educational issues including student engagement and teacher roles have been studied with a reference to programming lessons (White, 2017). For example, creativity and the applied features of programming subjects are emphasised for meaningful learning outcomes (Kujansuu & Tapio, 2004). It is also encouraged that simulation-based lessons combine activities that can stimulate students' behavioural, cognitive and emotional engagement (Isiaq & Jamil, 2018).

The Study

This study is conducted in two stages. Stage-1 built the ground for understanding programming lessons from the viewpoint of student engagement and meaningful learning. Stage-2 extended this understanding of learning to pedagogical practices with a specific attention to teaching aspects. The findings gained from these stages together have generated a rich pedagogical discourse that helps with the understanding of the educational dynamics in relation to simulation-based practices and its effectiveness in programming education.

Stage-1: Earlier Study

In this stage, we followed a mixed-method case study approach to explore the dimensions of student engagement in traditional and simulation-based programming sessions, and their impact on programming pedagogy. By using a self-report survey and a set of Critical Incident Questions (CIQ), our research provided useful findings on the dimensions of student engagement in simulation-based programming lessons (Isiaq & Jamil, 2018).

At this stage, we identified a strong interweaving relationship between three engagement dimensions, namely behavioural, emotional and cognitive in the simulation-based programming lessons. We found that simulation is able to facilitate personalised learning, higher engagement and a strong link between learning content and students' future work and profession. According to students' perceptions, simulation-based programming sessions were more collaborative and focused on specific learning goals. However, we identified the need for cognitively challenging tasks in such lessons for greater gains of meaningful learning. A key lesson learned at this stage was that the use of simulation for the delivery of programming lessons becomes effective when the pedagogical activities involve a balanced intervention of behavioural, emotional and cognitive exercises. These findings led us to study feasible approaches to designing and implementing suitable pedagogical activities that can ensure this balance of engagement dimensions. Therefore, we conducted the following stage of our research to understand the pedagogical aspects of simulation-based programming lessons through the lens of student perceptions and teacher reflections.

Stage-2: Present Study

With a continuation of the learning from Stage-1, Stage-2 focused on the exploration of effective approaches to designing and implementing simulation-based programming lessons. In this regard, we captured the experiences and perceptions of the instructors and students to evaluate the following aspects of teaching and learning:

- The pedagogical benefits for instructors and students in simulation-based programming modules
- The pedagogical challenges they face

- The pedagogical preparations required for effective participation in such academic programmes

Methodology

In Stage-2, we adopted a qualitative approach using focus group and semi-structured interview methods. The key reason for adopting a qualitative research approach was due to its provision of in-depth explanations of unexplored fields of this study (Creswell, 2007). Particularly, we used focus groups and interviews to collect a rich amount of opinion and experience of research participants through reinforcing and challenging their information (Stewart, Shamdasani, & Rook, 2007). Thirty-five students and four instructors of a second year computing module of a teaching-focused British university participated in the study. We had obtained ethical approval from the respective university before commencing our research.

First, the students attended five focus group sessions, each lasting about thirty minutes, and discussed the pedagogical activities that helped them to be engaged and achieve meaningful learning of the programming topics. Examples of the questions include: “When do you generally feel more engaged in the class?” “What is the role of your classmates in the lessons?” and “What makes you become inattentive in class and less engaged?”

Second, we interviewed four instructors of the programming module (simulation-based and traditional) and asked them questions about lesson planning and delivery techniques. Examples of the interview questions include: “How do you prepare the delivery of a simulation-based programming lesson?” “What challenges do your students face while participating in simulation-based programming lessons? Give some examples,” and “how do you know that your students have achieved the required knowledge and skills of programming?’. Each interview lasted about twenty-five minutes and its semi-structured nature allowed us to improvise questions for a better clarification of the responses.

All of the focus group and interview participants had attended a series of specially designed simulation-based and traditional programming lessons. For this reason, the academic experiences of the participants were practical and relatable. Therefore, the perceptions and reflections of these research participants on the teaching and learning aspects related to simulation-based programming lessons were valid and reliable.

Both the focus group and interview sessions were audio-recorded and transcribed by a professional transcriber. Then, we processed the datasets using NVivo software. We followed a thematic analysis procedure while describing the findings. In reporting, we triangulated the focus group and interview data along with the findings from Stage-1, which provided richer perspectives and comprehensive understanding of the impact of simulation-based programming pedagogy (Johnson, Onwuegbuzie, & Turner, 2007; Teddlie & Tashakkori, 2009).

Findings and Analysis

The focus group and interview data individually and together constructed a useful discourse on simulation-based programming pedagogy. The findings have been categorised in four broad areas (see Figure 1 below).

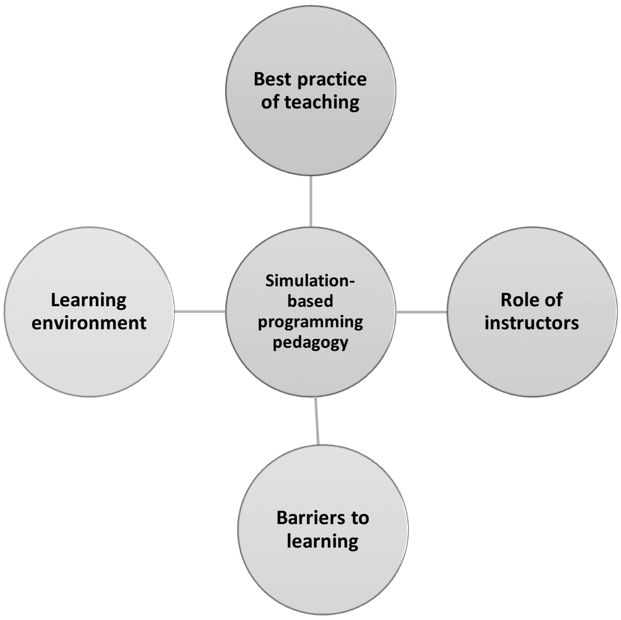

Figure 1. Discourse areas of simulation-based programming pedagogy.

Learning Environment

There was consensus among the instructors that the students are generally engaged in the simulation-based programming sessions. An instructor indicated that the attention and understanding of the students were greater compared to non-simulation-based sessions. The instructors also found the teaching of programming topics quicker and simpler in simulation-based sessions as students received real-time guided instructions in a step-by-step manner. A common challenge was a case of technological glitches, particularly when there was a network connection problem.

During the focus groups, students indicated the need for a strong link between lecturers and students when explaining or presenting new topics. They believed that the connection could be built through questioning and guided tasks. They also identified that preparing learning goals through 'working examples' could better facilitate the process. Some students suggested a number of essential conditions for making the simulation-based lessons more meaningful. First, prior to the commencement of any new topics they wanted structured guidelines and examples given to improve motivation and participation. They showed an interest in learning the process of programming, so they expected that their instructors would 'explain every detail' about how a program works. Second, students expected sufficient time for doing practical exercises. They also mentioned the need for a communication platform for sharing and consulting with instructors and classmates while completing tasks. Some students believed programming tasks could be better accomplished if there was a medium for prompt questioning and responses.

Barriers to Learning

Some students indicated a number of challenges they felt hindered their learning. For some, dis-engagement was the key barrier caused by lack of clarity of learning goals of some of the sessions. Less challenging tasks also caused dis-engagement:

> For me it was the xx lesson. I think it was so simple, I wasn't engaged at all … because there are different [proficiency] levels [of] … xx topic, and it was from beginning, and I was a little bit bored.

According to some of the students, they found the module quite exciting at the beginning, but gradually lost their enthusiasm. It is possible that they grasped the concepts and skills of programming very fast with the use of simulation, or the design of the module was not cognitively challenging enough in the latter part. Students also mentioned the need for challenging tasks, as they did not want 'to be spoon-fed.' Another barrier to learning was the different levels of prior knowledge of the students. According to a focus group participant;

> I know that some students don't have the solid knowledge, they get lost so easily, sometimes; students don't get everything all day.

The structure of teaching can also hinder learning in simulation-based sessions. Some students indicated that they felt their instructors were not fully supportive in some sessions. The finding suggests a need for greater teacher preparation and support for students in programming lessons.

Conversely, the instructors did not identify any major difficulties that their students had faced during the simulation-based programming lessons. However, they believed an over-reliance on the simulation-based activity caused some students' to give low attention to the tasks. Further application of other computing tools and techniques, such as artificial intelligence with a simulation tool could further enhance meaningful learning for students. The instructors mentioned that the lesson materials, such as worksheets and practice tasks that were prepared centrally, could be enriched by some modifications, for example through incorporating more problem-solving tasks.

Role of Instructors

There were varying preparation approaches by instructors for simulation-based programming sessions. One instructor mentioned that there was less preparation, as the person believed the simulation tool did most of the work. In addition, the instructor was less involved in the session design phase as the module leader completed this aspect mostly. Other instructors stated that they prepared themselves on the contents of the lessons mainly and, to some extent, the technological facilities in the classroom.

The students came up with some ideas about the effective roles of instructors. They found that programming concepts are complex, but could be learned easily through efficient teaching.

> There's couple of things with programing, every now and then where you think the task you're about to take is going to be incredibly daunting, and then when explained properly and well, it actually goes that it's really easy … and then applying it to other situations then again it also becomes easy…

The findings indicate an important role of the instructors in simulation-based programming sessions, which is generally perceived as highly technology-oriented. Some students stated that the instructors should organise collaborative learning tasks, as a few tasks were less inclusive:

> [In hands-on practice session] … you feel like: I'm gonna put my headphones on my head and ears and start to listen to music and don't worry about others; so you don't feel engaged [with others], you don't feel like a, yeah, feeling the lessons, it's just you, yourself and the computer.

The students also looked forward to demonstrations and detailed guidelines from the instructors. Additionally, they expected that the instructors would be more familiar with their learning needs and apply suitable pedagogical procedures for facilitating meaningful learning.

Best Practices of Teaching

By evaluating the engaging and non-engaging as well as enjoyable and non-enjoyable tasks through the lens of the research participants, the following instances of best teaching practices in simulation-based programming sessions have been revealed.

- Students did not like to be spoon-fed in the practice sessions, rather they wanted to experience challenging tasks, both independently and collaboratively. Prompt answers and explanations of students' queries helped them learn better.
- According to the instructors, although simulation-based programming activities were different from traditional programming lessons, still the assessment tasks were the same, such as timed examinations and written reports. Because of the practical nature of programming module, there is need for a rethink of assessment procedures in such academic programmes.
- The focus group participants mentioned that the instructors should be aware of the knowledgebase of their students. Otherwise, the teaching may become interesting for some students, but at the same time boring for others. The research participants advised the instructors to design differentiated simulation tasks for different levels of students.
- Demonstration of programming using simulation provided an enhanced learning experience for the students. The research participants believed programming could easily be learned when the instructor divides the tasks in steps and demonstrates the process as whole.

- Pre-session activities, such as reading materials and small tasks enhanced the productivity of practice sessions. Therefore, the instructors can design ‘flipped’ lessons where student can practise programming outside the class and share their learning experiences as well as demonstrate some steps in the class. However, it is important for the instructors to monitor the progress of the students as minor mistakes can lead them to failure and frustration about the programming tasks.
- The students and instructors emphasised the need for understanding the back-end processes of programming. They believed visual explanations of common errors could better explain the processes. They also deduced that the instructors should provide a rigorous support to students before they start practising programming, otherwise repeated mistakes can demotivate and dis-engage them from learning.
- The research participants prioritised the importance of psychological engagement for the effective learning of programming through simulation. They also suggested some pedagogical activities, such as workshops, collaborative tasks, process animation, book research and worksheets for engaging them to explore simulation and programming tasks more deeply.
- The students considered programming sessions to be demanding as they involved a high level of cognitive engagement and physical actions. Therefore, they recommended a flexible and comfortable learning environment, which allows refreshments and taking breaks in the middle of sessions.

Conclusion

The study identified some dissimilarity in the perceptions of students and instructors about simulation-based programming lessons. The issues included the nature of the learning environment, the roles of the instructors and pedagogical activities. Several learning barriers including less challenging tasks and ambiguity of pedagogical structures were identified as critical areas to address in the design and implementation of such academic programmes. The study provided several best practices of simulation pedagogy in programming sessions. However, we found the need for adequate pedagogical preparation as imperative for improving the quality of student learning experience.

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A STUDENT PERSPECTIVE ON MINIMUM REQUIREMENTS FOR MOBILE NOTE-TAKING

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Abstract

In recent years there has been a sharp increase in the number of students who own mobile devices. In this case study, a group of students explore the note-taking possibilities of mobile devices in various educational settings. Data was collected through a questionnaire, group interviews, and observation. For students, the ease of use of both devices and applications were important. Although they preferred to use one application, they did not give preference to a specific device. More importantly, students need to share information between devices as well as with fellow classmates. Finally, recommendations are made on the minimum requirements needed for effortless note-taking.

Introduction

Numerous researchers have shown that the use of mobile devices has increased dramatically over the years (Schepman, Rodway, Beattie, & Lambert, 2012; Sooryamoorthy, 2014; Wallace, Clark, & White, 2012). The astounding popularity of mobile devices is illustrated by the fact that in the first four years since the launch of iPads, more devices had been sold than any other product in Apple's history (Dilger, 2014). Furthermore, the results of a worldwide survey showed that mobile subscriptions reached the 5 billion mark in 2017, which is a penetration rate of more than 66% of the world population (GSM, 2018).

In South Africa, a general household survey completed in 2016 showed that 96% of households had a mobile phone, while only 21% had a computer (Statistics South Africa 2016, 2017). Not only do South African citizens have access to mobile phones, but 37% of them indicated in 2015 that they owned a smartphone as well (Poushter, 2016). From the above it is clear that mobile devices, albeit laptops, smartphones or tablets, are popular and readily available for day-to-day use. One can now ask how these devices can be used in education, especially in a learning activity as relevant as note-taking.

Literature Review

Taking into consideration the popularity of mobile devices worldwide, the importance of note taking in educational environments, as well as the realities of students, the focus of the literature review will be on note-taking and the use of mobile devices in education

Note-Taking

Note-taking refers to the typing or writing of information in a systematic way; it can also include the recording of images or voices, or both, during a lecture or a discussion (Schneider, 2014). The importance of note-taking for students was emphasized by several authors' research (Anderson & Armbruster, 1986; Cohen, Kim, Tan, & Windelmes, 2013).

Students often complain about the balancing act they need to perform in class by simultaneously trying to read from slides, actively listening to the lecturer, critically thinking about new constructs, and writing legible notes. If this process is so demanding, the obvious question is why lecturers do not simply provide students with full sets of notes or record all lectures. Russell, Caris, Harris and Hendricson (1983) found that if notes are provided, it is better to give students partial outlines only, as opposed to full sets of notes, as that enables them to add their own experience and thereby expand on the existing information.

Piolat, Olive, and Kellogg (2004) and Bui, Myerson, and Hale (2013), state that the process of note-taking is cognitively demanding. In this context, *cognitive demanding* refers to actions students take to simultaneously pay attention, organise the information, and record it in an understandable manner before it is forgotten (Bui & Myerson, 2014). For many years, university students, and first year students in particular, have been faced with the dilemma of how to recall the flow of information in traditional lecture periods (Piolat et al., 2004).

Bui et al. (2013) compared handwritten note-taking with taking notes on the computer and concluded that computers can be used with some success for note-taking. In spite of the findings of Bui et al. (2013), Mueller and Oppenheimer (2014) reiterate that the pen is mightier than the keyboard. They claim that note-taking on mobile devices, such as laptops, result in shallow processing because students transcribe what the lecturer say, word for word, while the cognitive demanding actions, as described above, do not take place.

Furthermore, Ward and Tatsukawa (2003) advocate that electronic note-taking still needs to engage the student's mind, and be cognitively challenging, while technology plays a supporting role (Ward & Tatsukawa, 2003), rather than being a distracter in class (Mueller & Oppenheimer, 2016). However, the reality in the classrooms are that students keep on using their mobile devices for personal activities and to some extent for note-taking (Vincent, 2016).

Mobile Devices in Education

Although mobile technology had not originally been designed for educational purposes (Traxler, 2010), its omnipresence challenges lecturers and researchers to develop applications so that it can be utilised in education. Students seem to use their mobile devices often and regularly, even more than their physical university libraries (Laurillard, 2012).

When students use mobile devices, the classroom's boundaries disappear, and, this learning environment without boundaries moves with the students wherever they go (Martin & Ertzberger, 2013). Johnson et al. (2013) note that tablets are emerging as powerful tools to be used inside as well as outside the classroom. The mobility, ease of input, and new screen format enables lecturers to present learning material in new ways (Clark & Svanaes, 2014).

In South Africa, the use of mobile devices in education is also increasing. Universities such as the University of KwaZulu-Natal (University of KwaZulu-Natal, 2013), the University of Johannesburg (Fripp, 2013), and some private universities (Alfreds, 2013) have also embarked on tablet projects. Furthermore, the Department of Basic Education of the Gauteng Province and three schools in the Eastern Cape province has embarked on tablet projects (Oxford, 2015; Wild, 2015). As a result of the above, many first-year students at South African universities will already have been exposed to the use of tablets when they enrol at universities.

When taking both the popularity of mobile devices and the value of note-taking into consideration, the question arises how students experience the use of mobile technologies in the various learning environments (Mackenzie & Knipe, 2006). To explore this, the following two sub questions were asked:

1. How do students use mobile devices to take notes in a typical health science course?
2. In the students' opinion, what minimum requirements should mobile devices have to ensure effective note-taking?

Research Method

This research study was exploratory and qualitative in nature, and the design is in line with that of a case study. BVSc students at a faculty of veterinary science at a university in South Africa participated in this study. The research was conducted in two phases. During the first phase, data was collected by means of a questionnaire, and during the second phase it was collected by means of group interviews and a class observation.

As part of phase 1, 179 (n= 365) pre-clinical training students who attended classes on a particular day completed an electronic questionnaire about their mobile device ownership, mobile device usage and internet access. This questionnaire was administered by the researcher and after the purpose was explained and consent was obtained, Clickers were used to collect their responses. These responses were counted and summarised using a Microsoft Excel spreadsheet.

In the last question of the questionnaire, student volunteers were invited to participate in the second phase of the study. Eight of the 179 pre-clinical training students volunteered to participate. This group of eight students consist of 2nd (n=1), 3rd (n=5) and 4th (n=2) year students. Half of the students were black (n=4); three were white and one an Indian student. Six female and two male students participated.

This article reports on how students used their mobile devices when they took notes. As part of the study, specific assignments were designed so that the participants could integrate mobile technology into their learning practices, particularly when taking notes in the typical educational environments of veterinary students. After exploring a particular aspect of mobile note-taking, participants had to report back on their experiences during a group interview.

The group interviews were held once a week for six subsequent weeks. Participants were asked to report on the specific device and applications they used for taking notes and whether or not they felt it worked for them. After written consent was granted, the group interviews were recorded and transcribed, the text was then analysed according to the method described by Henning, van Rensburg, and Smit (2004) to determine trends and recurring patterns.

Lastly, an observation was made when one of the researchers visited a practical anatomy class and observed how students used mobile devices. After permission was obtained from the lecturer and students, the researcher took photos of how the students took notes with and without their mobile devices.

Results

The results of the questionnaire administered during the first phase painted the picture of which devices the students had access to and how they already used them for social and academic purposes. Therefore, those results will be presented first. Subsequently, the feedback from Phase 2, namely the group interviews and observations, will be presented in the form of three themes: students' current note-taking practices, the mobile devices and applications used, and the perceived value of taking and sharing notes.

Mobile Device Ownership and Use

To confirm the use of mobile devices at this university, the participants were asked to indicate what mobile devices they were using at the time. In the electronic questionnaire, 96.6% of the students indicated that they were using a mobile device (laptop, tablet or smartphone) for either social or academic purposes. This usage is shown in Table 1.

Table 1

Mobile Device Uses For Social and Academic Purposes

Mobile Devices Used for Social Purposes		Mobile Devices Used for Academic Purposes	
Social media	158	Not using it for academic purposes	16
Email	148	Searching information	142
SMS	146	Accessing ClickUP (Blackboard LMS of the university)	116
Instant messaging	132	Taking notes	55
Videos and music	132	Taking photographs	109
News & weather	101	Recording lecturers	39
Browsing	129	Doing assignments & tests	61
Games	90	Discussion groups	70
Calendar	110	Other	16
Other	27		

The data from the questionnaire confirmed that the majority (96.6%) of the pre-clinical students owned a web-enabled mobile device. Of the students who participated in this study, 31% indicated that they used their mobile devices for taking notes during classes, 61% of them used their mobile devices for taking photographs during class, and 22% of the students had recorded a lecture in the past. This finding encouraged further exploration of the use of mobile devices more specifically on the use of mobile devices for note-taking purposes.

Current Note-Taking Practices

During the first group interview, participants were asked to indicate their current note-taking practices. Participants' explanations confirmed that students were already making use of their devices without the interference of lecturers or the university (Laurillard, 2012; Naismith, Lonsdale, Vavoula, & Sharples, 2004). It seemed to be irrelevant whether or not lecturers gave students copies of their presentation slides, or even lecture notes, before the class, as students took notes regardless of handouts. When taking notes, students either type or write on top of the electronic format of the notes, or they print the notes in hard copy and write on them in the traditional way. If the notes are not available beforehand, they either type the notes on their mobile devices, or they write on paper. After class, or when the slideshows become available, they organize and put all the notes of a subject together.

During the practical anatomy session, the researcher observed while students dissected and isolated specific anatomical structures. Some students printed out all the notes beforehand and came to the practical armed with an array of colored flags, pens and highlighters. They then did the dissection and took notes on their paper-based handouts as they went along. A few other students chose to use their smartphones or tablets and downloaded the notes on their devices beforehand. They opted to take photographs of their own dissections as they discovered the various anatomical structures and used an app with digital pens in a variety of colors to draw and highlight the various features on their picture (Figure 1).

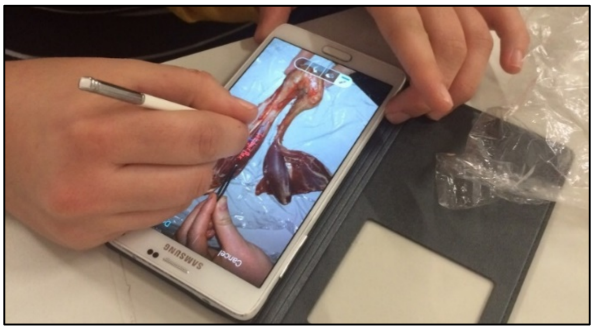

Figure 1. Taking notes with a smartphone.

Other students found it frustrating to divide their attention between their notes and the photographs of their dissection and opted to use their tablets as well. It seemed as if these students alternated effortlessly between the various devices, using each one in a slightly different way and for a different purpose, depending on their needs at the time.

Devices and Applications Used

To allow the participants to further explore the use of mobile devices for note-taking, the participants had to use applications of their choice to type notes and take pictures and videos and were then requested to organise and integrate the notes and images with the lecture notes they received from the lecturer.

The devices that participants experimented with were tablets (Samsung tablet, Samsung Galaxy 2 and an iPad), smartphones (Sony Xperia Z2, Lumia and Zest) and laptops. The mobile devices that have dedicated stylus recognition worked well, and participants could write and highlight text, make drawings, and write on pictures while using that application. The participants who used devices without a dedicated stylus downloaded a stylus application that did not work well, and they had to revert back to typing instead of writing.

Various Office applications such as King Office, Polaris Office, Office Suite 7, Documents Office and Microsoft Office, were also used. Some applications worked better than others, depending on what the participants tried to do and on which mobile device they used the applications. Typical actions were to highlight, format text and add objects like pictures. Although students attempted drawing on existing slideshows, they could not use the drawing function on a laptop. Participants also complained that not all Office packages were user friendly and that they had struggled to create new documents, especially on the smartphones.

The participants also experimented with dedicated note-taking applications such as Evernote, OneNote and S-Note, with mixed results. Although all these applications worked, documents could sometimes not be opened and edited, and in other cases documents could not be shared. The majority of participants explored Adobe, since the slides used in class were in PDF format. They mentioned that Adobe worked on all the devices and that documents could be moved between devices. However, they were unable to select a specific page to print.

In order to put together all the information collected during note-taking, and to make their note-taking effective, devices had to be able to sync with one another. This is confirmed by Mueller and Oppenheimer (2016), who concluded that the note-taking devices and applications used will differ from situation to situation, and that note-taking needed to be more effective rather than merely easier.

Note-Taking and Sharing of Notes

A significant theme that emerged from the feedback was the value of note-taking as experienced by the participants in the study. The veterinary students seem to have two specific opinions about note-taking. Firstly, note-taking was perceived as important because it was seen as an integral part of their own learning process. As one participant stated: “For me personally, sitting and putting the time into … making comprehensive notes for myself is almost two-thirds of the learning experience…” [P2].

But it was, secondly, interesting to note how these participants also regarded it as important to record and save information for future students (those currently in lower classes), especially in the form of visual notes like pictures with captions of specific diseases, and videos with voice recordings and explanations of real case procedures. The importance of sharing notes with one another, and of using notes that students from previous years supplied, also became clear as indicated by the following student remarks: "In Pathology it really helped going through what other students have made of each of the organ systems" [P1].

Discussion

It was clear from the onset of this study that the students who completed the questionnaire either owned or had access to mobile devices. It was further highlighted during the group interviews that students already used these devices as they saw fit in their different educational environments. Based on the students' feedback, the following should be taken into consideration when taking notes.

Ease of Use

When referring to what devices and applications they tried out as part of this study, participants regularly mentioned how difficult or easy some applications were to use or how some applications were not user friendly. This is an indication that ease of use is important when trying out applications on mobile devices and should and be taken into consideration when note-taking applications are developed. As a student mentioned, "But I am still trying to figure out how to use it. I didn't enjoy it. I like the pen and paper" [P3].

This is in agreement with what Davis (1989) also found: that ease of use is one of the possible indicators of users' attitude, intent to use or actual use of technology.

One Application Available on Multiple Devices

The participants also regularly referred to having everything they received, recorded or wrote down in one application. They experimented with various devices in the weeks of the study. According to them, there is not one specific device that will fit all their needs. As mentioned by one student: "You can't really only have one device and expect to use it all the time unfortunately. It is not practical" [P6].

Therefore, not only do the students want all their notes saved in one location, but they also want the notes to be available on various devices. Also, the saved notes should preferably be able to integrate seamlessly with whichever learning management system is used by an institution of learning.

Sharing Notes

In addition to being able to take notes and having everything together as a study unit, the participants emphasised the importance of sharing their notes. To do so, they need to save the notes in a format that is small enough to be transferred between devices. Participants not only want to share their notes with their fellow students, but also keep them safe for future students to access and learn from. To the participants it is important to have access to rare and special veterinary cases of the past, because it is possible that they will not see such a case during their studies.

One participant commented that they appreciated it when final-year students recorded the real-life cases that they were exposed to in the clinical setting and then made the information available to students in the pre-clinical years. The student said: “It is a lot easier to remember diseases like that if you actually have memories of the pictures, … what it looks like, … what you saw and different variations of the same type of disease” [P1].

Therefore, such an application should be able to allow students to share their information with others, for example, through social media like Twitter and Facebook, or email. In addition, if saved in the cloud, it would also be available on all the devices students use.

These participants used mobile devices in class for mobile note-taking. Researchers claim that if you verbatim take down notes without any brain processing, the value of note-taking is shallow (Mueller & Oppenheimer, 2014). However, what was interesting about these participants, is the fact that after they took notes (apparently shallow processing), which they organised after class,they integrated all the notes that they made for the day into one learnable unit. This integration of information, students claim, forms a significant part of their learning process and eventually influences their results.

Conclusion

It was evident from the literature that the majority of students own mobile devices and use them on a daily basis (Gikas & Grant, 2013; Kobus, Rietveld, & Ommeren, 2013; Traxler, 2010). This trend was also found to be true for the students in this current study. Therefore, this study aimed to explore the current practices and experiences of students when they take notes using their mobile devices. This article contributed by looking at the type of activities students would like to engage in when taking notes, taking into consideration the sophisticated technology that is available, as well as students’ higher levels of computer literacy. Minimum requirements are provided, that could be of great importance to creators of online applications aimed at institutions of higher education.

In short, participants in this study stressed the importance of ease of use and having a space where all their notes are available in one application from where they can seamlessly share their notes between devices and their fellow students. To make this possible, this application needs to be scalable over a variety of devices, so that students can choose which mobile device will fit a particular environment best. With the pace of technology development increasing (Columbus, 2015; Roser & Ritchie, 2016), more sophisticated note-taking applications are expected to be developed in the near future. It would be interesting to observe how the new age of cloud storage impacts on the note-taking activities of the future.

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THE USE OF TABLETS IN TEACHING POLITICAL ECONOMY AT CZECH UNIVERSITIES

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Abstract

The rapid development of tablets allows for their use in all areas of human activity. The objective of this paper is to express the range of possibilities for using tablets as smart technology in teaching political economy, as well as the percentage and structure of the students at Czech universities who use tablets in lessons of economic theory and what benefits the use of tablets brings them. The authors found that most students in all monitored fields of study used tablets in the school and found them affordable.

Introduction

The study of technical fields related to proficiency in foreign languages ensures plenty of job offers and higher wages for university graduates in the Czech Republic. In fact, the chance of students who graduate in technically-oriented fields at universities to find work is up to seven times higher than that of graduates from humanities schools. This is due to both the traditional focus of Czech companies on manufacturing and industry, as well as the unprecedented development of Information and Communication Technologies (ICT), which today controls the operation of virtually all companies and organizations. A great demand for people who are able to develop and program information systems and for people who are able to work with these systems has thus emerged on the labour market in the Czech Republic.

According to estimates of the recruitment agency Grafton Recruitment (2018), there is a shortage of several tens of thousands of Information Technologies (IT) experts in the Czech Republic today. One of the reasons for this is the large number of emerging IT centres that provide IT services around the world from the Czech Republic or are focused on the actual development of technology. Apart from IT specialists in virtually all areas of focus (from networking, to security, through programming, big data, data analysis, and artificial intelligence), graduates in fields such as construction, mechanical or electrical engineering, project management, economics, or logistics and transport management do not have to worry about finding work either (Grafton Recruitment, 2018).

The teaching of political economy in both fields of study takes place in the form of lectures that include both the history of economic learning as well as microeconomics and macroeconomics. From a methodological point of view, it is mainly of a descriptive nature, but students can use tablets to familiarize themselves with related texts that complement the construed material of the course or illustrate the lecture through references/links to complementary literature (charts, images, tables, etc.).

It holds true that graduates from both fields of study (Operations and Economics – OAE and Operations and Administration – OAA) use ICT a lot in their future work, whether it be in companies or government organizations. At this time, tablets can become a significant helper both in their practise at the workplace and in further education, whether it is formal or non-formal. Working with tablets already in their studies at university helps graduates to further orient themselves in ICT at specific workplaces in companies.

The goal of the study was to express the range of possibilities for using tablets as smart technology in teaching political economy, as well as the percentage and structure of the students at Czech universities who use tablets in lessons of economic theory and what benefits the use of tablets brings them. A sub-goal was to express the differences between male and female university students studying at Faculty of Economics and Management, Czech University of Life Sciences in Prague (FEM CULS in Prague) in their approach to working with tablets; whether there are any and if so, what they are.

Theoretical Background

Meeting the needs of today's always-on-the-move society has led to the rapid development of information and communication technologies and the widespread use of technological advances, such as laptops, tablets and smartphones, connected with each other through networks and software (Alhassan, 2016; Zidney & Warner, 2016). We are living at a time when laptops and desktops are being replaced by smartphones and tablets as the primary personal computers (Bonnington, 2015; Gillett, 2012). For example, "In recent decades, so-called mobile learning or m-learning has become a new paradigm in education as a consequence of technological advances and the widespread use of mobile devices to access information and for communication" (Castillo-Manzano, Castro-Nuno, Lopez-Valpuesta, Sanz-Díaz, & Yñiguez, 2017, p. 326). Furthermore, "As an advantage to traditional computers, tablet computers are mobile, which allows for anytime-anywhere learning" (van der Ven, Segers, Takashima, & Verhoeven, 2017, p. 201). Mobile handheld devices (e.g., tablets) can provide interactive instruction opportunities in teaching and learning as well as meaningful experiences for students and teachers (Sessoms 2008; Terras & Ramsay, 2012). Additionally, evolving mobile technologies contribute to seamless personalized learning, advanced interactivity in the classroom between teachers and students or among students, and a wide variety of instructional content and applications (Alelaiwi et al., 2015; Haßler, Major, & Hennessy, 2015; Song, Wong, & Looi, 2012).

The use of tablets as modern means of smart education is increasingly expanding not only at top foreign universities but also at Czech universities. Liaw, Hatala, and Huang (2010) state that the fast spread of tablets and similar technologies, together with inexpensive and accessible internet connection, has significantly altered the nature of university education. Several studies focused on tablet usage at universities have shown that these technologies positively contributed to improving the quality of the teaching process (Li, Pow, Wong, & Fung, 2010; Steinweg, Williams, & Stapleton, 2010). At the same time, Dickerson, Williams, and Browning (2009) characterize current students as advanced users of modern technologies.

Share of Women Among IT Workers

The latest data from 2015 show that women made up less than a tenth of the 150,000 people employed in IT fields in the Czech Republic (Hrabica, 2018). In 1995, the difference was not so abysmal. In this year, the statistics showed that there are almost 60,000 IT professionals in the Czech Republic; there was one woman for every two men in the industry. In almost a quarter of a century, the ratio has changed significantly. The share of IT professionals in the total number of employed persons in the Czech Republic has tripled since the 1990s, mainly in favour of men. In the IT profession there are currently the least number of women in programming where the representation of women is only about 3 % (Hrabica, 2018).

The Reasons for Women's Lower Interest in IT Studies

There are many myths circulating in society that have an impact on the fact that such few females choose IT disciplines, one of which is the claim that the field is more suitable for boys. The mothers of female students, who often co-decide on the future profession of their daughters, sometimes belong to a generation for which IT disciplines had been a great obscurity. Reserved attitudes can also be seen in primary schools, where there are no personalities who could help girls in overcoming the fear of devoting themselves to IT. As Hrabica (2018) states, in practice, the IT profession requires independence, organization and discipline so that the IT professional is able to find his/her own way to solve a given problem and carry it out with precision. According to the Headmaster of the Private Secondary School of Information Technology in Prague, Martin Vodička, sometimes even the best men working in IT lack this ability, while girls have it as a natural attribute.

For female students, choosing a field in IT has its specific advantages. If there are few women in the industry, they have less competition in the labour market. For some positions, women are actually preferred because of their better ability to communicate with customers and business partners.
There have long been very few female students of information disciplines, and they are actually coddled in schools and later in companies. In 2015, nearly 22,000 students studied IT disciplines in the Czech Republic; women made up less than a fifth (Hrabica, 2018). According to university teachers, female IT students are more often above the average and very conscientious both in their studies and in project management (Ministry of Education, Youth and Sports, 2018).

The average representation of women in information technology in the European Union is less than 16 % (Eurostat, 2017). The most feminized IT sector in the EU is boasted by Romania, where women make up 28 %. This is more than in Austria (27 %) and Ireland (22 %); in the Czech Republic, it is not even 10 %. The country with the least women working in IT is Slovenia, where women make up less than 4 % (Eurostat, 2017). According to the calculations of the agency NPR (2014), the number of women working in computer-focused fields in the US grew faster than the number of men from the 1960s to the 1980s. The peak was 1984, when 37 % of women studied computer science in the US. However, this figure has again fallen to less than twenty percent (NPR, 2014).

Researchers report that while the use of technology has increased more research is needed. For example:

- University lecturers use a wide range of technologies when teaching and there has been much research into how particular technologies are adopted. (Shelton, 2017, p. 303)
- Familiar and new technologies require a teacher to be able to confidently identify the pedagogical potential for effective learning and teaching. (Savage, 2016, p. 533)
- Considering the many technologies that can support students' work nowadays, studies describing specific practices are still needed in order to understand the many possibilities and constraints that can emerge from the use of these tools in the field of education. (Monjelat, Mendez, & Lacasa, 2017, p. 265)

Furthermore:

> Findings indicate that, currently, very little attention is specifically given to the knowledge that teachers need to foster early literacy through the use of technology. This is due to multiple factors, including the conviction that many new technologies (e.g., tablets) are not used much in schools. (Voogt & McKenney, 2017, p. 69)

However, we must realize that for many families in the Czech Republic (and other new EU member states), tablets and other ICT are not easily affordable. Currently, the average wage in the Czech Republic is EUR 1,250, which is approximately three times less than in Germany, for example (EUR 3,703; Eurostat, 2018). This fact has a significant impact on the level of use of smart technologies by students and teachers at various universities, according to the social structure of the students and also their teachers, in whose case age also plays a significant role.

Material and Methods

Methodology

In order to realize the research goal stated in the introduction of the article, the following hypothesis was established:

> University students, both men and women, use tablets (as an example of smart technology) in their studies on political economy to an equal extent, because they not only facilitate their current studies, but also contribute to their better integration into economic practice in the future.

The following procedure was established for the successful verification of the scientific hypothesis.

Participants were chosen from a lecture on Macroeconomics that took place in the summer semester of 2018 on 2 March, which was attended by 123 students in the fields of OAE and OAA. This lecture was selected for the research on the use of tablets in teaching the subject of political economy because both of the fields discussed are among the main fields of study at the Faculty of Business and Economics at the Czech Technical University in Prague and have decisively the largest share of students in the faculty. All 123 students that were present at the lecture volunteered as respondents for the research.

The questionnaire included six research questions. The questions asked about the gender of the students, their ownership of tablets, how often they use them in their studies on economics, what purpose they use them for, the affordability of tablets and whether the student would welcome the possibility of using them to a greater extent in studies on political economy.

The questionnaire survey method was the basic method used in the research. Subsequently, for the analysis of the questionnaires, first mathematical methods (relative frequency) were used and then comparative analysis was completed to express the difference in the responses of women and men. These differences between the responses of men and women were subsequently tested using the chi-squared test at a significance level of $\alpha=0.05$. Also, the descriptive method was often used. The conclusions of the article and the implications for tablet manufacturers and further research were subsequently created by synthesizing the knowledge gained from the analysis of the questionnaire survey.

Results and Discussion

Research Question No. 1
The first survey question was "Are you a man or a woman?" Of the 123 students present, 80 were women (i.e., 65 %) and 43 were men (i.e., 35 %). The gender structure of the present students of both disciplines has long corresponded to the typical composition of students at the Faculty of Business and Economics of the Czech Technical University, where about two-thirds of students are women, regardless of whether it is full-time or combined studies. The higher proportion of women participating in the survey is explained by the fact that the survey was carried out among the students of economic fields with a higher proportion of women, due to the nature of the future profession for which the students were preparing. However, in these fields of study, too, ICT subjects are significantly represented.

Research Question No. 2
The majority of students who filled in the questionnaire believe that tablets are affordable for all students or at least for those who work. According to experiences of teachers, the majority of students currently have at least a part-time job. The gender difference (almost 20 %) is evident in the answers to the question as to whether tablets are available for all students or just for those

who also work in addition to their studies (see Table 1). This may be due to the different consumer spending structure that exists between women (e.g., fashion) and men, the generally higher incomes of men in employment or due to income received from parents (*The Brussels Times*, 2018). According to the experience of the study authors, in the subconscious of the Czech public the life role of the man as the breadwinner of the family is still accepted, and parents have brought up by their young men accordingly.

Table 1

How Do You Assess the Affordability of Tablets?

Answer	Women		Men	
	Number of students	In %	Number of students	In %
They are affordable for all students	25	31.65	21	50
They are affordable for all students who are already working	48	60.75	17	40.48
They are not affordable for students	6	7.6	4	9.52

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Research Question No. 3

Essentially, men and women were the same in the structure of their answers to the questions of whether students own a tablet, whether they are planning to buy one in the near future, or whether they neither own one nor plan to buy one. From a gender perspective, **their answers as a percentage are practically the same** (see Table 2).

Table 2

Do You Own a Tablet?

Answer	Women		Men	
	Number of students	In %	Number of students	In %
Yes	29	36. 25	17	39.53
No, but I plan to buy one in a year	9	11.25	4	9.3
No, and nor do I plan to buy one	42	52.5	22	51.17

To verify the statistical significance of this statement, the null hypothesis was established: There is no statistically significant difference between genders in the answers to the question, “Do you own a tablet?”

Therefore, the conditions for using the chi-squared test were fulfilled (see Table 3). Testing was performed using the chi-squared test, and at a significance level of $\alpha=0.05$ the null hypothesis was confirmed, and it was found that there is no statistically significant gender difference in answer to the question, “Do you own a tablet?” (p value=0.909).

Table 3

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.191[a]	2	0.909
N of Valid Cases	123		

Research Question No. 4
On the other hand, the answers of the male students (men) were quite different from those of female students (women) to the question "How often do you take a tablet to school with you?" (See Table 4.) According to the answers to this question, men take tablets to school with them more often than women do. To verify the statistical significance of this statement, the null hypothesis was established: There is no statistically significant difference between genders in the answers to the question, "How often do you take a tablet to school with you?"

Table 4

How Often Do You Take a Tablet to School With You?

Answer	Women		Men	
	Number of students	In %	Number of students	In %
Always	4	10.52	4	19.05
Sometimes	17	44.74	9	42.86
Never	17	44.74	8	38.09

Therefore, the conditions for using the chi-squared test were fulfilled (see Table 5). Testing was performed using the chi-squared test, and at a significance level of $\alpha=0.05$ the null hypothesis was confirmed, and it was found that there is no statistically significant gender difference in answer to the question, "How often do you take a tablet to school with you?" (p value=0.645). The reason as to why this may be can be clarified by the analysis of the following research question No. 5 (see Figure 1 and Figure 2).

Table 5

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.876[a]	2	.645
N of Valid Cases	59		

Research Question No. 5
According to the answers to the question, "For what purpose do you use a tablet at school?" most students use tablets mainly for displaying materials for lectures or seminars or for their own entertainment, regardless of whether they are men or women.

Female students also use tablets to find additional information for their studies. For women, this use of tablets even surpassed their use for entertainment, which was actually the third most common use for women.

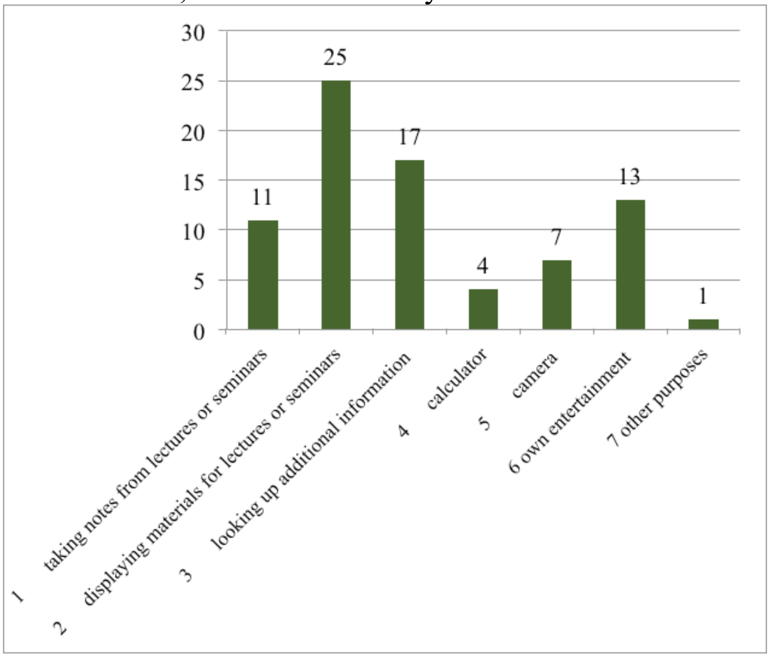

Figure 1. For what purposes do you use a tablet at school? (N =78 Women).

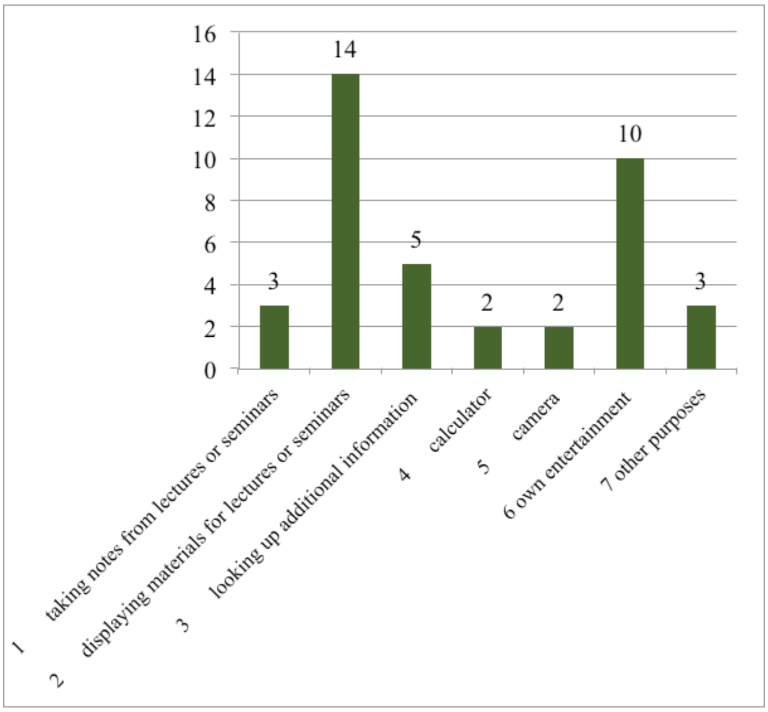

Figure 2. For what purposes do you use a tablet at school? (N=39 Men)

Research Question No. 6
In their answer to the sixth question in the questionnaire, i.e., whether the students would welcome the possibility to use tablets to a greater extent in studies on political economy. The majority of students were in favour of more extensive use (about 2/3 of respondents), both men and women alike. However, an interesting difference between the genders is that more female students (34.21 %) than male students (23.81 %) were not in favour of using tablets more extensively in studies on political economy (see Table 6). This difference of almost ten percent may be explained by the concern of female students that the more extensive use of tablets would extend their range of study duties. According to the experience of the authors of the study in the field of education, women simply put more consideration into their subsequent decisions and are usually more cautious. This is also reflected in their more responsible way of preparing for exams and in the fact that they care more about the final results of exams.

Table 6

Would You Welcome a Greater Use of Tablets in Classes?

Answer	Women		Men	
	Number of students	In %	Number of students	In %
Yes	7	18.42	4	19.05
Rather yes	16	42.1	10	47.62
Rather no	13	34.21	5	23.81
No	2	5.27	2	9.52

Analysis of the Hypothesis and Implications for Firms and Scientific Research

Verification of the Validity of the Proposed Hypothesis
The obtained research results confirmed the validity of the given hypothesis that university students, both men and women, use tablets (as an example of smart technology) in their studies on political economy to an equal extent.

Implications for Firms and Scientific Research

- It is necessary to change the school's focus on traditional knowledge transfer methods to dealing with the problem of how information is processed and used. The rapid development of tablets allows their use in all areas of human activity.
- It holds true that graduates from both fields of study (OAE and OAA) use ICT a lot in their future work, whether it be in companies or government organizations. At this time, tablets can become a significant helper both in their practise at the workplace and in further education, whether it is formal or non-formal.

- Working with tablets already in their studies at university helps graduates to further orient themselves in ICT at specific workplaces in companies.
- According to university teachers, female IT students are more often above the average and very conscientious both in their studies and in project management.
- In the case of the respondents in the two main fields of study mentioned, men and women do not differ very much in their opinions and basic approach to owning and using tablets in studies.

Conclusion

In the Czech Republic, the IT sector is an increasingly attractive field due to the significant increase in wages, among other things. For female students, choosing a field in IT has its specific upsides. If there are few women in the industry, they have less competition in the labour market.

If we summarize the results of the questionnaire survey on the use of tablets in studies on political economy at FEM CULS, it can be concluded that in the case of the respondents in the two main fields of study mentioned, men and women do not differ very much in their opinions and basic approach to owning and using tablets in studies. The differences in the responses on the issue of the affordability of tablets for students or their practical use is an exception. At universities, presently, large-display smartphones have become competition for tablets, allowing their substitution. Students stated the same thing in the discussion that teachers conducted on the results of the given survey, as a major reason why some of them do not buy tablets. They are interested mainly in merging both smart technology functions into one ICT device. On the other hand, they do not deny that the quality of work is greater for tablets in preparation for their studies.

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INSTRUCTIONAL TECHNOLOGY USE IN MATHEMATICS AND ENVIRONMENTAL SCIENCE GREEK PRIMARY SCHOOLS CLASSES

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Abstract

Research on types of instructional technology used in school classes for teaching is limited. This study focuses on the types of instructional technology that primary school teachers – in third and fourth year classes – tend to use in sessions of Mathematics and Environmental Science subjects. In each subject 160 sessions were observed. The frequency with which the instructional technology types were used in teaching was recorded. The main conclusion is that print textbooks, worksheets and the whiteboard are more commonly used. The use of ICT- oriented types (e.g., computers, video-projectors) while teaching Mathematics and Environmental Science is found to be limited.

Introduction

This project focuses on the field of instructional technology, an essential part of education science, which has been researched and reviewed over the last years. Experts, while identifying the basic points and principles of instructional technology, have arrived at various definitions. The most recent one, as stated by Gagne (2013), treats it as a set of teaching practices and delivery techniques that can facilitate learning processes and increase its' effectiveness, with or without the use of Information and Communication Technologies (ICT). It aims to clarify principles that can assist the desired effectiveness and that can be applied during planning, implementing and reviewing teaching interventions. Overall, it refers to the systematic study and use of methods that are justified as appropriate for educators (Gentry, 1995).

Instructional technology is linked nowadays to the use of technological means or types in education. This is because of the advancement of ICT over the last decades in combination with the wide research around its positive impact and benefits to teaching. More specifically, there has been research about the possibilities and potential of types, means and applications of ICT that the teachers should consider taking advantage of to achieve desired effective outcomes in their teaching work. This research has been expanding in all levels of education and in different subjects. Teachers are provided with a plethora of ideas of what technological types to use in different parts of their work (Uluyol & Şahin, 2016).

Using technological means in teaching is justified to give teachers opportunities to design a more interactive, more interesting and attractive session, which will help learners appreciate the necessity of ICT types and means in learning and their life generally (Kimmel & Deek, 1995).

The integration of instructional technology in the educators' actual work requires thorough preparation. It depends on various factors, which are relevant mostly to the social and educational context. Researchers conclude though that perhaps the most basic of these factors is the role and perception of the educators. It is educators who must decide and plan to use it. This decision is based on their ideas about the benefits that it may bring to the teaching intervention. This may refer to the level that intervention is facilitated using technology. It may also refer to the outcomes of learners and learning generally.

Apart from the teachers though, the context may influence the frequency of technological means, through interrelated factors, such as the availability of technological means or the subject or more specifically the unit taught and the nature of teaching projects (Gorder, 2008). It is for these factors that researchers and experts consider that the integration of technology in classroom should not be treated as a single unified topic but as a multidimensional matter. Each dimension requires individualized approach and study concerning the benefits, general issues and frequency of use in classroom by the teacher (Keengwe, Onchwari, & Wachira , 2008).

The dimension of the frequency of use of instructional technology and ICT calls for study. It is worth investigating how frequently educators tend to use applications of ICT in teaching. This kind of monitoring ICT use in classroom is crucial for evaluation, research and policy making as it provides significant insights about the reality, context and culture of teaching and schooling towards technology and instruction (Wagner et al., 2005).

It is in this direction that this project focuses. The project tends to identify how frequent the use of instructional technology in Greek Primary schools is. In doing so, it takes research findings into consideration. These findings claim that that subjects or units may influence the use of technology in classroom (Gorder, 2008). So, the project centers on two subjects of the Greek Primary School Curriculum. These are Mathematics and Environmental Science. This goal can be reached by observing teachers of primary schools in Greece, during teaching and identifying how much they take advantage of the means and types of instructional technology as they are guided by research to do so (Kimmel & Deek, 1995; Uluyol & Şahin, 2016).

The implementation and accomplishment of this study requires attention to the concepts of technology, educational and instructional technology, technological means and types used for instruction. Besides that it is necessary to investigate the methodological approaches (Cohen, Manion, & Morrison, 2011).

Literature Review

Although there has been significant research to prove that instructional technology assists teaching intervention, limited is the research to identify the types of instructional technology educators use. Literature has suggested that textbooks still dominate in teaching (Horsley, Knight, & Huntly, 2010; Knight, 2013) while use of other types of instructional technology is not common. This applies especially to ICT-oriented types (Kennewell &

Beauchamp, 2003). This research refers mostly to secondary or tertiary education levels. There is room and interest in carrying out similar research at elementary education.

Research and theory have suggested certain ways with which environmental and mathematical science teaching can benefit form the use of ICT. Using technologies has been stated to assist educators in implementing their teaching strategies, by allowing them or the learners to gather, use, investigate, manipulate, analyze and share information or data. Hardware, such as computers, laptops, projectors, and interactive whiteboards, in combination with software, such as applications, sites, simulators, and digital social networks has expanded the opportunities for communication and interaction. This might be between learners themselves, teachers and learners and generally the members of the education community and the wider social context (Eady & Lockyer, 2013; Gorder, 2008).

Instructional Technologies Types in Class

ICT therefore has been treated as an opportunity improve learning. The influence of ICT expands in various dimensions. A significant dimension is the benefits for teaching subjects. In many countries, curricula, which are influenced by literature, research have stated each subject can be enhanced by involving types and applications of ICT. Teachers are therefore expected by National Curricula to do so, under the general impression and aspiration that such approach might make learning more attractive and effective. Even in elementary schools, literature and curricula have pointed out types and task directions where types of technology, either software, or hardware can be of assistance. However, no benefit can occur automatically. If technology types are to be taken advantage of, teachers should act accordingly (Comi, Argentin, Gui, Origo, & Pagani, 2017; Uluyol & Şahin, 2016). Indeed, research has shown that teachers' decision about what type to use, in what way and for how long, influence significantly the outcome of the session. These outcomes may refer to knowledge that learners gain in what concern the subject taught as well as ICT. They may also link to skills or attitudes about ICT and their role in learning and everyday life generally. In short, the teacher is a crucial factor (Gagne, 2013; Kimmel & Deek, 1995).

Even the same teacher, however may use instructional technology types differently, depending on the subject. Certainly, there are general principles concerning how to use these types, which can be implemented in many, if not all, subjects. Literature though identifies subject-influenced implementation practices. This specification is based on the nature of each subject, its characteristics and individual, general goals around knowledge, skills and attitudes. These factors influence the types of instructional technology that might seem more appropriate and the practices that teachers should implement with them (Comi et al., 2017; Gorder, 2008).

Environmental science and mathematics teaching can therefore be assisted by ICT. In environmental science, types that can be used include computers, interactive whiteboards, websites, projectors, simulators, virtual experiments, data logging kits and sensors. These can provide the teacher with up-to-date-resources, opportunities for learners to experiment with contexts that are difficult to experience otherwise. For example, the teacher can help learners observe, test and understand phenomena of photosynthesis, pollution, global warning or the greenhouse effect. Learners can take part in discourse or activities around these topics that could be difficult to implement with conventional means (Law, 2009).

In mathematics classes, ICT can also help in many ways. Computers, interactive whiteboards, the Internet, spreadsheets, sites and software can assist in gathering information, in carrying out complicated and highly skilled calculations and statistics. By using these means, teachers can implement tasks that engage learners in activities that require or promote complicated arithmetical or geometrical skills and thinking. Such activities would be rather time-consuming and challenging if they were implemented without the use of technological means (Law, 2009).

In short, the benefits of using instructional technology types in environmental science and mathematics have to do with identifying accurate data, promoting interactive learning, by motivating learners to seek, test and experiment. These factors assist the promotion of knowledge skills and attitudes (Comi et al., 2017; Law, 2009).

Purpose and Research Questions

This project focuses on the types of instructional technology that primary school teachers tend to use in sessions of mathematics and environmental Science subjects. More specifically it aims to explore the frequency of instructional technology types' implementation in Greek Public Primary Schools.

The main points of this implementation are three. The first is that there is a variety of types specifically used in the classroom. The second is that there is a difference in the frequency of the use of these types (Gorder, 2008; Kimmel & Deek, 1995; Uluyol & Şahin, 2016; Wagner et al., 2005). Finally, the third has to do with whether there is significant difference in instructional technology use in environmental science and mathematics (Comi et al., 2017; Gorder, 2008;). The research questions are formed as follows

1. What types of instructional technology are used by teachers in the classroom?
2. Is there difference in the use frequency of these types?
3. Is there difference in the types of used between the subjects of environmental science and mathematics?

Methodology

The appropriate methodology should bear in mind the scope and the context of this project, which aims to identify the types of instructional technologies used in specific subjects. The project focuses on how much time educators spend using them during their teaching. The findings can give insights concerning the implementation of ICT in classrooms as teaching means. This can serve as a supplement to current research (Gorder, 2008; Kimmel & Deek, 1995; Uluyol & Şahin, 2016; Wagner et al., 2005). In doing so, it is necessary to point out the context of the project and the method used to collect the required data (Cohen et al., 2011).

The project focuses on environmental science and mathematics. The context is Greek Elementary Education (MINEDU, 2011). Research has justified that these two, just like other subjects can be assisted by instructional technology. Computers, the Internet, interactive whiteboards, along with other hardware or software specific for these subjects can be and are used in classroom to enhance teaching (Comi et al., 2017; Law, 2009). Though, as research points out that use of instructional technology is still limited, it is necessary to compare it with the use of traditional and conventional means, such as the textbook and worksheets. This calls for the use of a data collection tool that can help measuring quantitatively the use of each kind of means. This includes both ICT-oriented means and conventional ones. This collection method should provide data itself, so that the necessary comparison can then be carried out (Cohen et al., 2011).

Sample

For the scope of this research observation was selected as the most appropriate data collection method. Indeed, observation is known to be giving directly more accurate insights and information about what happens in classroom, and what approach, practices and means are being used by the educators (Cohen et al., 2011). After carefully preparing, studying and planning the observation process, researchers observed 80 elementary school teachers while they were teaching the subjects of environmental science and mathematics. These were teachers of the third and fourth grades of the Greek primary school. Pupils that attend these grades are between the ages of 8-9, or 9-10, respectively. These pupils attend four sessions of mathematics and two sessions of environmental science every week, according to the Greek curriculum. Each session lasts for 45 minutes properly (MINEDU, 2011).

Having in mind the timetable of the research, in combination with the teachers' workload and obligations, it was planned that each teacher would be observed for two hours in each subject. This was done as planned. This provided a total of 160 observations in each subject and 320 in both, which could give a wealth of data to achieve the goal of the research. During observation, the focus would be on the types of instructional technologies used. It was important to note down these types along with the amount of time each type was used, which could then give a percentage of frequency of their use compared to the total time of the session. The instructions and steps of implementation of the Teaching Dimensions Observation Protocol (TDOP) (Hora, 2015) were followed carefully (Hora, Oleson, & Ferrare, 2013).

Data collection

The project is of quantitative nature. The most appropriate instrument that can serve this method and the general scope of the project is the Teaching Dimensions Observation Protocol (Hora, 2015). TDOP is designed to reflect on the processes, means and approaches used by educators or learners during the teaching interventions.

The protocol primarily pays attention to three basic factors. The first one is instructional practice, which includes the methods and activities implemented by the instructor while teaching, which can be either teacher oriented or student oriented, depending on who has the primary role and responsibility. The second is student-teacher dialogue, which is linked to the communication and interaction between teacher and student, which can again be student led, or teacher led, depending on who is the primary speaker. Finally, the third basic dimension is the instructional technology dimension, which is focused on what means are used while teaching and in what context or goals. When implementing any version or adaptation of the specific protocol, it is expected to include these dimensions (Hora, 2015; Osthoff, Clune, Ferrare, Kretchmar, & White, , 2009).

Apart from the basic dimensions, however, there are other optional ones. The first is the learners' potential cognitive engagement in the teaching. The second is the dimension of pedagogical strategies. Lastly, the third one is the dimension of learners' engagement. Those optional dimensions are involved, whenever there is need for further detail of observing teaching practices (Hora et al., 2013).

This project, as it is designed, focuses on the third basic dimension, which is about instructional technology. Researchers who use this instrument are expected to emphasize the time spent on the use of specific technology types. This can help calculate frequencies of their use. These types can be: textbooks; smartboard or whiteboard; projector; PowerPoint presentations or digital slides; digital clicking response systems; demonstration equipment, which can be digital but not necessarily, as it may involve experiment equipment and tools; hardware such as laptops, cameras tablets, which promote interaction; movie files, such as YouTube videos; and simulations and websites of any kind that can assist in class.

TDOP implementation is done through seven steps. After the first step, which is the clarification of the project goals and the selection of the TDOP as an appropriate tool, the second includes selection of relevant dimensions. The third step includes clarifying the nodes and means for measurement. The fourth has to do with deciding if current versions and variations of the protocol fit the project or if there is a need for a new one. The fifth involves preparation of the research context and arrangements with the people who are to be observed. The sixth involves conduction of the arranged and planned observations. Finally, the seventh involves analysis, interpretation and dissemination of the results (Hora et al., 2013).

Data Analysis

Analysis of the findings was planned with the help of quantitative approach, either descriptive or inferential statistics. With regards to the first research question, the answer is expected to come from the former. By calculating and identifying relevant frequency, as a figure itself, it is possible to name which types are being used. With regards to the second research question, descriptive statistics is expected to give answer as well. By identifying means, range and mode, as criteria of tendency and distribution is it is possible to see which types of instructional technology are used more often. Lastly, with regards to the third research question, the comparison can be achieved by benchmarking measurements or even referring to inferential statistics and the use of the T-test. More specifically, for the sample of the study, the paired sample test was appropriate, since the pairs of data date referred to the subjects (Cohen et al., 2011; Swift & Piff, 2014).

Findings

The results of the observations and the frequency calculations have been gathered and their average has been identified. This has led to the desired findings about the types of instructional technologies used in classrooms. As far as the first question is concerned, the findings as shown from the calculated frequencies indicate that most mentioned types of instructional technology are being used in the mathematics and environmental science classrooms. These data are presented in Table 1. Almost every type has a use frequency value larger than 0, as it is noted to be used for a period, during the class. In fact, the only type not used and that gets a 0 value is the projector. In mathematics, specifically there was no observed use of videoclips either. Overall, in both subjects there is use of ICT-oriented instructional technology, such as the Internet and computers as well as conventional, traditional types such as the textbook. This finding is compatible to the relevant literature (Gorder, 2008; Kimmel & Deek, 1995; Uluyol & Şahin, 2016; Wagner et al., 2005;).

Table 1

Frequencies of Instructional Technology Types Use, as Percentage (%) of Session Time

Instructional Technology	Mathematics	Environmental Science
Instruments, Materials (IM)	1.76	4.06
Demonstration Equipment (D)	12.13	14.53
Posters (P)	0.88	4.34
Textbooks (T)	44.57	48.67
Worksheets	15.84	7.79
Projector (P)	0.00	0.00
Whiteboard (CB)	21.54	10.16
Movies, Documentaries, Video clips (M)	0.00	3.25
Education Software, Simulations (S)	0.52	3.46
Websites (WEB)	2.77	3.75

As far as the second question is concerned, the range of responses in both subject shows that there is a rather significant difference in the frequencies of use. These are illustrated in Figures 1 and 2 as well as in Table 2. The range as a measure of spread, reaches 44.57% and 48.67%. Indeed, the use of the textbook, which gets the maximum value, is more common that others, as it almost reaches half of the total time. Similarly frequent seems the use of worksheets, whiteboards and demonstration equipment, though not used as much as the textbooks. Instruments, materials, education software and websites are being less used. This justifies the research findings that state that in spite of the possibilities that ICT offer, textbooks still dominate teaching (Horsley et al., 2010; Kennewell & Beauchamp, 2003; Kimmel & Deek, 1995; Knight, 2013; Swift & Piff, 2014; Uluyol & Şahin, 2016).

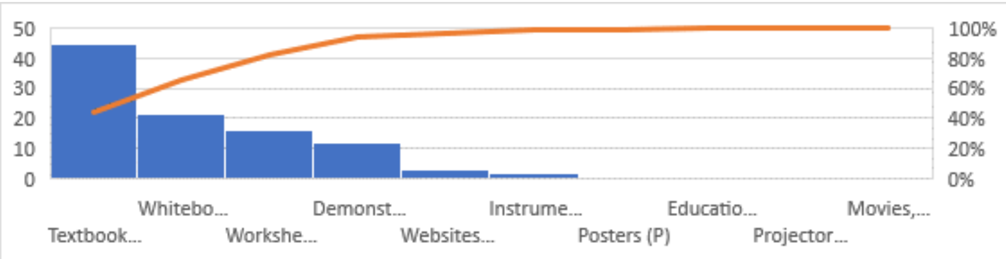

Figure 1. Instructional technology use in mathematics.

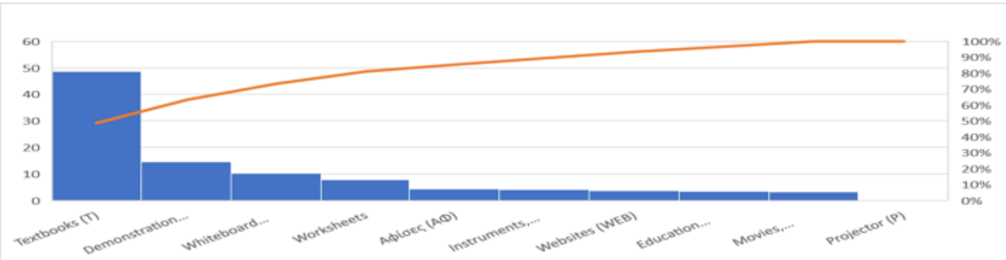

Figure 2. Instructional technology use in environmental science.

Table 2

Descriptive Statistics Values, as Calculated from the Frequencies

Instructional Technology	Mathematics	Environmental Science
Mean (μ)	10.00	10.00
Median (M)	2.27	4.20
Minimum Value	0.00	0.00
Maximum Value	44.57	48.67
Range (R)	44.57	48.67
Variance	205.06	201.64
Standard Deviation (σ)	14.38	14.20

Finally, as far as the third question is concerned, by implementing the T-test, the outcome is very low, as shown on Table 3. This signifies that overall, there is no significant difference in the use of instructional technologies in both these subjects. Certainly, individual types might differ. For example, white boards seem to be used more in mathematics, where the frequency seems to be double. However, simulations and software seem to be used more in environmental science. This finding might show that the instructional technology use depends on the subject taught too (Comi et al., 2017; Gorder, 2008; Law, 2009). However, in general no major difference..

Table 3

Descriptive Statistics Values, as Calculated from the Frequencies.

Variable		Mathematics	Environmental Science	t-value	prob
Instructional Technology	M SD	10 (14.38)	10 (14.20)	0	0.5

Discussion and Conclusions

This research aimed to identify the types of instructional technology used in classrooms, in the subjects of environmental science and mathematics in elementary schools in Greece. Instructional technology types are suggested through research to have significant benefits when implemented in the classroom. Such types could be conventional, e.g., textbooks or ICT-oriented, e.g., computers, websites, projection material, hardware, and software, such as simulations. The suggestions may be common in every subject (Gagne, 2013; Uluvol & Sahin, 2016). Additionally, there are specialized suggestions and practices that address specific subjects, such as environmental science and mathematics (Comi et al., 2017; Gorder, 2008; Law, 2009).

Despite this promotion of instructional technology, research points out that its' implementation in classrooms is in some cases limited (Gorder, 2008; Wagner et al., 2005). This research therefore aims to point out the frequency of implementation of instructional technology types used in the specific subjects, in Greek elementary schools. Within this scope, the project aims to identify at first what types of instructional technology are used; at second, which types are used more frequently and; at third if there is significant difference between the two subjects.

Data for this research were collected through observation. The Teaching Dimensions Observation Protocol was selected as an appropriate tool for this research. Thanks to TDOP, it was possible to observe, note, calculate and compare the amount of type that the teacher uses each type of instructional technology. This protocol also allows comparison with other means such as textbook and worksheets (Hora et al., 2013).

Data analysis was done by a quantitative approach. By calculating the time, it was possible to identify the percentage of the session duration, that each type was used. The findings show that plenty of means of instructional technology have been used in the classroom. Textbooks and whiteboards though seem to be used more frequently. With regards to the comparison between the subjects there seemed to be no significant differentiation. These findings are overall compatible to the conclusions of research around this topic (Gorder, 2008; Kimmel & Deek, 1995; Uluyol & Şahin, 2016).

Limitations of this project though, should be taken into consideration. The sample of the research was specific. Data came from a single area of Greece. This was done, due to time and place restrictions. The focus was in two specific subjects of the curriculum for only two grades of elementary education. Emphasis was paid in identifying frequencies of instructional technology types use. It might be worth expanding research to other subjects and other grades of Greek elementary school. Moreover, this could be combined with other relevant dimensions such as teaching practices and types of question. That would give a more complete picture of the teaching process and lead to more broad conclusions (Cohen et al., 2011; Hora, 2015).

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BUILDING DIGITAL LEARNING CONTENT FOR FRANCOPHONE BOOK TRADES TRAINING: ANOTHER STEP ON THE ROAD TOWARDS SUCCESS

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Abstract

The paper aims at identifying, emphasizing and questioning the characteristics and issues of ICT in the Francophone area, where French is a unifying force. It describes the mobilization of Francophone organizations for innovative projects such Massive Open Online Courses (MOOCs) and demonstrates how it is still not suited to needs. This finding stems from two surveys conducted between September 2016 and January 2018 on social networks, with the aim of building a Francophone MOOC in the book trading sector. The surveys' findings demonstrate that offering a suitable innovative learning tool is primarily a matter of commitment that needs time to mature and bear fruit.

Introduction

Nowadays, learning is not at all like what it would have been 15 years ago. ICT are developing rapidly and offer many perspectives to students, teachers and professionals alike (Willson & Pollard, 2009). Almost all countries, including Francophone ones understand the huge educational and financial challenge of these technologies (Sidir & Benchenna, 2008) that become a great springboard for the massive dissemination of knowledge and the fight against the digital divide.

However, ICT are undeniably a pedagogical upheaval that transform the positioning of the teacher as to what knowledge is no longer to be delivered but which is to be built by the learners through new processes (Biancarosa & Griffiths, 2012). This situation is valid everywhere, but it is very marked in the French-speaking countries where particular attention has been given to the digital by the political authorities and the French-speaking institutional organizations. I will first explain the reasons for this attention and give examples of mobilizations. Afterwards, I will make an inventory of innovative projects in progress proposed by francophone countries such us Massive Open Online Courses (MOOC) before focusing attention on a case study carried out by my master's degree students who were supervised by Vincent Demulière[1] and I. It concerns the feasibility study of a Francophone digital learning platform for book trainers and students. The purpose of this study is to apprehend the perception and expectations of Francophones about this new offer in terms on pedagogical contents, additional services and human resources.

ICT in the Francophonie Area

ICT are developing rapidly in the Francophone area where different countries and population share French with respect for cultural diversity. But, what does *francophonie* mean? What characterizes this part of the world? Why is interest is now focusing on ICT in this area? And what are the current mobilization and projects?

Francophonie: What Is It All About?
Albert Camus, who was awarded the Nobel Prize for Literature in Stockholm on December 10, 1957, said, "I have a fatherland, the French language" (Cortanze, 2010, p.11).

A brief review of the literature shows that French language is placed in the service of solidarity, development and rapprochement of peoples through the permanent dialogue of civilizations. We notice that it is also at the service of education, economic prosperity and environmental responsibility.

Worldwide, 274 million speakers speak this language, making it the fifth most spoken language in the world and also the second most learned language after English. It is the third business language in the world and the second most widely used in international organizations.

The importance of the French Language in the Francophonie
For many foreign speakers, learning French "is entering a rich, powerful and humanistic culture," as said Pierre Frath (2007, p. 23), professor of English linguistics at the University of Reims. This language still arouses a great deal of interest, in conjunction with the explosion of the African continent where 54.7% of the population are French speakers (AUF, 2018), and the French-speaking world population will count nearly 9% of the world's population by 2050, compared to only 3.5% today (Tagnan, 2017).

By 2050, the Francophone area will represent a vast market, one and a half times more populated than the European Union and carrying immense needs. In addition, the dynamic of today's French language teaching in China, the country's third-most-taught language, reflects the economic interest of French for those who are now embarking on the global and particularly African markets. This can only truly succeed if we continue to see significant cultural and scientific production in French. Indeed, it is striking to note that the use of French in scientific and technical publications continues to decline not only in the world, but also within the Francophone and even in France (Conseil Supérieur de la Langue Française, 2012).

Digital Challenges for French-Speaking Countries

Digital technology is disrupting politics, economics, and technology in all geographical and linguistic areas of the world. Nevertheless, there is a digital divide between developing and developed countries. Francophone developing countries are evolving in a digital environment where access costs are extremely high in relation to their standard of living. According to the International Telecommunication Union (ITU), which is a United Nations specialized agency for ICT, the cost of Internet access is higher in developing countries than in developed ones (Miéré, 2016). Furthermore, access to infrastructures does not necessarily provide the output needed to take full advantage of the potential of digital. Many rural and isolated areas are marked by the digital divide.

According to the report published by ITU, access to the Internet in rural areas is progressing much slower than in urban areas, especially in Africa, because the deployment of terrestrial communications infrastructure is so difficult to accomplish (L'Actu Web d'Edith, 2018). It is estimated that the differences are even more pronounced in the poorest countries for which data is rarely available. In addition, there are disparities in household income and expenditure within the countries themselves that have a significant impact on the affordability of online services and content for many citizens. Consequently, French-speaking developing countries are mainly consumers and not producers in the digital economy, as the fields of infrastructure and manufacturing industries of digital equipment remain essentially monopolized by developed countries.

Concerning education, the focus today is on innovation and excellence in the context of strong international competition that leads the educative community to promote collaboration with developed countries (UNESCO, 2012). Thereafter, what are the innovative strategies and logics displayed in the political and educational discourse by main institutional actors to overcome this digital fracture?

ICT & Political Mobilization of French-Speaking Countries

During the fourteenth Assembly of Heads of State and Government of the French-speaking countries in Kinshasa, on 13 and 14 October 2012, Francophone political leaders highlighted the importance of strengthening the presence of French in the digital world, particularly through social networks and collaborative platforms. From this summit it emerged that the appropriation of technologies is an issue of primary importance for the youth and for the achievement of sustainable development goals.

In this regard, the International Organization of La Francophonie (OIF, acronym in French) has mobilized massively to guarantee the neutrality of the Internet network, the freedom of expression and the protection of the common goods of the information society. Its major aims are to provide free software, and Internet governance. This organization sets up, for example, digital incubation platforms for young people to enable their online training. It also provides them with practical resources for the creation and management of businesses.

Several structures from the OIF have been mobilized in this context. I will refer to one prominent example; the Agence Universitaire de la Francophonie (AUF), which has invested significantly in the implementation of the Francophone Virtual University project to ensure the university's adaptation to the digital revolution. This virtual university provides a training tool with significantly lower costs for higher education bodies in Francophone countries. Its fields of action include research and training to ensure that information and knowledge are truly shared. Its aims are to increase the influence of French-speaking scientists in the international community and to provide researchers from these countries with tools similar to those of other researchers.

Furthermore, the goal of this agency is to support French-speaking universities to offer excellence in training. In this context, two programs are supported by this agency: The Open Distance Training (ODL) and MOOCs. Our study only examines the MOOCs and situates them within some of the ongoing Francophone projects.

Francophone Digital Learning Tools: A Focus on the Existing Offer

As previously emphasized, the AUF is mobilized in the ODL area. For the 2017-2018 school year, the AUF is offering 105 diplomas: 12 university degrees in medicine (DU), 13 licenses (L3), 22 Masters 1 and 58 Masters 2, alongside MOOCs intended for those who seek complementary training (AUF, 2018). These courses are suitable for students and employees who can take courses remotely. AUF member universities from different countries supervise these projects: Burkina Faso, Cameroon, Canada-Quebec, Egypt, France, Lebanon, Madagascar, Morocco, Senegal and Tunisia.
According to this literature review, the MOOCs are online courses of a university level available on the Internet (Landry, 2014) (Université de Genève, 2018). This acronym appeared in 2008 but it was only from 2012 that it became widely known. This year has been deemed by the New York Times (Pappano, 2012) as "The year of the MOOC," as many universities, led by prestigious Ivy League institutions, started to organize free online courses.

The term MOOC is an Anglicism, and several proposals have been made to translate it into French. Georges-Louis Baron proposes AMOR, which designates a Massively Open Learning Network. Jean-Michel Salaün opts for COPT, which designates Course Open for All or CLOT for Course or Online Training Open to All. However, it is widely agree that the spread of the English word is such that there is no need to translate it.

Since 2013, large French-speaking schools such as the Federal Polytechnic School of Lausanne and the National Conservatory of Arts and Crafts (CNAM) in France are developing their own MOOCs. The most popular topics for the French-speaking public are computer science, management and business, law, and political science. Three MOOC platforms currently dominate the sector: FUN (FUN.MOOC, 2017) for France Digital University, Coursera, which offers courses at major American universities, and Open Classrooms.

The proposed distance learning programmes cover the following areas (AUF, 2018): engineering sciences, medicine and public health, the environment and sustainable development, education and training, law, economics and management and humanities. In this last area, for instance, there is a francophone MOOC entitled *Cultural essence, political necessity*, which aims to understand the Francophonie as a geocultural and geopolitical space. This training lasts seven weeks and is carried out by the University of Lyon 3 in partnership with CNAM, FUN, Ecole Polytechnique Fédérale de Lausanne, the University of Cergy-Pontoise, and the RIFEFF – International Francophone Network of Training of Trainer Institutions.

Meanwhile, we note that the offer of distance education, in this case MOOCs, is delivered at a slower pace in Francophone countries, especially in those where French is neither the official language nor the main language used by populations. Indeed, the current offer is very rich in English and the situation remains highly unequal and fragile between developed and developing countries in the Francophonie.

What do Francophones really think of this situation? Today, professional French-speakers have the choice between a training offer proposed by the developed countries, mainly in English, and another offer of training in limited French. What do they prefer exactly? Is the criterion of language decisive in their choice? And how can we propose a quality offer more adapted to Francophone issues? To answer these questions, we will focus our analysis on the information and book trades sector in French-speaking countries that are part of Humanities. We note that its supply is scarce compared to other disciplines. We deal with these issues in the second part of the paper.

Francophone Digital Learning Offer: The Case of Information and Book Trades

The current offer is not sufficient for learners in information and book trades, who are either interested in widening their field of knowledge to meet the needs of the labour market, or to cope with changes in society in general. Indeed, there is the France Digital University platform, which lists some thirty distance learning courses in French. Of course, if learners are English-speaking, the offer is less existent. They can search for digital courses and/or lecture videos through the EdX or Coursera platforms. Meanwhile, the offers specifically dedicated to training in the information and book trades are rare. According to our analysis, it is not widely available in French, but by digging a little it is possible to find a list of courses that are likely to interest learners. We can cite for example, the MOOC *Gérer les Documents Nnumériques* proposed by the CNAM (EBSI, 2016). However, we do not find in any sole MOOC package, a comprehensive attention of fundamental subjects (such as the knowledge of the book actors, their role and tools in the book chain like publishers, broadcasters, distributors, booksellers and librarians) alongside the aforementioned subjects.

Therefore, we assume that if francophone information and book production such as trades' learners choose learning within MOOCs, it is not only just for its convenience, but also more for its quality contents. Secondly, we suppose that they prefer accessing «à la carte» training from home, that follows their needs, and that they have a particular fondness for MOOCs delivered in French.

The Project in Action: Methodology Description

The present analysis is part of a monitoring and reflection on the design of a French-language MOOC on the subject of the book trade that we have led since 2016. It is an innovative educational project that intends to offer French-speaking book professionals an online training tool that fully exploits the possibilities offered by digital technology. To date, there is not yet a project like this.

This present study is a collective project carried out by surveyors who came from very different backgrounds and have different profiles. First, five students enrolled in the MSC Book Trades and Digital Mediation in the Department of Culture at Clermont Auvergne University. Second, contractual and permanent teachers worked in this same university. All of them shared the same enthusiasm to see this project through to the end.

Note that Clermont Auvergne University directed multiple French-language consortia with Canada, Armenia, Quebec, etc., for research in science. It is a member of the Franco-Lebanese Association for Education and Culture, French International Network of trainers, the Association for the Management of knowledge in Society and Organizations. It is a part of the Fédération France-Québec Francophone networks of diplomas and former graduates as well as the French-language Regional Scientific Association.

Concerning the method chosen, we carried out two surveys and we used Facebook to send them. Indeed, we wished to reach the maximum of Francophone easily to discuss with them our object of study, which would have otherwise been difficult. In addition, we wanted to establish a virtual community made by individuals with different profiles but the same centers of interest, and make them participate in the project remotely (see Figure 1).

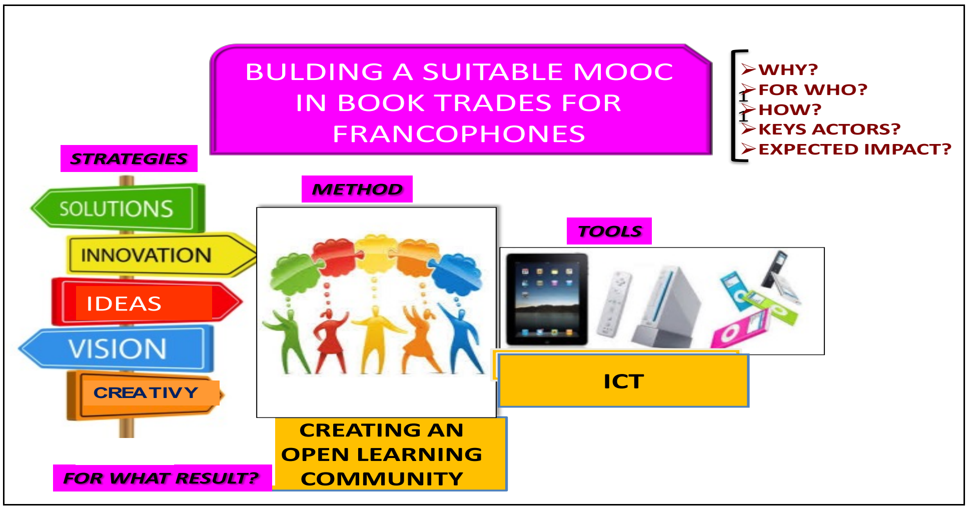

Figure 1. Purpose and issues of the project.

Therefore, we considered Facebook the ideal place to experiment with a Francophone digital learning tool, which would enable us to engage many persons who are involved in book production and/or love books. We moved up from 170 to 590 subscribers in March 2018.

A Focus on the Surveyors

Over two years, two groups of students (2 students in 2016-2017 and 3 in 2017-2018) have chosen to work on this project start to finish. During the 2016-2017 academic year, the first group carried out monitoring work on the MOOC theme and innovative pedagogies. They produced presentation documents, and conducted a feasibility study. The second group, which took over the following year, reflected on the content and the design of the future Francophone MOOC based on the findings of the first survey. They carried out the second survey that aimed to define precisely the desired courses.

Two coordinators lead this project. First, a book professional who led the group Bertelsmann, Flammarion, Privat and Chapitre.com before becoming a consultant and digital editing project manager in the company he co-founded: 4ePub. Second, a researcher in information and communication sciences whose work focuses on the management of innovative information systems projects (ENT, elearning and Digital Libraries) and the analysis of the representations and effects of these systems on the learning and professional practices of information specialists whose aim is to facilitate the knowledge access to learners.

Sample Description

Students and coordinators searched all existing training catalogues in French related to the book trades and identified all training organizations that deal with them (Klein, 2017) (Raffin, 2018). This work enabled us to list all the teaching modules related to the profession of the publisher and the bookseller. Then, we delivered a survey of these modules in the form of closed questions. Therefore, we have organized all educational modules that are likely to interest respondents, profession by profession. Also, we built other closed questions to identify needs of those surveyed and the requirements, according to the respondents, to follow for a good training.

The people, who join us, have different profiles: private trainer, teachers, pedagogical researchers, students, employees, jobseekers, ICT' Project Managers, and users of ICT tools. Very quickly, we received a great deal of feedback obtained via Facebook. As noted before, we have 590 subscribers who are either directly involved, have taken distance courses or are just curious about the project.

Moreover, we noticed that many people were ready to be part of the adventure when they joined us in the Facebook group. Many told us that a MOOC of this kind was missing in the training landscape. We will develop further the main findings of both surveys in the following section.

Francophones' Opinions: The Analysis of the Main Findings

Both surveys are complementary. The first survey aims to find out if Francophones know of examples of MOOCs and use them and if the new training offer that we propose interests them. The second survey aims to identify the teaching modules that interest these Francophones in order to build the training model.

The results are substantive yes and demonstrate the attention given to the project. Indeed, 92% of respondents showed interest in the project and wanted to continue communicating further to establish a successful collaborative project. They believed that it is an example of a new innovative educational idea that is useful to all, whether they are professionals or book lovers.

The Main Results of the First Survey
For the first survey, we had 221 responses in March 2017 (Klein, 2017) (Badra, 2017), and we reached 636 in April 2018 (Nanty, 2018). This survey reveals that 95, 5% of the respondents envision using the MOOC book trades' offer. Most of them want to develop a MOOC on book production and be able to have access to professional testimonials too.

For 79.1% of respondents, the MOOC would be used alone, without additional face- to- face training. The main reason advanced is that the MOOC makes it easier to combine private and professional lives.

Concerning the type of MOOC content, 57.3% of the respondents are interested in a MOOC bookstore, 68.4% by a MOOC edition and 68.2% by a MOOC library. They declared the availability of French MOOCs in one or more modules but they did not find a complete offer in the book trades.
In response to the question "Who can be the trainers?" the majority of respondents do not want a MOOC without professional trainers. Students were **not feeling able to deliver lessons**. However, it is the responsibility of MOOC managers to integrate them into the process to demonstrate that they have something to contribute to this training.

Furthermore, the analysis of the first survey results reveals that many southern French-speaking countries do not have specific training in the book trades. Thus, they are waiting with impatience for it. However, 67% of respondents highlighted the complexity of this project and considered that further collaborative work dealing with different aspects (such as technology, changes in human behavior, legal evolutions, and new practices in work processes) should be studied before designing the platform.

Finally, the respondents of the first survey believed, that a professional will be more interested in following the MOOCs of other professions than his/ her own, to become fully aware of the realities of book production.

What Are Results from the Second Survey?
In the second survey, 27.8% of respondents were men, and 72.2% were women. Of the twenty respondents, 72.1% of them lived in France, 11.1% were from Belgium, and 5.6% from the department of DOM TOM, la *Réunion*. All participants wished to be informed of the continuation of the project. This survey reveals that 83.3% of the respondents preferred the MOOC because it is dedicated to the book trades, 50% were interested because it is professional, and 50% were willing to use this offer because it is Francophone.

In this second survey, the respondents selected the teaching modules that interested them in the fields of bookselling and publishing. These modules are divided into six sub-sections namely communication / marketing, law, accounting, design, IT and the book market. The respondents showed by their choices a need to see or review the fundamentals of the profession. Indeed, in the field of publishing, 83.3% of respondents preferred following the accounting and management module and, 72.2% selected the computer module; 55.6% of the respondents chose the communication and marketing module. 66.7% chose the module and 55.6%, the design module.
In bookstores, respondents chose only three modules: accounting and management (61.1%), communication and marketing (55.6%) and the book market (55.6%).

Furthermore, the respondents highlighted the importance of integrating into the MOOC, specific content dealing with the cultural diversity and literary wealth existing in the different French-speaking countries.

According to the second survey, reasons that would push respondents to use the new offer are:

- Developing their knowledge on a specific area (74.4%)
- Sharing good practices (56.8%)
- Developing a concrete professional project (32.2%)
- Having a first look at the entire book world (25.6%)

Moreover we notice that the question of the price of training seems problematic for many in the first survey. Indeed, very few considered paying for access to MOOC content whereas 50% of respondents seemed interested in a paid certification in the second survey.

Discussion
The survey shows the expectations of Francophones who need to have a supply of inexhaustible, renewable and new knowledge and skills in the book trade (see Figure 2). The expected MOOC must be accessible to all in French and offer courses evolving according to changes and changing circumstances.

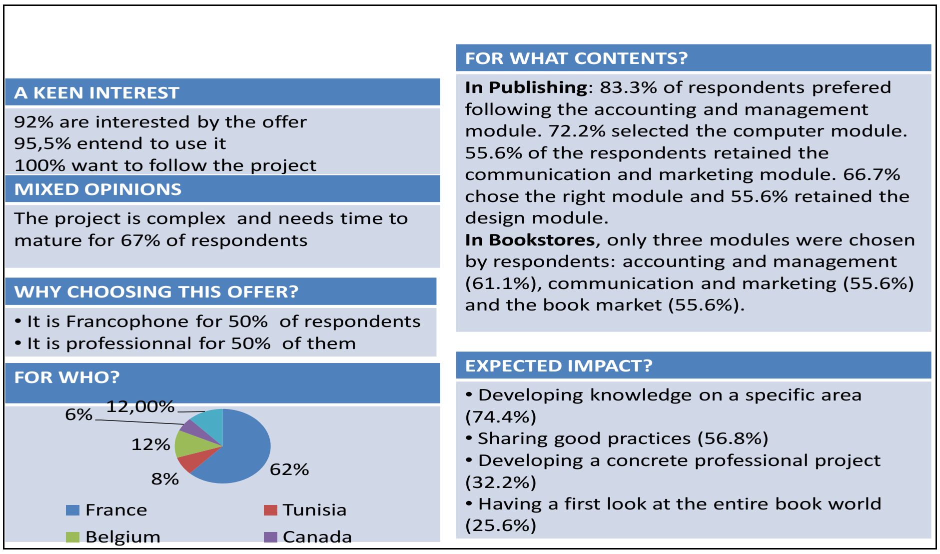

Figure 2. Prominent results in both surveys about the project.

We also see that the MOOC is a response to a real need. Indeed, it is difficult to go to face-to-face training, especially for small structures. Furthermore, the study shows that almost all the respondents in the two surveys want to have a training module for events in bookstores and publishing.

Among the most prominent points, we note the major thematic areas desired by Francophone professionals (teachers, trainers and other professionals), concerning the desired performance features of Francophone digital learning tools and the selectivity and high quality of information contents.

Finally, almost all respondents want to find in the platform, a multimedia educational content to use easily. This brings us back to the context of professional training and how to best build valuable economic model.

In addition, both surveys reveal that digital is important and should be addressed in the courses offered. The themes of digital and trade 2.0 are the most popular amongst all the proposals made.

Conclusion

The literature review has allowed us to understand correctly the importance given by French-speaking countries to the French language. It explains the main reasons that encourage French-speaking states to use ICT, and institutional organizations to further develop distance learning. The challenge is threefold: to fight against the digital divide, to democratize access to knowledge for all members of the Francophone community and to preserve their values and interests at the international level.

The knowledge of these facts has guided our fieldwork with an objective to offer a relevant and effective online learning tool to all Francophones seeking to acquire and/or strengthen their knowledge in the Book professions. Prior research work allowed us to identify the existing offer, and the strengths and limits of this offer, in order and thus to better define our scope of action.

The two surveys allowed us to collect the opinions of the interviewees on the expected training offer and to identify precisely their needs in terms of content, particularly on the desired courses in the fields of bookselling and publishing.

What Would be the Next Stage of the Project?

The project is already generating a lot of interest. Subscribers on Facebook give us their expertise and want to be more involved. Respondents to both surveys specified their expectations in terms of content and the desired performance features. Indeed, if the result of the market study proves conclusive, it is necessary to proceed to the realization of the business plan, which constitutes the logical continuation of the market study.

It will now be necessary to develop this plan to formalize the project and obtain bank financing, profit from participation from external investors, private investment, and to negotiate preferential rates and payment terms with a future supplier. Therefore, the next step of the project is to write the business plan in which the project will be developed. We also have to precise the roles of stakeholders, and to define our marketing strategy, the human resources management, etc. We have to include all planned expenditures and resources envisaged in the short and medium term.

Therefore, the drafting of this plan will be useful for us since it will enable us to structure our ideas, refine the project and ensure its viability. As it is aimed at fund-raisers, we must prove the sustainability and quality of the project and highlight the expected return on investment. Therefore, the business plan must be clear on the editorial side and consistent in financial terms.

Furthermore, we should define the desired performance of our platform. We must think about video editing of lessons (primary source), supplementary reading materials, assignments or evaluation exercises. We must also define the type of analyses, quizzes, collaborative works and practical exercises that help to develop the skills of learners and their networks.

To conclude, we can say that the project takes a new turn for the better but still represents significant challenges, because we have to prove the financial strength of the project as well as its scale. Therefore, we will liaise more closely with to the AUF to support us in our project.

In any case, the goal remains the same: creating an open learning community including teachers, computer scientists, professional in book strata, suppliers, producers, and other stakeholders that will produce goods and services by bringing value to learners who are themselves part of that same ecosystem.

Notes

1. Vincent Demulière is a book professional, consultant and a digital project manager in the 4epub'company.

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BACK TO CONTENTS

WHAT IS THE PUBLIC FACE OF CODING IN AUSTRALIAN PRIMARY SCHOOLS?

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Abstract

There is a perceived urgency to teach coding in schools from F-10. The premise most frequently used as the basis for this reasoning is future jobs, of which there are many proffered possibilities. It is therefore timely to consider where it (coding) fits, considering future workplace and career possibilities. The notion of coding being a *skill for all* has been present for almost two decades. Many have expressed a view that 20 years from now, maybe sooner, perhaps later, where post-school options are not yet known or determined, students will require a different skill set; on that there appears broad agreement. There is a wide commentary being proffered about what these futures are and how they are inextricably linked to digital literacies, and in particular coding.

The study sought to identify the extent to which schools made public their goals with regard to the place of coding in the curriculum. This was achieved by examining the websites of a sample of schools from each state and territory.

Introduction

Programming, now known as coding, has been taught in Australian high schools since the 1970s. Current documentation from various Australian education systems places a heavy weighting on coding from the early years of schooling. For example, *#Coding Counts* (State of Queensland, Department of Education and Training, Queensland, 2015) suggests that because the world of work is changing and that 3 in 4 of the fastest growing occupations require science, technology, mathematics and engineering (STEM) related skills and knowledge, there is a need to have "coding" explicit in the curriculum. This is a common response from other systems that have embraced coding in the curriculum. Though coding is represented in the Australian curriculum, Technology, the weighting is not necessarily consistent with that given other elements of the education system.

The essence of any educational movement is its implementation at a school level. As Australian primary schools grapple to respond to the challenge of teaching and learning of coding in the second decade of the twenty-first century, there is a need to review how the discipline of computer science is being valued and discussed in the school context. The interests and priorities of many outside of education, impact on the process of curriculum development for schools. In the case of coding, this has involved politicians, computer scientists, and industry with varied agenda. Less so has been the input from education.

Coding is and has been viewed under different guises. The history of teaching coding in Australian schools commenced in the 1970s; first limited to maths in high school and later, to the specific teaching of coding. Primary schools dabbled with Logo programming (Johnstone, 2003) in the 1980s, developed by Papert (1980) as a means of using the computer as an object with which to think. The current urgency to teaching coding in primary schools is different from these earlier days. It rests more with the reasoning that it is necessary for future jobs, of which there are many possibilities. It is therefore timely to consider where it (coding) fits, considering future workplace and career possibilities.

The notion of coding being a *skill for all* has been present for a considerable period of time. Many have expressed a view that 20 years from now, maybe sooner, perhaps later, where post-school options are not yet known or determined, students will require a different skill set; on that there appears broad agreement. There is wide commentary about what these futures are and how they are inextricably linked to Digital Literacies, particularly coding.

This review examines the many and varied conversations around coding in schools, primary schools in particular. It examines the work of commentators (social, media, political and industry), researchers, academics and policy makers. Whilst focused on understanding the Australian context, it also reviews the work of some international systems. Acknowledgement is made of the Australian state and territory responses where possible and endeavors have been made to examine individual school policy and practice across the respective states and territories of Australia.

The Literature About Coding

Programming, now called coding in education, draws upon the discipline of Computer Science. Jeanette Wing (2006) from the field of computer science defines computational thinking as "solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science.". She suggests that computer scientists then place these solutions within a computer language to be processed by a computer. Computational thinking describes the processes drawn upon when thinking about how a computer can be used to solve complex problems. This involves logical reasoning, algorithms, decomposition, abstraction, and patterns and generalization (Bers, Flannery, Kazakoof & Sullivan, 2014; Mannila et al., 2014).

These ideas from computer science have been translated into curriculum documents for education. From the perspective of the International Society for Technology Education (ISTE) (2016) a *computational thinker* develops and utilises strategies that show an understanding of how to solve problems using technology to develop and test solutions. In the ISTE Standards for Students, (Figure 1), a set of seven digital standards are proposed, of which computational thinking (coding) is one discrete element. Students are expected to develop a holistic understanding of each of these domains and how they might be used to resolve problems. This figure makes clear the connectedness of all domains without singling out computational thinking, connecting well with Wing's (2006) views that coding is a catalogue of thinking digitally.

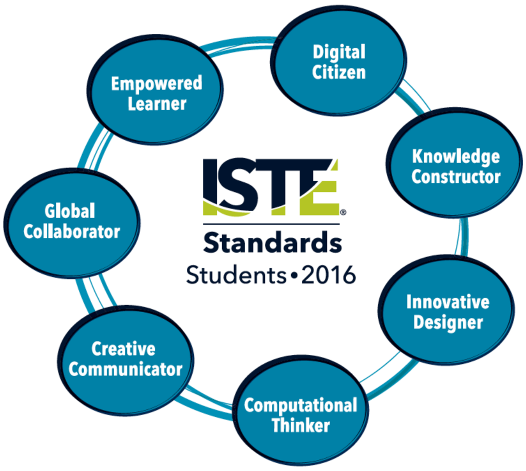

Figure 1. ISTE Standards for Students (ISTE, 2016).

In a glossary of the Australian Curriculum (n. d.), computational thinking is defined as:

> A problem-solving method that involves various techniques and strategies that can be implemented by digital systems. Techniques and strategies may include organising data logically, breaking down problems into parts, defining abstract concepts and designing and using algorithms, patterns and models.

Coding is viewed as one aspect of the Digital Technologies curriculum.

A Case for Coding in the Curriculum

In understanding the case argued for the inclusion of coding in the curriculum, it is necessary to consider the ideas of both commentators and researchers/policy makers. Commentators far outnumber the researchers/policy makers, and they are often linked to institutions and enterprises whose business is computer science and computer hardware/software.

The prospect of unknown future workforce needs has prompted a plethora of ideas about what work tomorrow might look like. We are at a crux in the 21st century where many are endeavoring to define what these jobs might be or what they might look like. They are inextricably linked to the rapidly developing and technological world we live in, but do they all require a sound knowledge of computational thinking?

The Commentators

Commentators bring various dimensions to the importance of learning to code. Journalists of online and paper documents enjoy the hype generated by writing about this topic. Often their contributions are generic and future work oriented. These vary from coding being a twenty-first century skill necessary for being a literate person (Crow, 2014; Prensky, 2008) to the professional opportunities provided by being able to code (Bradford, 2016). Crow suggests that it is a topic for all while others more specifically identify it as promoting the general skill of problem-solving. (Fractus Learning, 2017).

A recent report from the Foundation for Young Australians (FYA) (2017) *The New Work Smarts: Thriving in the New Work Order*, discusses areas of change where today's students need to be to cope with work in 2030. This report discusses the new skills required: Foundational skills, Technical skills and Enterprise skills.

The FYA (2017) clarifies these new work smarts and how they will impact on learning in Figure 2 (p. 4). Note the lack of specific reference to coding or computational skills.

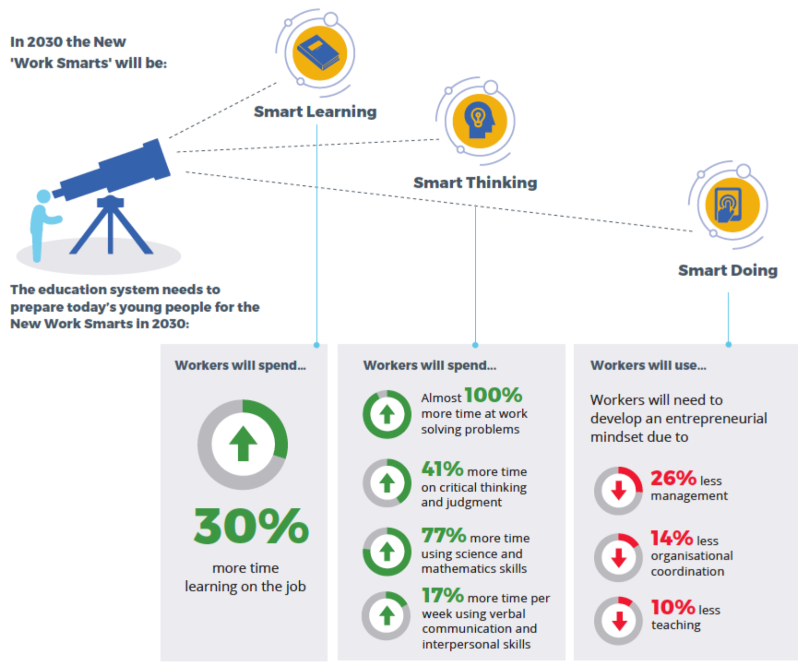

Figure 2: FYA Skills for the Future (Foundation for Young Australians, 2017)

In the list in Table1 drawn from *The Shape of Jobs to Come: Possible New Careers Emerging from Advances in Science and Technology (2010 – 2030)* (Talwar & Hancock, 2010), there is a shortlist of possible occupations of the future. Are there detailed references to coding or computational thinking in these descriptions?

Table 1

Future Occupations

1. Body Part Maker	10. Quarantine Enforcer
2. Nano-Medic	11. Weather Modification Police
3. Pharmer of Genetically Engineered Crops and Livestock	12. Virtual Lawyer
4. Old Age Wellness Manager / Consultant Specialists	13. Avatar Manager / Devotees - Virtual Teachers
5. Memory Augmentation Surgeon	14. Alternative Vehicle Developers
6. New Science' Ethicist	15. Narrowcasters
7. Space Pilots, Architects and Tour Guides	16. Waste Data Handler
8. Vertical Farmers	17. Virtual Clutter Organizer
9. Climate Change Reversal Specialist	18. Time Broker / Time Bank Trader
	19. Social 'Networking' Worker
	20. Personal Branders

The Researchers, Academics and Policy Makers

There is a worldwide momentum behind teaching coding with many countries experimenting with the inclusion of coding in the curriculum. (Sterling, 2016) This momentum has been generated by the Computer science and the Science, Technology, Engineering and Mathematics (STEM) sectors of the community. It varies in the reasoning: from work, global competition, and citizens being able to participate in daily life with some understanding of that which is controlling daily activities.

Common in this group is the fact that few will be coders in their jobs in the future but some aspect of coding knowledge will be required. Computer programming and coding will be a requirement in the digital economy, highlighting the global nature of the competition. Leon Sterling (Pro Vice-Chancellor: Digital Technologies, Swinburne University of Technology) identifies particular aspects of coding that will help students as critical thinkers able to solve problems, team players, designers of creative answers, innovators and entrepreneurs (in #Coding Counts, 2015. p.5) and strongly suggests coding to be the new literacy for all. Wilke (Senior Vice President, Cisco, Australia and New Zealand) suggests that innovators and entrepreneurs will need these skills to create new industries and new sources of wealth (#Coding Counts, 2015. p.4).

From a broader perspective, some policy makers argue for coding in schools from a *science, technology, engineering and mathematics (STEM)* perspective. (Committee for Economic Development of Australia (CEDA), 2015) This perspective cites coding as key to STEM learning and later working in STEM disciplines. Computer scientists (Crow, 2014; Wing, 2006) argue that computational think is an advantageous approach to thinking that can make contributions to many areas outside of Computer Science. These include representing problems, examining and critiquing multiple solutions to the same problem, error-identification and a readiness to respond to open-ended problems are generational skills of use across all STEM areas. (Bers, Flannery, Kazakoff & Sullivan, 2014) This aligns with the thinking that coding is about giving children the opportunity to engage with powerful ideas. (Papert, 1980) The computer just happens to be our era's best and most accessible tool for this purpose.

Some bodies such as International Society for Technology Education (ISTE) represent coding as having benefits well beyond the STEM agenda into other aspects of cognitive development. They claim the most important part of the K-5 coding experience is its ability to encourage and support creative expression and problem solving. Coding puzzles, tutorial progressions and unplugged activities (learning computing concepts without a computer) are all onramps to a world where students can be passionate and powerful enough to express their imaginations. Creativity, collaboration, persistence and abstraction are all thinking skills that coding contributes to.

Despite these reasons for learning coding in primary schools, a Google (2016) sponsored report, *Trends in the state of Computer science in the US*, suggested the growth of coding in schools developed minimally in the two years prior to the report. Principals, teachers and parents acknowledged the potential for coding programs in schools. Coding, however, is not evident in schools. Since 2015, the Australian National Curriculum has included a curriculum element, *Technologies,* of which Digital Technologies is one component. This component of digital technologies views coding as one aspect of learning in the digital ecosystem. Two years into this curriculum with politicians in various Australian states interested in coding's place in our schools, it is appropriate to study coding in Australian schools.

The Research Questions

This literature establishes that there is a wide interest from many sectors about coding in schools. However, the responsibility for teaching and learning related to coding rests with schools. Consequently, the context is evident to study the ways in which schools present their view of coding in learning for Australian children.

This study sought to answer these questions:

1. How is coding represented publicly by Australian schools?
2. To what extent do Australian schools place value on coding?

This provides a context for a qualitative study that subsequently examined one hundred and ten school websites.

Methodology

School websites are the location accessible to school communities and the public and therefore represent a public face of schooling. It can be reasonably assumed that websites are capable of providing evidence of that valued by the school community in relation to curriculum and learning. School websites are organised with a range of documents and statements.

This qualitative study used document analysis. The research interprets documents to give voice and meaning around a topic (Bowen, 2009). Document analysis, recognised as a social research method, is considered an efficient and effective research technique as there is generally a wide range of sources from which to draw. In this instance, websites provided a medium in which documents could be easily accessed: mission statements, strategic reviews, school improvement plans, newsletters, reports from national testing programs and other sources were reviewed. School websites were examined for reference to curriculum statements about ICT and Coding. This analysis was undertaken by the researchers. States and territories were represented proportionately, that is, selection was made as a proportion of schools in the Australian total. School ICSEA values (measure of community socio-educational advantage) were used to ensure a full range of schools from this perspective, urban/rural and school sizes were included. Both state and private schools were included. State and territory lists of all schools were compiled and by counting in fifties, schools were selected. A subsequent review of schools identified that all categories of schools were evident in the sampling. Further information about ICSEA values may be found at: http://docs.acara.edu.au/resources/About_icsea_2014.pdf

Websites were reviewed to locate references to coding in particular, Digital Technology as described in the Australian national curriculum and the use of Information Communication Technologies (ICT) as a pedagogical approach to learning. Investigating the websites required comprehensive searching of school annual reports, school improvement reports, vision and mission statements, photos, newsletters, events and lists of apps. This was not a linear process, requiring many null searches in websites. School websites are organized differently from state to state and from school system to school system. Search facilities on most school websites were untrustworthy. Manual searching was required, a lengthy process.

In examining school websites, consideration was given to the following data:

- Student enrolment numbers
- School ICSEA values
- Bring Your Own Device/Technology (BYOD/T) programs
- Explicit statements about Digital Technologies/ICTs for Learning
- Explicit statements about Coding

The researchers completed the study and analysis in November – December 2017.

Findings and Data

Table 2

School Data about BYOD, Technology Curriculum Statements and Coding

	Explicit Statement about Coding	BYOD/BYOT Program	Explicit Statement about ICTs for Learning
n=110	16 or 14.5%	17 or 15%	54 or 49%

Many school sites talked about digital resources with extreme differences noted in provision. Just half of schools investigated had statements (some inferred) about Digital Technologies and ICTs in learning. Only 15% of schools had a form of BYOD/BYOT program in place, most often limited to Year 4-6. Coding statements were found in just 14.5% of schools. Coding was most often only available as after school clubs or for a small select group: a broader coding curriculum was not evident.

Connectivity was evident in lists of ICT resources but not necessarily in the descriptions of actions or uses of Digital Technologies (DT). Teaching DT was not often a classroom learning priority. Teaching coding appears to have a similar low priority. Overall, Digital Technologies (and ICTs for Learning) has the appearance of a low public face.

Whilst a range of uses of DT and ICT was noted, it was unclear where it fitted into Learning and Teaching or the broader curriculum. It was most often noted in photos and references were evident in school reports or up front in Visions/Mission Statements. In the curriculum statements there was less evidence about how DT/ICTs for Learning were used.

If school websites were a public face, there would appear much that could be done to enhance their ability to communicate school priorities and a balanced curriculum, a curriculum that extends beyond Literacy and Numeracy. All schools had explicit Literacy and Numeracy statements.

It is clear that the use of ICTs in learning and teaching is developing in Australian schools with nearly half of the school websites including discussion on this topic, some intensively. The difference between these data and data about the teaching of Digital Technologies and coding may be a result of confusion by schools. There is a possibility that some schools and teachers view ICTs for learning and teaching as the same as teaching to the DT curriculum. Though the two can overlap, their intent is different as is the content to be taught. Generally, the confusion between the terminology DT, coding and ICTs for learning and teaching was evident in some schools and for some teachers.

The Research Questions Answered

1. *How is coding represented publicly by Australian primary schools?*

Despite the expectations of state and territory systems, the public face of coding is not very visible. Less than 15% of primary schools investigated had explicit references to coding. In these instances, references were often found in school newsletters, whilst it might have been expected that for a curriculum element given such prominence, it would have garnered a significant position in the unpacking of the school curriculum. However, noting that the broader curriculum was often not detailed at the school level (beyond Literacy and Numeracy), the researchers were not surprised at what they found. The curriculum section of a large number of schools websites examined showed little more than subject oriented booklists.

2. *To what extent do Australian schools place value on coding?*

One has to consider why coding has received such a high profile from systems, given its relative position in the Digital Technologies curriculum. It merits a few lines in the ACARA curriculum. There is an appearance that there is much hype around coding and the links to future workplace possibilities. It appears that commentators and commercial entities drive much of the coding agenda. Researchers on the other hand are more cautious, seeing that there are strong links to other agendas and ways of working, for example, links to STEM curricula and the cognitive challenges for all learners, not just those seeking a career that has not yet been invented. If schools are expected to invest so much time and funding in pursuit of a coding curriculum, they need to be absolutely clear as to why they are doing it. And this needs to be shared publicly. If a silo mentality is to be a part of schooling, the sharing of best practices and what works will continue to keep genuine innovation from emerging. It is the sharing of rich conversations between schools that enables substantial change to occur. The current low visibility of coding on school websites builds these silos and inhibits sharing.

Conclusions

The public-face of coding on school websites is sparse, that is not to say that coding is not being taught in isolated classrooms or in particular school programs. It could be said that the public-face of coding on websites is not consistent with the requirements of the current curriculum (ACARA and state/territory equivalents), and that the public-face of coding does not appear to align well with that aspired to by some government and policy documents.

Whilst systems have been quite explicit in detailing what a ‘digital curriculum’ might look like, it was not easy to glean much about this from school websites. This section of our document review has not borne the fruit expected, where it was expected rich stories about how schools are responding to the call to develop computational thinking or computational science (coding).

School websites appeared in the main to be formulaic, with generic templates supplied by systems and schools required to fill in the missing data in a localized context. Whilst this seems an ideal situation, in a great number of schools we found what might be considered important matters for a school's public face had either been removed, altered or retained with only a minimalist story available. Specific reference to the ACARA curriculum was not always evident and if present, scant detail of what each Key Learning Area (subject) looked like at either school or grade level was not evident.

The Way Forward

This study contains messages for systems about curriculum accountability When public funds are allocated to educational curriculum and related resources, there is an entitlement to know how the funds have been allocated, why they were allocated and the impact of this expenditure. This is of importance to those beyond a school community. There is also a need to inform parents, communities and others about how they (the schools) are responding to policy expectations. If coding is a genuine requirement of schooling, as policy suggests, then a higher visibility will be necessary.

Limitations of This Study

This study recognizes the problems caused by a small sample and the inability to access all school data. These limitations are however countered by the relative consistency of available data across the sites sampled and surveyed. The researchers maintain that the public face of schools is where parents and community would expect to find a comprehensive statement about a school and its curriculum.

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EXAMINING THE CORRELATION BETWEEN EDUCATIONAL BACKGROUND AND ACADEMIC PERFORMANCE OF FIRST YEAR COMPUTER PROGRAMMING STUDENT'S IN SOUTH AFRICA

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Abstract

The aim of this study is to establish what correlational relationship exists between a student's educational background as determined by his or her critical thinking and self-regulation skills and academic performance in first-year level programming courses. The student's achievement in the programming courses is specified as the dependent variable. A student's educational background is specified as the independent variable. The study group consists of 379 students studying Information Technology at the University of Johannesburg, Johannesburg and the Tshwane University of Technology, Pretoria in South Africa. No correlation was found between a first year computer programming student's educational background and performance in programming.

Introduction

In South Africa there are many indications that there is a crisis in the education system (Modisaotsile, 2012). Newspaper Headlines like: "Teachers in Court over Fake Qualifications," "Cape Schools Allowed to Fall into Ultimate Decay," "Maths Teachers Sums Don't Add Up," "KZN Matrics Still Lacking Textbooks," "SA Teachers Can't Teach," "Alarm Over AWOL Teachers," and "Teachers Not Coping with Overcrowding" – shows that the education system remains largely in a poor state of affairs. Poor communities, specifically those from rural areas, bear the brunt of the past inequalities (Moletsane, 2012). Prior to 1994, education in South Africa was designed to privilege whites and disadvantage blacks. It has been 24 years since the end of apartheid in the country, and although South Africa has one of the highest education budgets in the world and spends a larger portion of its budget on education than the United States and United Kingdom (Cohen, 2017), the inequality of the education system still propagates. As a result, the South African schooling system is failing to provide higher education institutions with students that can cope with the jump from high school to university (Moutan, Louw, & Strydom, 2013).

With the transition from high school to university already being problematic, Information Technology (IT) students also find the subject computer programming difficult. The competencies required for success in computer programming are: (a) logical reasoning – which is a student's ability to think logically and analytically; (b) non-verbal reasoning – which enables students to analyse and solve complex problems without relying upon or being limited by language skills (e.g., identifying relationships, similarities and differences between shapes and patterns, recognizing visual sequences and relationships between objects, and remembering these); (c) numerical reasoning – mathematics; and (d) verbal logic – which is a students' ability to extract meaning from complex information and problem solve (University of Kent, 2017). These skills however, are not being taught in the South African educational system.

Mapping South Africa's Educational Background

The prevalence of poverty in townships and rural areas is reflected in the schools within these communities. There are many problems that South African township and rural schools face, the most common of them being a lack of basic facilities such as water, electricity and toilets, poor provision of educational resources such as textbooks, a shortage of classrooms resulting in overcrowding, poor quality of teachers, a shortage of mathematics and science teachers and the learners themselves.

Lack of Facilities

Poor facilities in most schools, but especially rural areas, is commonly cited as a factor contributing towards the poor performance of learners (Hugo, Jack, Wedekind, & Wilson, 2010). Many rural schools in South Africa endure what can only be described as appalling circumstances. As Draga (2017, p.238) describes, "Crumbling classrooms, horrendous bathrooms, cracked fences and non-existent libraries and laboratories remain a reality for thousands of school-going children across South Africa." Examples of the state of disrepair in rural schools abound: Tsakani Primary School in Kagiso on the West Rand, do not have enough chairs, desks and other learning materials for their learners (Dipa, 2015). There are approximately 40 learners in a classroom and many of them have to share desks and chairs due to a shortage. At the Glen Primary School in Port Elizabeth learners sit on a cold concrete floor (Sobuwa, 2017). An audit conducted in 2015, on hygiene, at approximately 200 Gauteng government schools revealed that schools have on average 100 learners to one toilet (Wicks, 2015). At the Lufhereng Secondary School in Soweto a "45m electrical cable runs through the principal's office door, across the schoolyard, over a street, down a side alley and through a window, finally connecting to a plug in the tiny kitchen of a four-roomed RDP house" (Macupe, 2017, p.1). Statistics released by the Department of Basic Education (DBE), state that 22% of government schools have either untrustworthy water or no water and 15% have untrustworthy electricity or no electricity (Motsepe, 2016). Twenty-four years into democracy this is inconceivable.

Poor Educational Resources

The problem regarding unequal distribution of resources is still commonplace. Text books are considered significant resources for learners' reading and writing development. Just two weeks before the matrics wrote their final exams in 2017, English textbooks were still in short supply at some KwaZulu Natal schools (Wolhuter, 2017). Not only are textbooks in short supply, but also some schools do not allow their learners to take textbooks home, which obstructs learning, especially in rural schools where this practice is most prevalent. De Vos (2018, p.1), rightly asks "Why should some learners be able to work from textbooks at home and others not?" To add fuel to the fire, 77% of South African schools have no libraries and 86% have no computer laboratories (DGMT, 2015).

Overcrowded Classrooms

Research has shown that smaller classrooms result in an overall improvement in reading and mathematics especially in the earlier grades. Small classes are especially beneficial to learners from low socio-economic families and those whose first language is not English (Howie, 2003). Overcrowding has a negative impact on teaching and learning as learners do not get to engage one-on-one with their teachers. Learners who are struggling with certain concepts get lost in the system. Many teachers who work in overcrowded classrooms have low morale and self-esteem. Large classrooms are also not conducive to dynamic teaching strategies (Marais, 2016). The South African Government stipulates that there should be no more than 35 learners to a classroom (Department of Basic Education, 2013, p. 55). However, according to the Cape Argus (Tswanya & Hlati, 2017), Solomon Qatyana Primary School in the Strand has a ratio of 1 teacher to 46 learners and at Tinley Manor Primary School near KwaDukuza some classes have up to 120 learners (Shaikh & Msomi, 2018).

Qualifications of Teachers

The South African Council of Educators (SACE) reported in 2016 that hundreds of teachers had been found to have fraudulent teaching qualifications and were dismissed as a result (Maromo, 2016). The plight of teachers being unqualified (have a Grade 12 certificate and are in the process of studying for a teaching qualification) and underqualified (have a degree but not a teaching qualification) in South Africa is real (Jansen, 2015). According to the Department of Basic Education, schools currently have over 5000 underqualified or unqualified teachers (Phakathi, 2017). The reality is that due to the shortage of teachers in South Africa, the DBE has its hands tied. Additionally, there is a high absenteeism rate amongst teachers (Ndaba, 2017) especially in the poorest quintiles in South Africa. The Centre for Development and Enterprise (CDE) Executive Director, Anne Bernstein, agrees that teachers do not spend enough time in the classroom and when they do they are not active (CDE, 2011). Teachers who are regularly late and absent not only form a poor learning environment but also lull a learner into adopting apathetic learning habits and a passive outlook towards their own future (Taylor, 2008). In the teachers defence, the National Professional Teachers Association (NAPTOSA) Executive Director, Basil Manuel, says that teachers are overworked due to the overcrowding in the classrooms leading teachers to being burnt out and therefore absent (Ndaba, 2017).

Shortage of Mathematics and Science Teachers

The CDE recently reported that not enough teachers are graduating in South Africa, especially in the subjects of mathematics and science. "Teacher shortages, especially in gateway subjects such as maths and science, are seen as a key contributor to SA's poor educational outcomes" (Gumede, 2017, p.1). The teaching system is producing only a third of South Africa's requirement of about 25 000 new teachers a year (CDE, 2011) and only a few teachers graduate in mathematics and science. The challenge for the Department of Education is emanated from teachers' low salaries and poor working conditions, which are identified as strategic areas in need of improvement in order to recruit new and retain experienced teachers in the profession (Nilsson, 2003). Currently the Department of Basic Education has a bursary scheme in place, offering a four year bursary to students studying a bachelor's degree in education, specifically targeting mathematics and other scarce skills educators lack (Jacobs, 2013).

Literature Review

Research shows that the type of high school a university student attended directly affects their academic performance (Ali, Haider, Munir, Khan, & Ahmed, 2013; Birch & Miller, 2007). It is therefore assumed that a student who does well in high school will also do well at university, however, many researchers argue this point. Considine and Zappala state that the high school environment as well as a teacher's expectations of a learner, sets the boundaries to learning (2002). Thus, if a student attended a decent school, offering smaller classes with qualified teachers who gave individual attention and participated in extra mural activities, these students would perform better academically than students who attended the schools mentioned above.

The Programme for International Student Assessment (PISA) (OECD, 2010), however, believes that many disadvantaged students achieve well above what is predicted as do a proportion of students from privileged backgrounds perform below what is predicted. For any group of students there is a range in performance. This can be considered as a phenomenon named *educational resilience* (Pedrosa, Dachs, Maia, Andrade, & Carvalho, 2006). Yorke and Longden (2004), Cleyle and Philpott (2012), and Toni and Olivier (2004) concede that students can become committed to making a positive change in their lives and commit to their university studies by using their challenging circumstances as an incentive. What high school factors then affect a student's success in university? According to Vermunt and Verloop (1999), one of the goals of teaching is for a student to master independent learning skills such as critical thinking and self-regulation.

Critical Thinking

Critical thinking is one of the most important mental tools that learners must have to become competent computer programmers, as problem solving forms the foundation on which computer programming is built (deRaadt, 2008). Research indicates that very few students are able to engage with and solve programming problems that involve critical thinking (Gomes & Mendes, 2007). Critical thinking is directly related to academic achievement (Cevik, 2013) as students who have critical thinking skills on a higher level are more likely to achieve academically than students who have critical thinking skills on a lower level (Akbıyık & Seferoğlu, 2006). It is thus imperative that high school teachers teach students to ask questions, problem solve, analyse ideas and think critically. To make this happen, teachers themselves have to possess these skills in order to transfer the learning (Karagöl & Bekmezci, 2015). It is, however, questionable that these skills are being taught in all South African schools.

Self Regulation

Self-regulated learning is a process that assists students to better manage their thoughts, their behaviour and emotions with the aim to successfully navigate their learning experiences (Zumbrunn, Tadlock, & Robert, 2011). Self-regulation is an important predictor of achievement at university (Zimmerman, Bandura, & Martinez-Pons, 1992). University students need to be self-directed in their studies, continuously monitoring their learning and self-reflecting on their progress (Zimmerman & Schunk, 2008). At high school, a limited amount of self-regulation is required for learners to achieve, as teachers and parents constantly remind and guide learners to complete their homework and assignments, assist the learners with preparing for tests and give constant motivation and feedback on the learners' progress. Whereas at university, students are expected to motivate themselves and develop their own goals and learning strategies: "University requires students be proactive and self-disciplined and engage in self-creation, self-initiation and self-evaluation of academic tasks" (Bembenutty, 2011, p.5). However, many university students lack the ability to self-regulate and struggle to set academic goals for themselves. Students find it difficult to identify appropriate learning strategies and therefore start off their academic journey at a disadvantage (Bembenutty, 2011).

Many of the students who enrol for the National Diploma Business Information Technology at the University of Johannesburg and the National Diploma Information Technology at the University of Pretoria where this study was conducted originate from former "black schools" that were beset with the problems described above. This may offer possible explanations for the poorly developed skills of students who at universities struggle to cope with the demands of higher learning.

Context of the Study

Performance in computer programming modules at Higher Education Institutions (HEIs) has traditionally been low. Within the context of world-wide shortages of skilled programmers, it becomes imperative that greater success is achieved in HEIs. The low success rate in programming modules is ascribed to the abstract nature and content of programming courses and the inadequacy of pre-university education to prepare students for the cognitive skills required for success in such courses. In the quest for identifying those attributes that may have an impact on student success in the programming modules, the research question asked was:

Is there a relationship between a novice South African programming student's educational background as determined by their critical thinking skills and self-regulatory skills and their performance in programming modules?

Sub Question 1: Does a student's critical thinking ability affect their academic performance in computer programming?

Sub Question 2: Does a student's self-regulation ability affect their academic performance in computer programming?

Method

The participants of the study were a group of 186 first year students enrolled for the National Diploma Business Information Technology (NDBIT) at the University of Johannesburg (UJ) and 193 first year students enrolled for the National Diploma Information Technology (NDIT) at the Tshwane University of Technology (TUT).

Data collected consisted of a student profile questionnaire (SPQ) and examination results. The SPQ was piloted before being finalised. This questionnaire was completed by students during their first year of studying computer programming. The examination results were from the students' programming module, Development Software 1: UJ - Development Software 1A (DSW01A1) and Development Software 1B (DSW01B1); and TUT - Development Software 1A (DSO171AT) and Development Software 1B (DSO171BT). Student numbers were used as the key field to link the data sets. The Development Software 1 (DS1) results were used as the dependent variable throughout the study.

DataAnalysis

Students' educational background was determined by them being encouraged to think critically at school and their ability to self-regulate their learning.

Critical Thinking

The subscale contained items that attempted to establish the extent to which students believed that their critical thinking skills were developed at school. In order to statistically determine critical thinking encouragement at school, an exploratory factor analysis was used to identify different items. The critical thinking factors identified at school were: Factor 1 = study habits, Factor 2 = analysis, Factor 3 = encouraged to think independently. Factor 3 was discarded due to the Cronbach Alpha value being 5.88, an unacceptable inter-item correlation according to George and Mallery (2003, p. 231). The relationships and patterns within each remaining item were then correlated with the dependent variable DS1 mark.

Table 1

Correlation of Critical Thinking and DS1 Mark

Correlations		
		DS1 Mark
Factor 1 (at school) - Study habits	Pearson Correlation	-.098
	Sig. (2-tailed)	.057
	N	376
Factor 2 (at school) - Analysis	Pearson Correlation	.000
	Sig. (2-tailed)	.996
	N	377

A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 1: study habits variable and the students' performance in DS1 variable. There was no correlation between the two variables, r = -.098, n = 376, p = .057. The results show that for this group there is an insignificant correlation between students who were encouraged to develop good study habits at school and performance in DS1.

A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 2: analysis variable and the students' performance in DS1 variable. There was no correlation between the two variables, r = .000, n = 377, p = .996. The results show that for this group there is an insignificant correlation between students' who were encouraged to analyse their work at school and performance in DS1.

Self-Regulated Learning
The data indicated that the majority of students regulate their own learning experiences. In order to determine which self-regulated learning traits correlated with a student's success in their DS1 mark, exploratory factor analysis was used to identify different items. The self-regulation factors identified at school were: Factor 1 = metacognitive ability, Factor 2 = self-efficacy, Factor 3 = motivation to learn. The relationships and patterns within each item were then correlated with the dependent variable DS1 mark.

Table 2

Correlation of Self-Regulated Learning and DS1 Mark

Correlations		
		DS1 Mark
Factor 1 (self-regulated learning) metacognitive ability	Pearson Correlation	-.022
	Sig. (2-tailed)	.669
	N	370
Factor 2 (self-regulated learning) self-efficacy	Pearson Correlation	.055
	Sig. (2-tailed)	.292
	N	370
Factor 3 (self-regulated learning) motivation to learn	Pearson Correlation	-.119
	Sig. (2-tailed)	.022
	N	370

A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 1: metacognitive ability and the students' performance in DS1 variable. There was no correlation between the two variables, r = -.022, n = 370, p = .669. The results show that for this group there is an insignificant correlation between the students' metacognitive ability and performance in DS1.

A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 2: self-efficacy and the students' performance in DS1 variable. There was no correlation between the two variables, r = .055, n = 370, p = .292. The results show that for this group there is an insignificant correlation between the students' self-efficacy and performance in DS1.

A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 3: motivation to learn and the students' performance in DS1 variable. There was a medium, negative correlation between the two variables, $r = -.119$, $n = 370$, $p = .022$. Overall, there was a small inverse correlation between the students' motivation to learn and performance in DS1.

Discussion and Conclusion

The quality of the South African education system can be summarised by statistics indicating that out of 100 learners who start school, 50 will reach Grade 12, 40 will pass, and only 12 will qualify to study at a university (Spaull, 2013). The background of this study highlighted a lack of facilities, poor educational resources, overcrowded classrooms and a lack of qualified teachers as potential contributing factors of a learner's poor performance. Next, the high school factors that could affect a student's success at university namely, critical thinking and self-regulation were discussed. In order to determine if students were taught to think critically at school, they were asked a series of questions, for example, to what extent they were encouraged: to plan before attempting a task, to have an inquiring mind and to ask questions, to find multiple solutions to problems, to break a problem into different parts in order to solve it, etc. It is well known that students in high school are taught to rote learn rather than think critically. However, the students in the study, self-reported that their critical thinking skills were developed in high school. In this context though, a student being encouraged to think critically at school, could not be correlated with performance in programming modules at the university level. In order to determine if a student was able to self-regulate, students were asked a series of questions, for example, I believe I will do well in this course, I work hard at a task even though I don't like a task, I keep checking that I'm on the right track while I'm busy with a task, I plan first before I begin with a task, etc. In high school, a limited amount of self-regulation is required for learners to achieve, whereas at university, students are expected to motivate themselves and develop their own goals and learning strategies. In this context though, a student's self-regulation ability, could not be correlated with performance in programming modules at the university level.

This study forms part of a series of studies looking at the pre-entry attributes thought to influence the performance of students in computer programming. The pre-entry attributes in previous papers included problem solving ability, socio-economic status, performance in school mathematics, English language proficiency, digital literacy and previous programming experience (Barlow-Jones & van der Westhuizen, 2017). Many researchers (Ali et al., 2013; Birch & Miller, 2007; Considine & Zappala, 2002) state that the type of school a child attends influences his or her academic achievement at university. However, it could be concluded, in this study, that educational background did not predict academic achievement in computer programming in a higher education institution.

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CODING FOR GIRLS: DISMISSING THE BOYS CLUB MYTH

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Abstract

This paper describes a study that was conducted over a two-year period. The aim of the study was to introduce girls to programming through the use of innovative tools. These tools, namely Mindstorms Robotics and Scratch were carefully chosen for their unique characteristics. The objective of the study was to provide girls with an opportunity to view programming in a positive manner. A quantitative analysis was performed, and the results indicate that the majority of the girls were motivated to learn programming skills. This paper not only provides insight into the minds of girls learning programming, but can also serve as motivation for educators teaching girls programming skills.

Introduction

Research indicates that the growth of computing careers is set to continue rising until 2020 (Watson & Li, 2014). However, the dropout rate of students enrolled for Computer Science 1 (CS1) is high (Bennedsen & Caspersen, 2007), and female student enrolment is on the decline (Kelleher, Pausch, & Kiesler, 2007). This may be due to a number of factors. For example, female students tend to be less confident about CS1, and they underestimate their ability (Carter & Jenkins, 1999; Funke, Berges, Muhling, & Hubwieser, 2015). This may be due to the stereotype of the male scientist that still persists today. It is well known that students who are introduced to computer programming at a young age, may well become the computer science university graduates of tomorrow. Therefore, it is important to equip young minds at an early age. This may be particularly relevant given the stereotype that girls seem to think exists.

To address the issue of skilled programmers, some governments, such as the UK and Finland, have introduced programming within the classroom from primary school level (Department for Education, 2013). However, due to the cognitive difficulties associated with programming it may be beneficial to teach students the art of algorithmic problem solving as well as programming in a fun and motivating manner (Badger, 2009). Games and interactive graphical user interfaces (GUI's) are approaches that have been seen to be successful.

Extant literature indicates that such approaches (tools) provide necessary elements for learning. Elements such as understanding and motivation can strongly contribute to easier learning of how to code (Piteira, 2011). These tools provide a platform for students to build, reinforce and practice fundamental computer programming concepts, while adding an element of fun. Such tools often scaffold students as they make use of action instead of explanation; accommodating a variety of learning styles and skills; reinforcing mastery skills; providing an opportunity to practice; and affording an interactive, decision-making context.

This research aims to investigate whether such tools appeal to girls, as in almost all western countries, women are severely underrepresented in the discipline of computer science. Only 20% of an intake within any given department are female (Funke et al., 2015).

Literature Review

Women are significantly under represented within the field of computer science, with gender differences significantly noticeable already at school level (Funke et al., 2015). For example, female students often have weaker marks, only doing what is required of them, and they are less fascinated, adopting a pragmatic approach to programming. However, they are also more enthusiastic to seek assistance and readily attend extra tutorials, preferring smaller groups over larger ones. Interestingly, female students are more consistent and, when confronted with a problem, admit that there is a problem before the problem becomes a larger one. Another aspect that affects the learning process for girls is emotions (Chetty & van der Westhuizen, 2013). Research indicates that happiness has a positive and anxiety a negative influence on the learning process and the motivation of female students (Funke et al., 2015). Communication is very important to female students. Denner et al. show that girls benefit from collaboration where they work together as a pair, one being the driver and the other the navigator.

On the contrary, male students are more confident as they depict the typical role model of the male computer scientist. They seem to have more hands-on experience, try and test things out (scientific curiosity), and have more interest probably due to the gaming industry. The result is that male students often produce better marks. However, male students are often less structured and often do not admit when there is a problem until the problem at hand is almost insurmountable (Carter & Jenkins, 1999). Additionally, they do not readily attend extra tutorials.

Funke, et al surveyed computer science teachers with the notion of observing the gender differences (Funke et al., 2015). The main findings of this qualitative study resulted in 14 categories (coded) that teachers perceived to be true about programming and gender, namely:

- Structuredness;
- Self-confidence;
- Scientific curiosity;
- No differences;
- Results;
- Interests;
- Learning receptivity;
- Accuracy;
- Previous knowledge;

- Perseverance;
- Creativity;
- Frustration;
- Teamwork and
- Evolution (Funke et al., 2015).

It is interesting to note that a high number of participants (teachers) did not perceive any differences between genders.

Although genders differ in terms of programming, the idea of using games to teach fundamental computer programming concepts could be a generic approach that is not influenced by gender (Lawhead, 2002). Using games as well as interactive GUI's as a learning tool is advocated, as games have the potential to positively contribute to successful learning (Piteira, 2011). For example, the use of Lego Mindstorms robots is one such game that can provide an innovative teaching tool for building students computer programming skills. Scratch is another useful tool that can be used to promote the notion of programming.

There is still a need to further examine and analyse quantitative evidence on the topic of gender as enrolment figures drop, especially amongst females. This can only benefit the research community so that educators can get an understanding of how to attract female scientists into the field of computer programming.

Research Design

Previous research indicates that female computer programming students are on the decline and gender inequality within the workplace is prevalent. The motivation for this study arose to transform the notion of girls' perceptions of programming so that they are able to make more informed decisions in the future related to their careers.

While Funke, et al. based their work on surveying computer science teachers' responses to gender differences, this study is based on analysing the responses of the girls themselves.

Research Questions

To expand on other researchers' work, the research questions posed for this study were as follows:

1. Did gender differences influence learning programming skills? Which gender differences influenced learning?
2. Did the use of tools used to learn programming skills influence gender?

Participants

In 2015, 36 Grade 4 girls participated in learning fundamental computer programming skills ranging from variables, step-by-step instructions, decision making, loops and modular programming using Lego Mindstorms Robotics. In 2016, 32 Grade 5 girls learnt similar skills using Scratch

Additionally, three computer programming holiday clubs were conducted, two for Lego Mindstorms Robotics and one for Scratch. These holiday clubs were also conducted with girls ranging from ages 9 to 13 and one of the holiday clubs included boys. The first Lego Mindstorms Robotics holiday club consisted of 25 girls, and the second holiday club for Lego consisted of 6 boys and 8 girls. The Scratch holiday club consisted of 14 girls and 9 boys.

Materials

The coding course in 2015 (Lego Mindstorms Robotics) was conducted over a period of three months, each class being held weekly for one hour. The class was structured according to aims and objectives with tasks that the girls needed to complete. For the Lego Mindstorms Robotics course the girls worked in groups of two or three.

The coding course in 2016 (Scratch) was also conducted over a period of three months, again for one hour a week. These were the same girls who had completed the Lego Mindstorms Robotics course the previous year so they had prior knowledge of programming skills. For this course, the girls worked independently. The holiday courses for both the Lego Mindstorms Robotics and the Scratch course followed a similar pattern in terms of structure and content. These holiday courses took place in 2016.

For all of the courses each lesson comprised of learning a fundamental programming skill. A discussion as well as demonstrations were presented. The girls were then asked to complete a basic task around the skill, and then they were given a problem to solve that included the programming task. For example, one task may have been to program the robot to stop at a red traffic light. Another task may have been to develop a game using Scratch where the sharks eat the fish.

Instrument

A questionnaire was distributed to the girls at the end of each course. There were a variety of questions, and they were identical for both courses except for the tool name change. Girls were asked questions, such as “What did you enjoy most about programming?” And “Did you find programming easy?”. The questionnaires for the holiday courses were the same as the questionnaires used for the school coding courses. Students were asked to stipulate gender.

Data Analysis

The questionnaire consisted of ten questions with one of the questions having sub-questions related to a topic. The data was analysed quantitatively using SPSS.

Results

The results are discussed according to the questionnaire with a focus on answering the research questions.

Lego Mindstorms Robotics

Enjoyment of the course. Ninety-six of the participants agreed that they enjoyed the Lego Mindstorms Robotics course. Interestingly, all the boys enjoyed the course, and there were a few girls that did not enjoy it.

Skills enjoyed expanded. This question was a follow up question from the previous question where students were asked what they enjoyed. Some of the written answers were:

- We learnt new things I didn't know;
- Bot fighting;
- Mazes;
- I enjoyed learning about the switch and sensors;
- I enjoyed that at the age of 10 you can do amazing things;
- I enjoyed experimenting with the programming and working with the partners; and
- I enjoyed how the robots were real and we programmed real robots.

Ease of building the robot. Fifty-one girls found it easy to build the robot and 13 girls found it to be difficult. Three of the 5 boys found it easy to build the robot.

Programming skills. Eighty-three percent of the boys found programming easy compared with 63% of the girls. This is particularly interesting as it corresponds with previous research where boys do better than girls. This question is aligned with skills enjoyment and is discussed in detail below.

Keeping up with peers. Again, this question may highlight some gender differences as 100% of the boys felt that they could learn programming at the same pace as their peers. However, only 74% of the girls felt that they were academically aligned with their peers. This response reflects previous research that stipulates that girls are less confident and afraid to experiment.

Collaboration within the group. Both boys and girls felt that collaboration within the group took place and that their peers would assist them if need be, with 75% boys and 73% girls indicating positive collaboration. However, when asked to expand on their answers, girls' group dynamics were complex. Some girls indicated that their peers were controlling and that there was much unnecessary arguing.

Skills enjoyment. This question was divided into sub-questions pertaining to a skill learnt. The students were asked to rate the level of enjoyment from 1 (most enjoyed) to 6 (least enjoyed). Each sub-question is now discussed.

Building the robot. All of the boys indicated that this task was most enjoyable (level 1) whilst only 36% of the girls indicated building to be most enjoyable. Ten percent of the girls found this to be the least enjoyable activity while the rest of the girls' indicated across the range (level 2 to level 5).

Basic movement. Interestingly, both genders found the basic fundamental skills of learning to program using step-by-step instructions least enjoyable. One hundred percent of the boys and 39% of the girls reflected this.

Looping. Again, most girls and boys disliked learning how to program using a loop where 100% boys and 33% girls found this task tedious.

Decision-making: colour sensor. A third of the girls (33%) indicated that learning to program using the colour sensor was very enjoyable. The colour sensor allows educators to develop interesting tasks, such as "when the robot gets to the colour green it must sing a song and turn around." Interestingly, all the boys only found this task to be moderately fascinating.

Decision-making: touch sensor. All of the boys found the touch sensor enjoyable. This may be attributed to the fact that the boys enjoyed the "bot fighting," where the robots had to touch each other and score points, as well as bump into each other and push the robot off the mat. Thirty-nine percent of the girls found this skill to be moderately enjoyable.

Development of the final project. Only 50% of the boys enjoyed developing the final project, which included all the programming skills learnt. Almost 80% of the girls felt that this task was enjoyable.

Dislike of the course. The students were asked whether there was anything that they disliked about the course, and none of the boys indicated that they disliked anything. However, 29% of the girls disliked aspects, such as building the robot and negative group dynamics.

Scratch

Enjoyment of the course. All the boys enjoyed the Scratch programming course, and 81% of the girls enjoyed it.

Skills enjoyed expanded. This question was a follow up question from the previous question where students were asked what they enjoyed. Some of the written answers were:

- Learning all the coding like variables and broadcasts;
- Writing a program;
- Creating and playing games which adds a bit of fun to the lesson;
- I enjoyed making the ball game;
- I enjoyed how we got to program it ourselves;
- I enjoyed the maze and how we worked independently; and
- I enjoyed programming different programs and making the ball game with the counter and high-score.

Table 1

Gender Influencing Programming Skills

Gender Difference	Highlighted
Girls	
Have weaker marks, only doing what is required of them	
Less fascinated, adopting a pragmatic approach to programming	√
More enthusiastic to seek assistance	√
Prefer smaller groups over larger ones	√
More consistent and when confronted with a problem, admit that there is a problem before the problem becomes a larger one.	
Happiness has a positive and anxiety a negative influence on the learning process and the motivation	√
Communication is very important	√
Girls benefit from collaboration	√
Boys	
More confident	√
They seem to have more hands-on experience, try and test things out (scientific curiosity)	√
Produce better marks	
Often less structured and often do not admit when there is a problem until the problem at hand is almost insurmountable	
They do not readily attend extra tutorials	

Programming skills. Interestingly, only 67% of the boys found it easy to write a program using Scratch as opposed to 73% of the girls. This differs from the results found when the students were learning to program using Lego Mindstorms Robotics. However, more than 80% of the girls tested had already completed the Lego Mindstorms Robotics course. This may have influenced the result, as previous research shows that prior programming experience is an advantage to learning a new programming language (Bergin & Reilly, 2005).
Keeping up with peers. Although the boys found the programming more challenging than the girls, more of the boys (88%) felt that they were able to keep up with their peers. This may be due to the notion that boys often feel more confident as computer scientists. Fewer girls, 73%, felt that they were able to keep up with their peers.

Collaboration within the group. The Scratch course was structured in such a way that students worked independently of each other. However, students worked along-side each other where they could assist each other. All the boys as well as 78% of the girls felt that their peers would readily assist them if they required help. As their facilitator, I observed that students were keen to assist each other. It seemed to provide them with an opportunity to solve problems and learn from other' code.

Skills enjoyment. This question was divided into sub-questions pertaining to a skill learnt. The students were asked to rate the level of enjoyment from 1 (most enjoyed) to 6 (least enjoyed). Each sub-question is now discussed.

Building a Sprite. All the boys rated this aspect of Scratch as level 4 – not really enjoyable. Thirty-two percent of the girls also did not really enjoy this while 39% of the girls did enjoy developing a Sprite.

Creating a background. The majority of both the girls and the boys did not find this aspect very enjoyable with more than 60% of both genders indicating it at level 4 – 6.

Movement and the Sprite. All of the boys found this aspect reasonably enjoyable while 50% of the girls enjoyed coding the Sprite (s) to move. Fifty percent of them did not find it enjoyable.

Controlling the movement of the Sprites. All of the boys as well as 70% of the girls enjoyed developing the code to enable the Sprites to move in a controlled manner. For example, they learnt programming instructions that allowed a user to press the up, down, left and right arrows so that the Sprite would move around. This often took place as part of a game that was developed, such as a Sprite moving through a Maze.

Creating a game. All of the boys and 85% of the girls found it enjoyable to develop the code for a game. As facilitators, we observed that there was much excitement around the coding with students using their imaginations and extending or adding elements to the games that were developed. They enjoyed playing each other's games and learning from each other.

Creating an interactive storybook. Both the boys and girls did not enjoy creating an interactive storybook. This aspect of Scratch makes use of repetitive instructions. Students may have found this monotonous.

Discussion

The findings of this study confirm the results from previous research conducted by Funke et al. As shown in Table 1 this study found comparable results based on gender.

Did gender differences influence learning programming skills? Which gender differences influenced learning?

When considering whether gender differences influenced learning a programming skill, this study shows that gender can influence learning. Some of the gender differences that may have influenced learning refer to:

- Boys found it easier to learning programming concepts as opposed to girls;
- Boys felt more confident in the role of learning programming skills;

- Both genders benefit from collaborative learning, however group dynamics within girl groups can be challenging; and
- Gaming is a beneficial tool for both genders to make use of for learning programming skills.

Table 2 tabulates Funke et al.'s categories to show whether any of these gender differences are highlighted for this study.

Table 2

Funke et al. Categories Linked

Category	Gender
Structuredness	Girls
Self confidence	Boys
Scientific curiosity	Boys
No differences	
Results	
Interests	Boys
Learning receptivity	Boys
Accuracy	Girls
Previous knowledge	Girls
Perseverance	Boys
Creativity	Boys, girls
Frustration	Girls
Teamwork	Boys
Evolution	Boys, girls

Did the use of tools influence gender?

Bruckman, Jenson and De Bonte (2002) found that gender did not influence learning and performance for programming. However, they did find that motivation and interest were factors that influenced both genders learning programming. Boys tend to spend more time playing computer games and more time programming. Therefore, one key element to encourage girls to learn programming skills may be the tool used to teach girls.

Table 3

Tool Characteristics and Gender Appeal

Tool Characteristic	Gender	
	Boys	Girls
Lego Robotics Mindstorms:		
Enjoys learning programming skills	√	√
Building the robot	√	

Tool Characteristic	Gender	
	Boys	Girls
Ability to learn programming skills	√	
Confident in learning programming skills	√	
Collaboration	√	
Basic programming skills		
Complex programming skills	√	√
Development of a project for demonstration		√
Scratch:		
Enjoys learning programming skills	√	√
Ability to learn programming skills		√
Confident in learning programming skills	√	
Independent learning of programming skills		√
Learning programming skills through gaming	√	√

Table 3 tabulates a list of characteristics found from this study that attract girls as well as boys to the tools used in this study. Boys found that it was easier to learn programming skills when Lego Mindstorms Robotics was the tool as opposed to Scratch. The girls felt that Scratch was a good tool to make use of to learn programming. However, both boys and girls enjoyed learning programming skills using both tools. Therefore, these tools can be seen to motivate both genders to learn programming skills. In both cases girls were less confident learning programming so ensuring that the tool is fun motivates girls. This may lead to an increase in confidence among the girls. Interestingly, girls' confidence in their ability seemed to rise when they had prior knowledge of programming skills. This needs to be investigated further and can be a key element in female student enrolment

Limitations

The samples used as part of this study are small and are not representable of a significant portion of a population. The socioeconomic representation is small as the school is a private school with pupils' representative of affluent families within a community.

Conclusion

Over the last 30 years much research has been focused on the development of programming skills. From low pass rates, to the difficulty that surrounds the learning and teaching of computer programming, as well as the group of people that engage in the activities around learning programming. It has also been validated that male students are motivated and confident to take CS1 while female students remain reluctant. Therefore, more research should focus on changing these statistics given that computer programming skills are still on the rise. Attracting young girls at an early age may be key to changing perceptions. In this study, we address the concept of gender within a programming context to determine whether gender does influence the learning of programming skills at a young age. We also observed a variety of learning characteristics that may attract girls to learning programming skills. The research was motivated to provide a learning environment for girls where the mechanics of learning a programming language is not the only system in place to learn programming. Creating environments that address sociological factors, such as fun, motivation and collaboration may provide learning for a more diverse group of people (Kelleher & Pausch, 2003).

Future Work

Future work will focus on finding techniques that assist girls in engaging with programming as well as researching tools to assist girls with programming. Evaluating the impact of such methods is imperative to furthering research in this area.

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AN EDUCATIONAL ROBOTICS ACTIVITY TO PROMOTE GENDER EQUALITY IN STEM EDUCATION

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Abstract

In the future boys and girls will be employed in, and maybe create, new jobs connected with technology. We present a project whose aim was to raise interest in STEM education in K12 students and, in particular, to address the lack of participation of female students in STEM careers. For this reason, in September 2017, 20 students (12 girls and 8 boys) took part in a two-weeks robotic camp to learn robotics and its application on agriculture. An evaluation of attitudes and performances was accomplished by delivering a questionnaire and by recording the results from day-to-day challenges.

Context of the Study

Women around the world have been fighting for their own basic rights for centuries. All the basic human rights had to be conquered through the years, and now, even if something has already been achieved, the effects of gender inequality still persist. They persist for example in stereotypical gender perceptions that affect people's reasoning in every aspect of everyday life, across different generations and cultures. The weight of gender discrimination assigns strict roles to both men and women producing harmful effects, because it represents a limit for our mind and therefore for society at large.

A study from the European Institute for Gender Equality (EIGE) reports that the term *gender equality* itself is not well understood, as it is mostly regarded as a women's issue (EIGE, 2012). On the contrary, the European Commission (EC) defines gender equality as "the result of the absence of discrimination on the basis of a person's sex in opportunities and the allocation of resources or benefits or in access to services" (p. 16). Even though all ages should be targeted to face inequalities, Biemmi and Satta (2017) state that stereotypes and prejudices, including those regarding gender, are the result of social categorization that begins in the first years of life (e.g., pink is the colour for girls and blue for boys), and it continues thereafter becoming increasingly invasive. Even if school could promote projects on emotional education and respect for differences, the dominant school model remains the traditional one where these processes are rarely present.

Another aspect of gender equalities is explored by Han (2016), who studied the association between features of national educational system and gender gap in STEM related occupational expectancy across 49 countries, including Italy, examining data from PISA 2006. Gender gap in STEM education, career and wages, in fact, can be influenced both by individual factors and by macro-level factors, such as stratification and standardization of educational systems. Stratification of education systems seems to be associated with a larger gender gap in STEM occupational expectancy. Moreover, top-performers seem to show a stronger relation between the availability of several school types at the secondary level of education and expectations of students for their future career. An Italian national source for statistical data (Servizio Statistico MIUR – 2016) stated that only a few female students pursue a STEM career: only 16.3% of students choosing vocational education on technical fields are girls.

Moreover, in the academic year 2014/15 the share of female students enrolling for their first year in a bachelor course in the field of Humanities was 75%, whereas only 31% of girls chose a technical course like Engineering. The reasons why girls do not pursue a technical career could be related to socio-cultural motivations as well as educational, but the worst thing is that this is echoed in the difficulty of accessing those careers that are strongly related to science and technology. Unfortunately, these careers are the most promising, in terms of future employability and economic reward, and it is therefore impairing for women not to benefit from this opportunity. The Italian Department for Gender Equality (Dipartimento per le Pari Opportunità della Presidenza del Consiglio dei Ministri – DPO) and the Italian Ministry of Education (Ministero dell'Istruzione, dell'Università e della Ricerca - MIUR) chose to take action against this situation and launched a call for proposals. This call intended to fight stereotypes describing girls as unfit for studying STEM subjects by involving primary and lower secondary schools in a summer activity on math, science, technology, computer science and coding.

Robotics as Mean to Foster STEM Education

To involve and motivate girls to think about a future career in STEM related fields, authors relied on some personal experiences (Cesaretti et al., 2017; Scaradozzi, Sorbi, Pedale, Valzano, & Vergine, 2015; Scaradozzi et al., 2016a; Scaradozzi et al., 2016b; Scaradozzi, Screpanti, Cesaretti, Storti, & Mazzieri, 2018) and some literature findings reporting positive results in fostering STEM by means of Educational Robotics (ER). First of all, Sanders (2009) states that Robotics is the true integrated approach to STEM education, meaning that it can put STEM fields together fostering the re-elaborations of notions and an active learning. Moreover, ER education can also empower future citizens of the digital world and the nowadays boys and girls in the field of Cybersecurity (Kasemsap, 2017), enabling them to protect themselves from the potential danger of a connected life. Benitti (2012) showed that ER holds a great potential, even if it hasn't reached its full expression in terms of research outcomes, because research in this field lacks large samples for quantitative investigations. A further investigation by Mubin, Stevens, Shahid, Al Mahmud, and Dong (2013) states that research is still needed to make robots and curricula fit for students. Later on, we can find examples of ER curricula into schools. For example, the work of Veselovská and Mayerová (2017) presents qualitative evaluation of activities from an ER curriculum developed for lower secondary students. Scaradozzi et al. (2015) and Scaradozzi et al. (2016a) present features and some results from an experimental curriculum on robotics as a curricular subject in an Italian primary school.

Robotics and Its Impact on Gender Equality

Master, Cheryan, Moscatelli and Meltzoff (2017) studied 96 children holding strong stereotypes that boys were better than girls at robotics and programming. Girls reported lower interest and self-efficacy in these domains than boys. Boys and girls participating in the treatment group (they were both involved in robotics and programming activities) reported a significant change in interest and self-efficacy. Especially, girls of the treatment group reported higher technology interest and self-efficacy if compared with girls belonging to the control group, that did not experience the activities. Moreover, they did not show a significant gender gap relative to boys' interest and self-efficacy. Reich-Stiebert and Eyssel (2017) studied university students, evaluating the impact of gender on robotic activities. They argued that if teachers' gender influences students' learning outcomes and motivation, robots can produce a similar bias. They found that robots' gender had no influence over the sample and, unexpectedly, the gender-stereotypical tasks increased the willingness of participants to put all their efforts in overcoming the stereotypes. Also, at the European level, robotics is considered an effective means to reduce the gender gap. We can mention just two (out of more) EU funded project on the topic: "TWIST" (http://www.the-twist-project.eu/en/) and "Roberta goes EU" (https://cordis.europa.eu/result/rcn/46888_en.html). To reach a robust, sustainable European economy which can compete with new emerging markets, the female capacity must be developed and deployed effectively. To this end, TWIST (Toward Women in Science and Technology) created genderless activities in science centres and museums. "Roberta goes EU" addressed the lack of female engineers by carrying out activities of robotics in a variety of environments reporting positive results.

Methods

The following subsections provide an account of the activities of the project, which took place in Ancona (Italy) at the school I.C. Novelli Natalucci in September 2017. The school, the university Università Politecnica delle Marche and the start-up TALENT srl. co-designed a two-weeks activity on robotics and its application to agriculture. The university prepared some of the materials and tools to make it possible for students to build and program the automated vegetable garden. The university also provided support in the design of activities and analysis of results. TALENT srl. carried out the activities in the classroom involving the students in meaningful activities.
In the following subsections authors provide further details on the activities.

Underlying Pedagogical Approach

The pedagogical theory that helped designing and carrying out activities was constructionism, which suggests that building knowledge is the natural consequence of an experience of creation and experimentation. Students are encouraged to directly observe their own actions and analyse the consequent effects. They are called to share ideas in a highly motivating context. From this point of view, technology and innovative learning environment let students learn with their peculiar style of learning. Relying upon Gardner's theory of multiple intelligences, students are encouraged to acknowledge their own skills and abilities. This can help them to think about their future, both in terms of studies and career. A learner-centred approach was employed, problem-based learning (PBL): after a brief explanation of the fundamental aspects of robotics, students faced challenges focused on the collaborative research of effective solutions, thus fostering also project-based learning and peer tutoring. All the activities were designed on the TMI model (Think, Make, Improve), as suggested by Martinez and Stager (2013): first, students try to figure out what a solution to the problem can look like (Think); second, students try to realise the solution by building and programming the robot (Make); third, students watch closely their artefacts and try debug or improve them (Improve).

Tools and Materials

The following list of materials illustrate what a single group of students used during the activities:

- 1 kit Lego Mindstorms EV3 Education
- software Lego Mindstorms EV3 Home Edition
- 1 kit Lego Pneumatic Add-on Set
- 1 kit Lego Renewable Energies
- 2 sensors Mindstorms Temperature Sensor
- 1 sensor SparkFun Soil Moisture Sensor
- 1 Arduino EV3 Adapter
- 1 Arduino UNO board
- Spare materials (plastic bottles, tape, etc.)

Contents of the activities

The project lasted two weeks: 5 days a week and 4 hours of activities planned each day. Week 1 was focused on providing all students with the basic notions on robotics. Week 2 was focused on designing, building, programming and testing a robotic structure whose aim was to simplify the daily work of a hypothetic farmer in a vegetable garden. Week 1 offered a more structured kind of activity, while Week 2 purposefully left students free to explore solutions, thus fostering responsibility, autonomy and self-confidence. The schedule of activities for Week 1 is:

- Day 1: Designing a robot: the roles. (Defining team and roles; How to build a simple program; How to build a simple robot; Challenge 1).

- Day 2: Man-Machine-Robot: what's the difference? (What is a machine? What is a robot? Differences and similarities between men, machines and robots; Challenge 2; Challenge 3).
- Day 3: The artificial brain of a robot (Sequencing, Selection, Iteration: three ways to code; Challenge 4; Challenge 5).
- Day 4: Debugging (How to find software errors; Challenge 6; Challenge 7).
- Day 5: Final challenge (Complex instructions that build on skills acquired during the previous activities; Challenge 8).

The schedule of activities for Week 2 is:

- Day 1: The vegetable garden (Designing the vegetable garden: what sensor and actuators should we use?).
- Day 2: Robotic artefacts to build the automatic vegetable garden (Building sensors and actuators).
- Day 3: Robotic artefacts to build the automatic vegetable garden (Testing sensors and actuators).
- Day 4: Sharing the artefact: implementation. (How to present the whole automatic vegetable garden: building and programming a story).
- Day 5: Final Exhibition. (Teachers, parents and locals are invited to the great exhibition of the automatic vegetable garden).

Participants

The call for proposal required 20 students; 60% of them had to be female. The age range of participants was from 11 years old to 13 years old. Not all participants came from the same school or class. A personal choice of educators was to divide participants into six groups. The aims of this choice were to provide students with the possibility to expand their personal abilities by combining them with those of their teammates and to learn to manage themselves and the others to accomplish tasks within the time at their disposal. Table 1 (p. 326) reports the distribution of students' gender between groups in the first two columns.

Challenges

Challenges were designed to stimulate participants to use the knowledge they acquired, reworking it to build and program a robot. The educator acted as a facilitator and as a judge in the challenges. Tasks in each challenge were:

- Challenge 1: The mobile robot had to cover a distance (1 metre).
- Challenge 2: The mobile robot had to move across an established path (without using sensors).
- Challenge 3: The mobile robot had to move along a square path (without sensors).
- Challenge 4: The mobile robot had to use a gyroscope to rotate.
- Challenge 5: The mobile robot had to use a gyroscope to move across a square path.

- Challenge 6: The mobile robot had to use an ultrasonic sensor to reach a fixed distance from an obstacle (25 cm).
- Challenge 7: Students had to find the bug in the project of a mobile robot using an ultrasonic sensor to perform a task.
- Challenge 8: Final path for a mobile to follow.

Questionnaire

At the end of the project, participants answered a questionnaire aiming to assess their attitude towards the activities. It was divided into 14 Likert-type items (Q1-14) and 4 open-ended questions (Q15-18). Items are:

- Q1 - I understood the instructions and the explanations that the trainer gave me.
- Q2 - The trainer was helpful and careful to my needs and questions.
- Q3 – I found engaging the method that the trainer employed.
- Q4 - It was easy to build in team all the robots and the automatic vegetable garden with my group.
- Q5 - It was easy to use the software and the pc.
- Q6 – I attended gladly to the activities.
- Q7 - The classroom's environment was peaceful.
- Q8 - My team got on well together and we helped each other.
- Q9 – My relationship with one (or more) classmate(s) improved.
- Q10 - I think I understood the fundamentals of building a robot and a technological vegetable garden.
- Q11 - It was fun to discover how to build a robot and a technological vegetable garden.
- Q12 - I think I understood the fundamentals of programming a robot and a technological vegetable garden.
- Q13 - It was fun to discover how to program a robot and a technological vegetable garden.
- Q15 - I also learnt …
- Q14 - I'd like to be involved in other activities of Robotics.
- Q16 - What is the thing you liked the most in this laboratory?
- Q17 - In your opinion, is there anything that went wrong?
- Q18 - Is there anything you would have liked to do in the laboratory?
-

The rating scale for Q1-Q14 was: 1 (No, at all), 2 (A little), 3 (Enough), 4 (Very much), and 5 (Yes, definitely). Students answered to Q15-18 writing free text. To evaluate results authors explored groups of questions targeting:

- *Educator*: relationship between students and educators (Q1-3).
- *Building:* building robots and the automatic vegetables garden (Q4, Q10-11).
- *Programming:* programming robots and the automatic vegetables garden (Q5, Q12-13).
- *Teamwork*: teamwork attitude (Q6-9).

Q14 is a global index, because if students had been positively involved, we could presume that they might be interested in carrying out some other similar activities. This is an important question because the final objective of the whole project is to raise interest toward STEM education and careers in young girls. To analyse open-ended questions (Q15-18), authors regrouped similar answers and labelled them into categories, following the main actions recalled by words and phrases used by students in the free text:

- Using/programming; understanding; inventing; cooperating (Q15).
- Cooperating; building; programming; challenge; teachers (Q16).
- No; Yes, cooperating; Yes, decorating; Yes (Q17).
- No; Yes, building; Yes, decorating; Yes, cooperating; Yes, more (Q18).

Results

The following subsections provide information about results from the project. Challenges, questionnaires and artefacts built within the project are shown and will be discussed in the final section of this paper.

Challenges

Table 1 shows the results from each challenge. Groups are reported in rows. The first two columns show the Female (F) and Male (M) representation within groups. Columns show results from challenges. The last column ("Rank") shows the final rank of each group. Numbers from 1 to 6 represent the rank the group obtained from the challenges. Actually, there were several ex-equo, thus resulting in a range of ranks from 1 to 4.

Table 1

Results From Each Challenge

	F	*M*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Rank*
Yellow	3	0	1	2	2	1	1	2	3	4	2
Pink	0	3	1	1	3	1	3	3	1	1	1
Green	0	3	2	3	1	2	3	4	3	2	3
Blue	3	0	4	4	2	2	2	1	3	2	3
White	4	0	3	3	3	3	2	1	1	4	3
Beige	2	2	4	4	3	2	2	2	2	3	4

Questionnaires.

Mean results from areas for questions from Q1 to Q14 are shown in Figure 1. Results from Q15, Q16, Q17 and Q18 are reported in Figure 2.

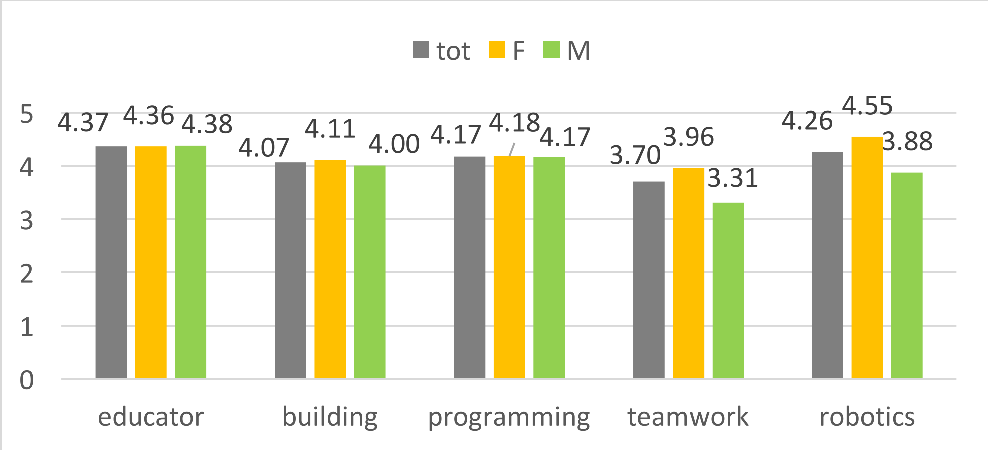

Figure 1. Mean values of answers to open questions per area. Green bars refer to male students, yellow to female students and grey to all students.

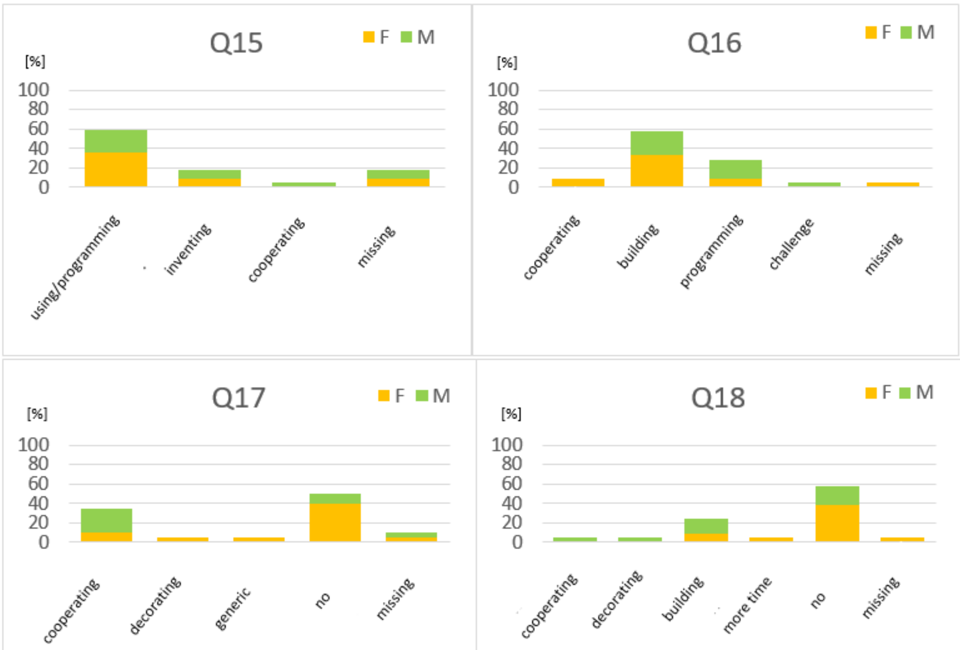

Figure 2. These four graphs show how many students answered and how they answered to Q115, Q16, Q17 and Q18.

Artefacts.

Figure 3 shows the final artefact of the project. Three small plants were used as case studies for implementation. Rosemary (on the right of the picture) was monitored by a humidity sensor, which acquired data from the soil, and a pump, that forces water through the hose. When the humidity sensor reports a value below the threshold, the water is pumped through the hose, otherwise the pump is still. Sage (on the left of the picture) was monitored through a light sensor and an LED: if the environmental light falls below a threshold an LED is lighted up, otherwise it is turned off. Basil (the plant in the middle) is monitored by a temperature sensor, which measures the soil's temperature and reads the value on the EV3 brick display. If the value is acceptable the light on the EV3 brick is green, otherwise the light turns red. There is also a mobile robot (on the right), equipped with an ultrasonic sensor that continuously patrols the table's perimeter, without falling down, to shoo away flies.

Figure 3. This picture shows the final artefact of the activity.

Discussions and Conclusions

Questionnaires (Figures 1 and 2) showed a good liking for activities in each area. The most appreciated area seems to be the *educator* area, while *teamwork,* even reporting overall positive results (mean rating=3.70), has lower ratings if compared with other areas. Looking closely, there seem to be some differences between male and female students: liking for teamwork is higher for girls than for boys. Mean values for Q7, Q8 and Q9 in all the 20 students are respectively 3.05, 3.55 and 3.7, while Q6 is 4.6. This seems to highlight that on average activities were perceived as likeable, but boys (mean values for Q7, Q8, Q9 respectively equals to 3, 3, 3.13) were less inclined than girls (mean values for Q7, Q8, Q9 respectively equals to 3.08, 3.92, 4.08) to work in a team. This result is in line with what educators noticed during the project and with results from Q17 in Figure 2. Looking at the final scores (see Table 1), best ranks are achieved by groups made up of girls. Worst position is achieved by the group made up of 2 boys and 2 girls. The best growth trend is reported by the group "Blue," which stunned the educator with tenacity and behaviour. *Building* and *programming* seem to be appealing to both boys and girls, but looking at Figure 2 it seems that students would have liked to have more building in their activities. This may be an interesting hint for future activities as it could be introduced a different schedule of activities to balance the time spent in building and programming. The overall experience was positive in many ways. Girls involved reported not only good results in terms of achievement, but they also stated to be interested in having more experiences in the field of technology (see *robotics* in Figure 1), which was the main goal of the project, but more importantly this is an objective for society at large.

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DIGITAL TECHNOLOGIES USES IN EDUCATION: A COMPARATIVE STUDY BETWEEN PORTUGUESE SCHOOL PRINCIPALS AND TEACHERS

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Abstract

This paper presents the results of a study developed in a doctoral program in education in field of information and communication technologies in education. The study aimed to develop knowledge about the use of digital technologies (DT) in educational contexts, in specific ways, by Portuguese school principals and primary and secondary school teachers. Organized according to a descriptive and exploratory quantitative methodological approach, the study involved data collection from 133 school principals and 1,908 schoolteachers. The results show that school principals present favorable scores of self-efficacy and use of technologies in their professional practices. In same way, high levels of use of technologies in the teachers' practices were identified. The comparative analysis allowed us to distinguish the schools based on levels of technological proficiency evidenced by their principals and the use of the technologies evidenced by their teachers.

Keywords: Self-efficacy, school principals, teachers, technology integration, technology uses in education.

DT in Education: Self-Efficacy, Beliefs, Roles and Use of Technologies by School Principals and Teachers

This study fits into the domain of digital technologies in education with a focus on the use of DT in the professional practices of school principals and teachers. We assumed as relevant the analysis of the beliefs and perceptions of school principals' own practices with technologies of school principals because it has been proved that school principals play an important role as promoters of the integration process of technology in teachers' professional practices in their schools. They should enhance the modernization of practices, teaching and learning, information management and communication between the many educational agents. The process of technology integration in schools requires a favorable combination of all the factors and agents, involving schools, teachers, school principals, students, parents and policy makers.

The DT integration in education is not a simple process; there are a considerable number of inhibiting factors or barriers that need to be analysed and considered. Barriers to the DT integration have been the focus of several studies in the last decades. In many studies and research papers, enhancing factors and obstacles have been analysed. Factors like lack of teacher training, lack of access to technological equipment, teacher motivation, innovative educational projects, stiffness of school curricula and others were pointed out.

Recently studies have pointed to motivational aspects, particularly the sense of self-efficacy, as one of the constraining factors of the educational integration of DT, mainly on their use in the classrooms (Kler, 2015; Petko, Egger, Cantieni, & Wespi, 2015). In the national context, recent studies also pointed to teachers' self-efficacy as a major factor in the DT integration in school practices, as high levels of self-efficacy proved to be directly linked to higher levels of performance with technologies (Piedade, 2010; Piedade & Pedro, 2014; Pedro, 2011; Santos, 2015).

Other studies have identified a strong link between schools' leadership and management practices and the effective process of integration of technology in school daily activities in classroom pedagogical activities and in management and institutional communication practices. The role of school principals in the process is the focus of several international studies (Afshari, Bakar, Luan, Afshari, Say, & Fooi, 2010; Cakir, 2012; Çakir, 2014; Moolenaar, Sleegers, Bryant, & Bryant, 2015; Seyal, 2015; Wong & Khadijah, 2017).

Similarity, Tearle (2003) contended school context and culture, as a whole, play a strong influence on the use of DT in the classrooms. In particular, (a) the support from the school administration and management boards and (b) teachers' constructivist perspectives on teaching and learning play an important role in encouraging the use of technology in teaching practices.

The role played by school administration was also noted by Daly, Pachler and Pelletier (2009) when referring specifically to the challenge of developing in the school principals an appropriate "vision" about the role of ICT in the specific school context. Also, Weng and Tang (2014) in their study with 323 school administrators in Taiwan found that technology leadership strategies had a significantly positive impact on the effectiveness of school administration. The same authors pointed out that technology leadership strategies should be considered as a relevant part of school principals' training programs, in order to improve the effectiveness of such administrative innovation in their school context.

Ibrahim, Razak and Kenayathulla (2013) showed why it is important for principals to acquire the knowledge and skills that will enable them to transform their schools into smart schools. These authors concluded, "A smart school is an educational establishment that adopts instructional processes and educational management practices that foster systemic changes that are intended to enable learners to surmount the challenges posed by the information technology era"(p.828). To that end, school principals need to become proficient users of a variety of software including word processing, spreadsheets, databases and email.

Digital technologies provide a set of potentialities to increase performance of school principals in many dimensions of their professional practices (e.g., communication, assessment, scholar administration, planning, financial, etc.). Zainally (2008) relayed, "ICT provides several facilities for educational administrator to perform their tasks" (p.24). The same confirmation was provided by Maki (2008, quoted by Makewa, Meremo, Role & Role, 2013), "ICT plays a vital role in supporting powerful, efficient management and administration in education sector"(p.48).

In last years, several quantitative studies have analysed the use of technologies by school principals in their daily activities (Afshari et al., 2010; Arokiasamy, Abdullah, & Ismail, 2015; Çakir, 2014). These studies showed a moderate level of technologies use in principals' practices as well a moderate level of competence. On the other hand, Hoque, Razak and Zohora (2012) pointed out the use of technologies by principals was limited and, in general, the technolgies were not effectively integrated in their practices.

Research Aims

This paper is based on a wider research (Piedade, 2017) where, among other goals, the author aimed to analyse the practices and proficiency levels in digital technology use presented by Portuguese public school principals as well as technology use by primary and secondary teachers.

The following research questions were assumed:

- What are the levels of proficiency and the levels of DT use in professional practices presented by school principals?
- Is there a correlation between the level of proficiency and the level of DT use presented by school principals?
- What are the levels of DT use in primary and secondary teachers' professional practices?
- It is possible to identify a relationship between the levels of proficiency and DT use presented by a school principal and the level of DT use presented by the school' teachers?

Methodology

This national study assumes a descriptive and exploratory nature and fits into a post-positivist research paradigm (Creswell, 2007). A quantitative based approach was undertaken for data collection and analysis. Data was collected through three self-report scales, organized in two online questionnaires: the "Computer Self-Efficacy Scale" and "DT Use in Scholar Administration Practices Scale" applied to school principals and the "Measure Teachers Technology Use Scale" applied to school teachers.

Cassidy and Eachus (2002) developed the Computer Self-Efficacy Scale applying the general precepts postulated by Bandura's Social Cognitive Theory. The authors present the instrument as *domain-specific*. It is originally composed of 30 items with a 5-point response options scale in Likert format (ranging from 1 'totally disagree' to 5 'totally agree').

The authors developed the DT Use in Scholar Administration Practices Scale for this research, and it appears as a multidimensional scale, as it considers that technology use by school principals may register different frequency and intensity considering different dimensions of their professional daily practices. In this way, the scale was organized in five dimensions: (1) Communication, (2) Planning, (3) Meetings Promoting, (4) Evaluation, and (5) Administrative

Management. The items are presented in a Likert format scale, and school principals are requested to select an answer according to the shown scale, which varies between ’rarely used’ (1 point) to ‘very often’ used (5 points).

The Measure Teachers Technology Use Scale is proposed by the authors (Bebel, Russel, & O´Dwyer, 2004) as a multidimensional instrument that considers that the use of technology by teachers does not happen in the same way and with equal intensity in different professional tasks. In this way, the scale is organized into seven dimensions: (1) Preparation, (2) Professional email, (3) Delivering Instruction, (4) Accommodation, (5) Student Use, (6) Student Products and (7) Grading. The items are presented in a Likert format scale, and teachers are requested to select the answer choice according to the shown scale between "rarely" to "very often," listed with values ranging between 1 and 5, respectively.

For this article, we will consider the total score of the scales and the score of each dimension. Aside from the process of translation and adaptation of the instruments, it was necessary to analyse their psychometric quality, thus seeking to eliminate any less discriminative items. The internal consistency of the Computer Self-Efficacy scale was previously evaluated by researchers in previous studies, and a Cronbach's alpha coefficient of 0.94 was found, revealing a high internal consistency (Piedade, 2010; Pedro, 2011).

Therefore, in order to validate the DT Use in Scholar Administration Practices Scale, a pilot-study was conducted with 8 public school principals with more than 10 years of experience. High internal consistency was also found. The DT Use in Scholar Administration Practices Scale registered a Cronbach's alpha coefficient of 0.97. The same internal consistency was found in the post analysis with the responses of 133 school principals (α=.904). The analysis of psychometric quality of Measure Teachers Technology Use Scale was evaluated previously by the authors in another similar study, and a high internal consistency was found (α=.93) (Piedade, 2010; Pedro, 2011). The same internal consistency was found in the post analysis with the responses of 1,908 school teachers (α=.92).

In order to obtain answers from the greater number of school principals and teachers of the national public education, it was decided to invite the entire population of 831 schools. The probabilistic and simple random sample was organized with 133 school principals and 1,908 primary and secondary teachers in Portuguese public schools. The school principals were predominantly male (52.63%), who were between 51 and 60 years old (51.13%), had been teaching for more than 20 years (78.95%), and had more than 11 years of experience in school management activities (67.67%). The majority of the school principals have specialized certification in school management and administration (75.19%). The school teachers were mostly female (76.36), were between 41 and 50 years old (42.19%), and had been teaching for more than 21 years (57.66%) however 53.51% of them were teaching in the current school between 1 and 10 years.

According to the comparative analysis we organized a sub-group of the sample with 31 school principals and 572 schoolteachers. For that we considered only the school principals with more than 10 teachers responding from their school. The data were collected through the use of online survey systems, then organized in a spreadsheet and analysed through the use of different statistical procedures developed with IBM SPSS Statistic software (v.23).

Results

Taking into account the variables under analysis - self-efficacy in the use of technology and use of the DT in the professional practices of school principals and primary and secondary teachers – the results were organized in the following sub-sections: (a) level of proficiency and level of use technology in the each dimension of the school principals professional practices; (b) level of technology use in each dimension of the schoolteacher´s professional practices; and (c) comparative analysis crossing the results of the principals and the teachers.

Self-Efficacy and Use of DT by School Principals

By analyzing the scores of Table 1, it can be seen, in the level of proficiency variable, that school principals have a score of 3.95, which reveals a favorable sense of self-efficacy in technologies use, taking into consideration that the values of the scale rage between 1, indicating a reduced perception of self-efficacy, and 5, meaning a high perception of self-efficacy. In the same way, for the variable use of technology in professional practices, a score of 4.22 is presented, revealing a high level of use of technologies.

The results for the various dimensions of the DT use scale showed differences in the mean values registered in each dimension, although the data revealed favorable levels of utilization in all dimensions. It appears that the administration dimension has the highest score (M=4.45), revealing a strong use of technology in supporting of school management activities. In the opposite direction, the communication dimension presents the lowest score (M=3.98). The values registered in the standard deviation are near zero showing reduced variance in the participants' responses.

Table 1

Mean Values and Standard Deviation of Proficiency Level and Level of DT Use by School Principals (n=133)

Variables	Mean	Standard Deviation
Score of Proficiency	3.95	.48
Score of DT Use	4.22	.64
Dimensions		
1 – Communication	3.98	.66
2 – Planning	4.25	.72
3 – Meetings Promotion	4.13	.81
4 - Evaluation	4.23	.80
5 – Administrative Management	4.45	.81

Pearson correlation coefficient was calculated in order to explore the relationship between the proficiency level and the level of DT use in professional practices, in various dimensions, presented by school principals.

Table 2

Pearson Correlation Coefficient Between Variables Under Analyses (n=133)

	DT Use	1 Communication	2 Planning	3 Meetings Promoting	4 Evaluation	5 Administrative Management
Score of Proficiency	.33**	.27**	.39**	.30**	.31**	.19*
DT Use		.87**	.77**	.82**	.90**	.85**
1 Communication			.61**	.66**	.72**	.66**
2 Planning				.74**	.59**	.48**
3 Meetings Promoting					.61**	.52**
4 Evaluation						.83**

**Correlation is significant for α= .01
*Correlation is significant for α= .05

Observing the coefficients shown in Table 2, it appears that the variables are correlated positively and significantly (r=. 33). In the same way, it is also possible to find significant correlations between the scores of the DT use and with all the dimensions of the scale.

DT Use by Primary and Secondary Teachers

According the data organized in Table 3, it is possible to identify a high level of DT use by primary and secondary teachers in their teaching practices (M=4.31; SD=. 77). The analysis of the score of each dimension of the scale allows us to visualize different intensity of technologies use by teachers. Thus, the highest scores were in teaching preparation (M=4.53), teaching grading and assessment (M=4.17) and instruction activities (M=3.98). These results reveal a strong use of the technologies in activities related to the teaching planning, classroom instruction and students' grading and assessment. Contrarily, the lowest scores were in student products (M=2.20) and student use (M=2.83). The results in these dimensions express a limited use of technologies by students in their learning activities as well to support their learning products and outcomes.

Table 3

Mean Values and Standard Deviation of Level of DT Use by School Teachers (n=1908)

Variables	Mean	Standard Deviation
Score of DT Use	4.31	.77
Dimensions		
1 – Preparation	4.53	.66
2 – Professional email	3.48	.77
3 – Delivering Instruction	3.98	.95
4 – Accommodation	3.83	.92
5 – Student Use	2.83	1.08
6 – Student Products	2.20	1.06
7 – Grading	4.17	.91

Comparative Analysis of the School Principals' and Teachers' Results
In order to comparatively analyse the levels of self-efficacy and technology use by school principals and the level of technology use by school teachers the results were organized taking into account the data collected from 31 principals and 572 teachers.

The following table shows the technology use evidenced by a group of teachers in each of the 31 schools and the technology use and self-efficacy scores evidenced by each school principal.

Table 4

Comparative Analyses of Scores of School Principals and Teachers

School	n Teachers	Teachers Technology Use Score	School Principal Technology Use Score	School Principal Self-efficacy Score
School 1	10	3.31	3.76	4.44
School 2	19	3.17	3.52	3.59
School 3	12	3.67	4.52	4.15
School 4	10	3.46	4.14	3.63
School 5	27	3.58	4.67	3.52
School 6	14	3.46	2.05	4.11
School 7	21	4.13	4.48	4.04
School 8	12	3.54	4.52	3.67
School 9	22	3.67	3.76	3.74
School 10	23	3.42	4.71	4.67
School 11	13	3.71	4.33	3.93
School 12	15	3.50	4.10	3.74
School 13	17	3.38	5.00	4.26
School 14	15	3.67	4.76	2.56
School 15	14	3.69	4.19	4.26
School 16	13	3.58	4.05	3.26
School 17	22	3.04	4.33	4.63
School 18	16	3.31	4.10	3.89
School 19	18	3.44	4.86	3.85
School 20	20	3.21	4.71	4.85
School 21	29	3.54	3.86	3.63
School 22	39	3.42	4.10	4.44
School 23	24	3.98	4.71	3.67
School 24	14	3.61	4.57	3.89
School 25	23	3.38	4.33	3.89
School 26	41	3.46	2.33	2.33
School 27	12	3.34	4.62	4.63
School 28	14	3.86	3.76	3.74
School 29	11	3.75	4.67	3.44
School 30	12	3.88	4.33	4.15
School 31	20	3.52	3.62	3.96

In order to explore the relationship and the association between the variables under analyses the Pearson correlation coefficient was calculated and organized (see Table 5).

Table 5

Pearson Correlation Coefficient Between Variables Under Analyses

School Principal Self-efficacy Score					School Principal Technology Use Score	
	School	n Teachers	Pearson Coefficient	*Sig.*	Pearson Coefficient	*Sig.*
Teachers Technology Use Score	School 1	10	.19	.41	.46	.18
	School 2	19	.40	.09	.16	.52
	School 3	12	.35	.27	.18	.57
	School 4	10	.00	.99	.17	.40
	School 5	27	.35	.08	.18	.38
	School 6	14	.41	.14	.27	.35
	School 7	21	.34	.16	.32	.15
	School 8	12	.37	.25	.37	.23
	School 9	22	.23	.31	.13	.56
	School 10	23	.18	.36	.16	.39
	School 11	13	.14	.64	.01	.99
	School 12	15	.19	.47	.08	.98
	School 13	17	.17	.70	.21	.43
	School 14	15	.38	.16	.04	.90
	School 15	14	.13	.66	.07	.81
	School 16	13	.10	.75	.01	.98
	School 17	22	.11	.62	.06	.78
	School 18	16	.18	.65	.09	.73
	School 19	18	.19	.56	.10	.70
	School 20	20	.51*	.02	.11	.65
	School 21	29	.19	.34	.18	.35
	School 22	39	.24	.30	-.07	.66
	School 23	24	.10	.65	.05	.80
	School 24	14	.51	.09	.46	.09
	School 25	23	.25	.31	.23	.29
	School 26	41	.24	.14	.24	.14
	School 27	12	.49	.09	.39	.21
	School 28	14	.30	.30	.25	.39
	School 29	11	.34	.30	.06	.86
	School 30	12	.38	.22	.17	.60
	School 31	20	.39	.19	.15	.54

*Correlation is significant for α= .05

Observing the Pearson coefficients shown in Table 5 it is not possible to identify significant correlations between the variables. Only in school 20 is it possible to identify a moderate correlation between the teachers' technology use and the school principal's self-efficacy.

In order to identify patterns of similarity between the schools, an exploratory cluster analysis was performed taking into account the *nearest neighbor* technique. Before the clusters were defined, ANOVA statistical analysis was performed between the score of technologies use by the teachers and the score of proficiency of the school principal (F = 2.24, sig = .002) and between the score of technologies use by the teachers and the score of technologies use by principals (F = 1.52, sig = .38). According to ANOVA results, it was possible to create clusters of schools considering the proficiency score presented by the school principals because only this variable showed statistical significance. Three clusters of schools, presented in Table 6, were identified based on the self-efficacy score of the principals and schoolteachers' technology use score: (a) a cluster of schools with lower levels of self-efficacy presented by the principal as well lower levels os technology use by school teachers; (b) a cluster of schools with moderate levels of self-efficacy presented by the principal as well moderate levels of technology use by teachers; and (c) a cluster of schools with high levels of self-efficacy presented by the principal as well high levels of technology use by schoolteachers.

Table 6

Clusters Analysis Based on Self-Efficacy Score of School Principals and Technology Use Score of School Teachers

School	n	Subset for alpha = 0.05		
		1	2	3
School 26	41	-1.18		
School 14	15	-1.170		
School 16	13	-.45		
School 29	11		-.23	
School 23	24		-.07	
School 5	27		-.06	
School 8	12		-.05	
School 7	21		-.01	
School 11	13		.02	
School 21	29		.13	
School 24	14		.23	
School 9	22		.23	
School 12	15		.25	
School 31	20		.29	
School 4	10		.30	
School 2	19		.33	
School 30	12		.35	
School 19	18		.36	
School 18	16		.44	
School 25	23		.45	
School 3	12			
School 27	12			
School 15	14			

School	n	Subset for alpha = 0.05		
		1	2	3
School 28	14			
School 6	14			
School 13	17			
School 22	39			
School 1	10			1.18
School 10	23			1.29
School 17	22			1.54
School 20	20			1.61
Sig.		**.19**	**.34**	**.87**

Discussion and Conclusions

This study aimed to analyse the levels of proficiency and use of DT by principals in their professional practices. It also sought to analyse the level of DT use by primary and secondary teachers in their teaching activities and practices.

The results indicate that school principals have favorable levels of self-efficacy and DT use in several dimensions of their professional activity.

The analysis of the correlation between proficiency level and the DT use revealed that the variables are significantly correlated. The variable association revealed to be positive and significant between proficiency level and all dimensions of DT use scale. Thereby, we can infer that the level of self-efficacy is directly related to the ability to use technology in several dimensions of a principal's daily practices.

Taking into consideration the results of teachers' DT use it was possible to identify a favorable level of use in teachers' professional practices, in particular in planning activities, delivering instruction and students' grading and assessment. In contrast the results showed a lower level of DT to support de students' learning activities and products in the classroom.

The study also intended to analyse comparatively the levels of DT use by school principals and by school teachers to try find a possible relationship between the constructs. The comparative analysis did not find a statistically significant association between the variables. However, it was possible to create three clusters of schools based based on the self-efficacy score of principals' and school teachers' technology use score. In order to examine in more detail the relationship between digital technologies by principals and by teachers and understand how these variables relate to each other, it will be important to observe and analyse each school context in particular.

Through its exploratory nature, this study presented relevant results that need to be consubstantiated by more national and international studies where the role of school principals in innovation processes and DT integration in their schools is continually and deeply addressed.

Methodological Limitations and Future Work

The option of a quantitative study with a descriptive, exploratory and correlational nature - in which a set of variables is defined and statistical relationships are explored - implies the loss of some capacity for deeper, detailed and contextualized analysis when compared with a qualitative and naturalist approach.

The use of self-report scales presents as a limitation the fact that they do not measure effective use of digital technologies by participants but rather their personal beliefs and perceptions, about their practices.

An awareness of the limitations evidenced in the quantitative studies, was balanced by the premise that they could be overcome by the objectivity and the procedural and scientific accuracy associated with the quantitative and rationalist studies.

Although we can not affirm that the study is representative of the populations under analysis, school directors and teachers of the national public education, namely by the size of one of the samples (16% of the directors and 1.5% of the teachers), the results can be somewhat generalized to populations with the same characteristics based on the randomness of both samples.

Taking to account the main results and some of methodological limitations of the study it's important to define some lines of future research. First, it's important to develop new research about digital technologies use by school principals applying the use scale created in the present study. The results obtained in new studies will allow establishing comparisons with the results and conclusions presented in this study, validating them (or contradicting them), and will contribute to improve the metric quality of the scale. Second, it is also important to analyse what specific actions and programs are promoted by school principals in their schools in order to facilitate and improve the effective use of technologies by teachers and students. Third, it is relevant to try to find a possible relationship between style of school principals' leadership (transformational and transactional) and digital technologies use in schools by teachers and students.

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BACK TO CONTENTS

THE INDIVIDUAL INNOVATIVENESS THEORY: A FRAMEWORK TO INVESTIGATE TEACHERS' VIEWS ON TECHNOLOGY

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Abstract

This paper has two objectives: to briefly describe the Individual Innovativeness Theory and the five adopter categories and to show how it was used in a mixed methods study that investigated the integration of technology in the classroom of Modern Languages courses in the state of Paraná, Brazil. The theory was used to select participants for the qualitative phase. Results showed that by focusing on the adopter categories it is possible to establish new strategies to improve technology integration in the classrooms and long-term planning. They provided a good starting point to understand teachers and their relationship with technology.

Introduction

Several researchers have been studying the impact of technology and its relationship with education (Lawless & Pellegrino, 2007; Zhen, 2008). Higher education institutions, especially in developed countries, regularly use information and communication technologies (ICT) in their courses (Anderson, Varnenhagen, & Campbell, 1998; Zhen, 2008). Educational institutions have made high investments in technology (Zayim, Yildirim & Saka, 2006).

The impact of technology on teaching and learning has been perceived in all fields of teaching and numerous evidences and works show the potential benefits to the teachers who carefully integrate it in their classrooms. Consequently, the integration and use of technology has been the goal of many educational institutions (Zhen, 2008).

Since the early 1980s computers have been expected to transform traditional education. However, despite the potential of technology and all the research and evidence that it is being increasingly used by teachers, (Lawless & Pellegrino, 2010) the diffusion of technological innovations for teaching and learning has not been generalized or deeply integrated by the curricula (Zayim et al., 2006).

More than three decades later transformations in educational practices have not yet taken place, and the fact that integration did not happen in the expected way is one of the mysteries of contemporary educational practice (Karasavvidis, 2009). Technology integration in education is still a problem with no definitive answer.

There are many reasons why innovative technologies have not been widely integrated into teaching: lack of equipment, of technical support for teachers, of training, of accessible models for change to take place, of funds from the institutions, of time; technology problems; and resistance to change by teachers; among others (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Karasavvidis, 2009; Vrasidas & Glass, 2007).

Despite the several reasons mentioned, the key factor pointed out by several researches, is the teacher (Chen, 2008; Zayim et al., 2006). The teacher is the guardian of technology, the one who not only determines what goes into his or her classroom, but also who is responsible for how it is used in the classroom (Zhao & Tella, 2002). This does not mean that the teacher is responsible for the lack of success in implementing changes in education. That would be a simplistic way of approaching the issue. However, the perspective of this professional has proven to be valuable for studies that focus on integration and seek a deeper understanding of the phenomenon.

The teacher's decision to integrate or not technology, in turn, is also affected by several factors: age, teacher education, attitudes, beliefs, among others. Understanding teachers' relationship with technology is, for this reason, in many senses, one of the keys to understanding technology adoption.

Although the Foreign Language (FL) teaching area is one of the only areas of study that has a specific field to study its relationship with technology – Computer Assisted Language Learning (CALL) – the situation is not different from other areas in education, and integration has not occurred as expected. In general, technology is of secondary importance in classroom settings, being used to provide additional activities or complement instruction. True and meaningful integration is still in its early stages in several educational institutions (O'Bryan & Hegelheimer, 2007).

CALL/ Technology is still an innovation in the language area in various contexts and for language teachers in several parts of the world (Carless, 2013; Van den Branden, 2009). This is the situation in different settings in Brazil, where the integration of CALL remains at the very beginning stages (Barsotti & Martins, 2011) in many parts of the country[1].

A mixed methods study was then conducted to investigate technology integration in the classroom of Modern Languages courses in the state of Paraná, Brazil. The objective was to analyse the factors that determine technology integration from the point of view of teachers and in the context of higher education. The focus was on this specific group due to the central role they play in the education of future language teachers.

It is important to mention that there are no specific or comprehensive frameworks or models in the CALL field to study the integration of technology in the classroom by FL teachers (Hong, 2009).

This paper will briefly describe this study and its main results. Then, it will focus on Rogers' (1995) Diffusion of Innovations Theory and its sub-theory the Individual Innovativeness Theory that was used to select participants for the qualitative phase of the study. The use of this theory proved to be useful to develop new strategies to improve technology integration in the classrooms and long-term planning.

The Study

Since integration is a complex issue, the option was for a mixed methods study that would provide a comprehensive picture of all the questions approached and a deeper understanding of the teachers' views. Rogers' Diffusion of Innovations Theory (1995) and Hong's Spherical Model of L2 Teachers' Integration of CALL Technology into the Classroom (2009) were the theoretical and analytical models that respectively guided the research. Hong's model considers that there are three sets of factors that represent the essence of this integration: CALL technology education, teachers' individual factors and contextual factors.

This mixed methods study adopted a sequential explanatory design that consisted of two distinct phases: a first phase with a quantitative approach and a second phase with a qualitative approach. The final inferences were made from the results of both phases of the study. Analytically, the use of technology in the classroom was not considered a unitary construct, but rather multifaceted. Contextually, different educational institutions, not just one or two universities, were investigated. The purpose was to avoid methodological, analytical and contextual constraints commonly found in studies on the integration of CALL.

For the first quantitative phase a questionnaire was developed to collect data. The instrument was validated by a panel of experts, tested in a pilot study and, finally, applied to a sample of 152 teachers from 33 Modern Languages courses from public and private institutions throughout the state of Paraná. Statistical analyses were performed to examine the relationship between the three sets of factors from Hong's Spherical Model and the multifaceted uses of technology by the teachers of undergraduate language courses in Paraná.

The results concerning technology identified four different uses: (1) Technology for Delivering Instruction (TDI); (2) Technology for Class Preparation (TCP); (3) Teacher-directed Student use of Technology to Perform Tasks (STPT); and (4) Teacher-directed Student use of Technology during Class Time (STCT). Results also showed the influences of individual factors, contextual factors and prior CALL/ICT education on the uses of technology. Individual factors and contextual factors were identified as important predictors of CALL/ICT integration.

Participants were then selected for the qualitative phase according to the results of the quantitative phase and to Rogers' Individual Innovativeness Theory. Sixteen semi-structured individual interviews were conducted. The qualitative phase deepened the quantitative results and explained the unexpected results and the results that could not be answered in the quantitative phase.

The integration of the results showed that in addition to individual and contextual factors, apparently prior CALL/ICT education should not be dismissed as a predictor of CALL/ICT integration. It was also possible to provide a clearer picture of CALL in the Modern Languages courses in the state of Paraná.

This research on the integration of CALL in the Brazilian context sought to contribute to a broader understanding of CALL and to show ways for integration to take place in other contexts. In the next sections Rogers' (1995) Diffusion of Innovations Theory will be explained as well as the Individual Innovativeness Theory.

The Diffusion of Innovations Theory

Rogers' (1995) Diffusion of Innovations Theory is one of the main theories that try to explain the process of change and the adoption of innovations in several fields and professions (Anderson et al., 1998; Stanley, 2012). Various authors recognize it as the most comprehensive work in the area, and it has been extensively used as a theoretical framework in studies on innovations (Albirini, 2004; Keengwe, Kidd, & Kyei-Blankson, 2009).

Rogers (1995) defines diffusion as "the process by which an innovation is communicated through certain channels over time among members of a social system" (p.10). According to the author, there are then four main elements in the diffusion of innovations:

1. The innovation – "An idea, practice, or object that is perceived as new by an individual or other unit of adoption." (p.11).
2. A communication channel – "The means by which messages get from one individual to another" (p.18).
3. Time – This refers to the innovation decision process (from knowledge to adoption or rejection), to the innovativeness of the individual (how early or late he will adopt the innovation), and also to the innovation's rate of adoption.
4. The social system – The social context where innovation diffuses.

An innovation then is related to the perception of the user. This is what decides the newness of an innovation. As to communication channels, studies show that most individuals rely on the opinion of near peers who have adopted the innovation rather than on the opinion of experts. Thus, diffusion is a social practice.

Rogers' (1995) Diffusion of Innovations Theory is made up of several sub-theories or interrelated theories. Each of them focuses on an aspect of the diffusion process. According to Albirini (2004) and Surry (1997), the most widely used of them are:

1. The Innovation Decision Process Theory
2. The Individual Innovativeness Theory
3. The Rate of Adoption Theory
4. The Perceived Attributes Theory

The Individual Innovativeness Theory
According to this theory, some individuals are more innovative than others and for this reason will adopt an innovation earlier than the majority of the group. That is, some individuals have more or less of innovativeness than others. It is a continuous variable that is separated into categories, essentially a conceptual design. Rogers (1995) states that there are five adopter categories: (1) innovators, (2) early adopters, (3) early majority, (4) late majority, and (5) laggards. The values and the dominant characteristics of each category, according to Rogers (1995), are summarized below:

1. Innovator (venturesome)
   - Adventurous, eager for new ideas, risk taker.
   - Controls considerable amount of financial resources to absorb possible losses due to unprofitable innovations.
   - Disposition to accept occasional setbacks when an innovation is unsuccessful.
   - Ability to understand and apply complex technical knowledge.
   - Capacity to deal with a high degree of uncertainty about an innovation.
   - Plays an important role in the diffusion process: launches the new idea in the system.
   - Gatekeeping role in the flow of new ideas.
2. Early adopter (respect)
   - More integrated part of the local system: localities.
   - Greatest degree of opinion leadership in most systems.
   - Speeds the diffusion process.
   - Not too far ahead of the average individual in innovativeness: serves as a role model.
   - Embodies successful use of new ideas.
   - Makes judicious innovation-decisions.
3. Early majority (deliberate)
   - Adopts new ideas just before the average member of a system.
   - Interacts frequently with peers.
   - Rarely holds positions of opinion leadership in a system.
   - Important link between the very early and the relatively late in adoption.
   - Relatively longer innovation-decision period than the innovator and the early adopter.
4. Late majority (skeptical)
   - Adopts new ideas just after the average member of a system.
   - Adoption is the result of economic necessity and/or pressure from peers.
   - Approaches innovation skeptically and cautiously.
   - Adopts only when most others have adopted an innovation.
   - Adoption only happens when uncertainty is removed, has to feel safe.
5. Laggard (traditional)
   - The last to adopt an innovation.
   - No opinion or leadership.

- The most localite.
- The reference is the past.
- Interacts primarily with others who also have relatively traditional values.
- Suspicious of innovations and change agents.
- Relatively lengthy innovation-decision process;
- Rational resistance to innovations: limited resources.

These categories are based on abstractions from empirical investigation. They are ideal types, that is, conceptualizations (Rogers, 1995). The innovativeness continuum cannot be broken into clear parts and exceptions can be found. However, the summary above gives a useful starting point to make a distinction between adopters using Rogers' (1995) categories. In diffusion research Rogers' method of adopter categorization is the most widely used (Mahajan, Muller, & Srivastava, 1990; Rogers, 1995). Although some information is lost by grouping individuals, its main advantage is that it is a simplification that helps the understanding of teachers' behavior.

Adopter categorization based on innovativeness. Considering an adopter population, the distribution of the five categories population typically follows the well-known bell-shaped curve. Adoption is plotted over time on a frequency basis (Rogers, 1995). By using a diffusion curve it is possible to compare the innovativeness of an individual with other members of a system. According to several authors (Butler & Sellbom, 2002; Mahajan, et al., 1990; Rogers, 1995; Wilson, Sherry, Dobrovolny, Batty, & Ryder, 2001), the spread of each category is approximately as follows:

- Innovators: 2 – 3%
- Early Adopters: 13 – 14%
- Early Majority: 34%
- Late Majority: 34%
- Laggards: 16%

The use of adopter categories relies on labels, and this can be problematic. However, they are also powerful markers of meaning (Wilson et al., 2001). Rogers' (1995) classification model based on innovativeness to describe the adoption patterns of individuals in a group has a series of advantages. Mahajan, et al. (1990) highlight the following: ease of use; it offers mutually exclusive and exhaustive standardized categories, by which results can be compared, replicated, and generalized across studies; and because the underlying distribution is assumed to be normal, continued acceptance of an innovation can be predicted and linked to the adopter categories.

According to Wilson et al. (2001), "The idea that people fall on a receptivity continuum seems to have some empirical support, and can help us think about adoption in terms of meeting individuals' needs" (p. 299). The adopter categories can also be used for *audience segmentation*, "a strategy in which different communication channels or messages are used with each sub audience" (Rogers, 1995, p. 275). And this is another valuable aspect of this categorization.

How the Individual Innovativeness Theory Was Used in the Study
To classify respondents into the five categories the individual innovativeness scoring procedure developed by Anderson, et al. (1998) was used. The data that teachers provided for Part 3 of the questionnaire (Digital Literacy) was used, and a composite score was calculated for innovativeness by summing the level of self-reported expertise indicated for each of the 26 statements of that section. All the 26 items started with "I can ..." and the possible answers were 1 for totally disagree, 2 for disagree, 3 for does not agree or disagree, 4 for agree, and 5 for totally agree.

The presumption was that for an individual to "totally agree" with his/her expertise with a certain tool, it probably meant that he/she adopted this tool relatively earlier than an individual who rated his/her knowledge of use of a certain tool as "totally disagree." The total possible cumulative score for innovativeness was 130 and the lowest was 26. Sample scores ranged from 39 to 130, and when plotted resembled an S-shaped curve which lent confidence to the assumption of normality. Nevertheless, the Anderson-Darling test was also used to verify the normality, and the result showed that the distribution was normal.

Rogers' (1995) adopter categories and individual innovativeness scores were used to classify how many of the sample were innovators, early adopters, early majority, late majority and laggards. The statistical procedures were applied to the total score. The percentages of each category were applied to the number of participants and the results were the following:

- Innovators – 3% (n=4) – the teachers who had the highest scores in the summative scale
- Early Adopters – 14% (n = 21)
- Early Majority – 34% (n = 51)
- Late Majority – 34% (n = 52)
- Laggards – 16% (n = 24) – the teachers who had the lowest scores in the summative scale

Based on the distribution of the participants into these categories, 16 teachers were selected to participate in the second phase of the research, the qualitative phase. In addition to the criterion of individual innovativeness, it was also necessary that the teacher volunteered to participate in the second phase when he or she answered the questionnaire in the first phase.

The final sample consisted of 16 teachers. In total, 16 interviews were conducted with: 1 Innovator, 2 Early Adopters, 5 teachers of the Early Majority category, 4 teachers of the Late Majority category and 4 Laggards. The attempt was to maintain a proportion similar to that of the theory, but the focus was to listen to the voice of the majority – the mainstream faculty (Geoghegan, 1994) – that is composed of members of the Early Majority, Late Majority and Laggards. Teachers from 12 different educational institutions (3 private, 2 federal (public) and 7 state (public) were interviewed. They were located in 8 cities in the state of Paraná: 4 teachers from the capital and the rest from 7 cities in the countryside. In 3 institutions there was the case of 2 teachers from different categories of adopters.

Results

The use of the Rogers (1995) adopter categorization showed that it was possible to observe patterns in the CALL integration process in the context of the study. Individual initiatives that promote the use of technology were observed mainly in two participants, one from the Innovators category and another from the Early Adopters category. They stood out from the others in terms of the uses they made of technology and the perceptions they had of this dimension. A third participant in the Early Adopters category also showed characteristics of this category, but time constraints affected the integration of CALL in his/her practice. Rogers (1995) explains that there is a tendency to reverse the adoption process if explicit difficulties arise.

The four respondents in the Laggards category showed several traits of this group, but in one case it was possible to see how the influence of another teacher affected this categorization. According to Rogers (1995), diffusion occurs over time, but the system has a direct effect on diffusion through its norms and other qualities and also indirect influence through its individual members, which was what occurred in one of the institutions. Participant E10 (Innovator) exerted influence on the other professors of his/her institution encouraging the use of technology by the other professors of the Modern Languages course, including participant E4 (Laggard). This participant showed that he is probably no longer in the category in which he was categorized when he answered the questionnaire.

As for the participants in the Early Majority and Late Majority categories, it was also possible to observe several dominant characteristics of each category. However, it was noticed that at least one respondent in each category did not exactly fit into that category. But Rogers's categories of adopters (1995) are ideal types and the author explains that exceptions are found and there are also no clear boundaries between the five categories.

The context, however, can also affect categorization, as participant E7 explained. According to him/her, his/her questionnaire responses were given when he/she worked in an institution that had many technological resources, completely different from the institution at the moment of the interview. He/She believes that this affected his/her responses and if questioned then he/she might have been ranked in a different category, probably a less innovative one.

The use of Rogers's Theory of Diffusion of Innovations (1995) and its sub-theories in the study was not to accurately determine the categorization of the participants or to determine the factors affecting the integration of technology, but rather to have a better understanding of this process based on the characteristics of the teachers interviewed in the qualitative phase.

However, it was possible to perceive the presence of some dominant characteristics of these categories in the participants. And it was also possible to relate the four uses of technology to the five categories. The Innovators and the Early Adopters were those that showed more involvement and more frequent uses of the four dimensions. They were exceptions when compared to the other participants. Despite one exception or another, the voice of the majority, that is, the Early Majority, the Late Majority and the Laggards, showed to be convergent, and they corroborated the results of the first phase.

It was possible to observe that the individual characteristics of the adopter categories can be used to focus on how to improve and integrate the uses of the four dimensions of technology. Adopters from each category have different characteristics and different needs when integrating technology. The biggest differences are noticed in the extremes of individual innovativeness, and it is necessary, therefore, to have different approaches to meet the needs of each group.

Final Remarks

By using Rogers' Theory of Innovation Diffusion (1995) in the analysis and interpretation of the results it was possible to see that the degree of individual innovativeness generates standards in the process of CALL/ technology integration. It was also possible to outline some of the individual characteristics of teachers in relation to technology.

The initial intention was not to determine the characteristics of the adopters in detail. However, when we noticed that these characteristics could be observed and categorized, it was seen that it is possible to focus on specific strategies to deal with each group and to meet their needs in relation to technology use, thus increasing its integration. In addition, it is possible to anticipate and focus on specific groups.

One of these strategies is related to the so-called technological climate of institutions (overall teachers' technology education, i.e., the total number of hours that the FL teachers devoted to courses and workshops during their pre- and in-service period divided by the number of teachers in each school).

The report of the influence of the Innovator in one of the institutions showed the importance of the technological climate (Hong, 2009) in the context of the study. Universities or course departments could identify the Innovators and Early Adopters so that their motivation and abilities would influence other language teachers and changes could occur. But this should not be the only strategy since it is very fragile. The example of one of the participants who, because of lack of time could not make greater use of technology, endorses this. But, together with other procedures, it can help a more effective integration of technology.

The responsibility for integrating technology, then, should not be only the teachers', even if they are Innovators or Early Adopters. Institutions should provide conditions for teachers to work using technology, and this includes not only infrastructure, but also time. The first steps to integration can begin in the departments, but the joint movement of departments, teachers and institutions in general is likely to be more successful than individual initiatives.

By explaining how the Individual Innovativeness Theory was used in the study, the objective was to offer another possible framework to investigate teachers' views on technology. And thus establish new strategies to try to make technology integration a more effective process. The theory provided a good starting point to understand teachers and their relationship with technology and showed that it can provide a theoretical foundation for the field. However, future research could focus in the development of a specific instrument that could be used to measure individual innovativeness, one that could be adopted in different contexts.

Note

1. It is important to point out that this is not the situation in the whole country and changes have taken place since research was conducted. Brazil is a nation of contrasts due to its size and social and economic reasons; however, it is not the objective here to explain such an ambiguous scenario.

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LEADING FOR DIGITALIZATION: EXPLORING THE LEADERSHIP PERSPECTIVE

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Abstract

This paper focuses on how school leaders understand digitalization and the digital competences needed for leading digitalization in Swedish schools. In this small study, 31 school leaders at the end of their studies in the Swedish national professional development program for school leaders answered a survey, mainly based on open questions, regarding professional development and leadership for digitalization. In the analysis, Dexter's four categories of (a) setting the direction, (b) developing people, (c) developing the organization, and (d) developing teaching and learning, were used to bring order in the data. The results show that school leaders see digitalization as a wide and complex concept including technical, pedagogical, administrational and organizational challenges at all levels of the school organization.

Introduction

There has been a rapid growth of digital technologies in today's knowledge society (Selwyn & Facer, 2014). However, they have been slower to gain foothold in schools (Livingstone, 2012). In recent years, Swedish schools have invested heavily in digitalization, e.g., 1:1, laptops and Information and Communication Technology (ICT) systems (Håkansson Lindqvist, 2015; Hansson, 2013; Grönlund, 2014; Grönlund, Andersson, & Wiklund, 2014). Despite this, how these efforts have affected teaching and learning continues to be somewhat vague (National Agency for Education, 2009, 2013, 2016).

Every third year the National Agency for Education (2009, 2013, 2016) evaluates the implementation and use of digital technologies and digital competences in Swedish schools. In the reports from 2009 and 2013, results showed that investments and access to digital technologies have increased while pedagogical development and digital competences appear to have fallen behind (2009, 2013; see also the Swedish Schools Inspectorate, 2012). According to such results, the report also points at the need for a strategic leadership for promoting the uptake and use of digital technologies (National Agency for Education, 2009, 2013).

In 2016, the National Agency for Education reported on similar conclusions, pointing out a necessity for professional development in the area of digitalization for all levels of Swedish schools. Here, the role of the school leader and the schools leader's competence to strategically lead for digitalization and pedagogical development appears to be a key factor. Moreover, although the number of school leaders who report having sufficient digital competence to lead the strategic work with digital technologies had increased since 2009, one third of all school leaders stated that they do not have sufficient skills (National Agency for Education, 2016). Thus, there appears to be a need for supporting school leaders' strategic work with digitalization.

At the same time, studies on school leadership and digitalization conducted in the Swedish context seems to be few (Håkansson Lindqvist, 2015). The few studies at hand, contribute to the idea that the leadership is important for the strategic implementation of digital technologies for teaching and learning in Swedish schools (Petersen, 2014, 2016; Svensson, 2015). Here, there appears to be an emerging need for professional development of school leaders' digital competence for leading digitalization in schools (cf. Grönlund et al., 2014; Håkansson Lindqvist, 2015; Hylén, 2011; Pettersson, 2017), as well as for further research on the school leader perspective on digitalization in school.

With this short backdrop, the aim of this paper is to explore how school leaders understand digitalization and digital competences needed for leading digitalization in Swedish schools. The following research questions are posted:

- How do school leaders understand what is meant by digitalization in their profession as school leaders?
- What professional development seems to be needed to support the work in leading for digitalization?

The Swedish Context

In order to adapt the education system to the requirements of the digitalized knowledge society, national efforts for promoting the uptake and use of ICT in Swedish schools have been implemented for many years (see Håkansson Lindqvist, 2015; Jedeskog, 2007; Tallvid, 2015). Despite a long history of efforts in ICT in Swedish schools, the first political proposal for supporting strategic leadership for leading for digitalization in schools was presented in 2002 (Ministry of Education, 2002). These efforts have involved a variety of new challenges in all levels of the school system. Recent reports show that while accessibility to technology in Swedish schools is said to be good, the technology is not being used as expected (National Agency for Education, 2103). Thus, proposals to strengthen digitalization in schools were further articulated in the Swedish National IT-strategy (The Committee for Digitalization, 2014) and National digitalization strategy for schools (Swedish Government, 2017) in the terms of *adequate digital competence*. While the role of the school leader has been seen to be important for the digitalization of schools, the focus and efforts in supporting this work have fallen behind in relation to digitalization. Therefore, in line with the new policy documents, a national effort in professional development in leading for digitalization has been implemented by the National Agency of Education.

Leading Digitalization (*Leda Digitalisering*) (National Agency for Education, 2018a) is one of several national school development programs in Sweden. The program is directed to school leaders and school organizers who are interested in gaining more knowledge in what digitalization can lead to for the organization, the school and teaching. The program aims to increase skills in leading for digitalization in the organization and for those who recognize digitalization as an area of development for the organization, using collegial professional development as a process to support this work. The aim of the module is to map one's own organization's strengths and when complete to have an elaborated and established development plan on the school or school organization level. The module provides increased knowledge and competence about the possibilities of digitalization to support school development and more efficient administration, and to develop and strengthen the learning environment for students.

Leadership in the Midst of Digitalization

In international research, strategic digital leadership has been in focus related to the school leader's responsibility of leading for digitalization and the importance of the role of the school leader. According to Sheppard and Brown (2013), this role can either facilitate or impede complex change. McLeod, Bathon and Richardson (2011) describe the intersection of school leadership and digital technology as using technology to teach and involving the traditional content of educational leadership. Williams (2008) emphasizes the role of school leaders at a time of rapid growth of digital technologies. Dexter (2008) describes the role of the school leader as vital for students' digital competence. Overall, the most important issue in the digitalization in schools is said to be the presence of informed and effective school leaders (Dexter, 2008).

In their study, Leithwood and Riehl (2003, 2005; see also Leithwood & Jantzi, 2006) argue that a successful school leadership includes four functions and processes. These functions are related to (a) *setting the direction* including goals, norms and vision, (b) *developing people* including educational support, supportive learning environments and development of learning cultures, (c) *developing the organization* including organizational infrastructures that support learning and development, and (d) *developing teaching and learning* including structures for pedagogical development. Part of these four functions and processes is the formulation of goals and how goals are being put into actions and activities that can drive organizational and educational change and development (Leithwood & Jantzi, 2006; Petersen, 2014).

Over the years, there have been attempts to re-conceptualize Leithwood and Riehl's framework (2003, 2005) to be used in a digitalized context, for example, as for understanding aspects of ICT leadership (Dexter 2008; Petersen, 2014) and the development ICT policies in school and education (Vanderlinde, Dexter, & van Braak, 2012). Re-conceptualization of the four categories has also enabled the analysis of strategic digital school leadership as a means for taking advantage of digitalization and educational change in schools (Dexter 2008; Petersen, 2014).

In this study, these four categories will be used to analyze aspects related to leading for digitalization. Specifically, they will be used to understand not only what is meant by digitalization to school leaders, but also what professional development seems to be needed to support the work in leading for digitalization.

Method

The data used in this pilot study were gathered through a survey answered by 31 school leaders at the end of their studies in the Swedish national professional development program for school leaders. The National School Leaders' Training Programme (Rektorsprogrammet) is a national program on an advanced academic level, which provides new knowledge and networking opportunities and initiates school development processes. The studies comprise 30 ECTS over a period of three years and are mandatory for all newly employed school leaders as of March 15, 2010 (National Agency for Education, 2018b).

The survey, mainly based on open-ended questions, considered if the school leaders were participating in a program for leadership for digitalization, what digitalization meant for them in their profession as school leaders as well as what professional development they felt would support the work in leading for digitalization. The school leaders were also asked if they were familiar with or were participating in the National Agency for Education's module *Leading Digitalization*. In the analysis, data in the form of free text comments were coded and categorized according to the method of Hjerm and Lindgren (2010). In the first step text and sentences were coded by giving them names and notes describing the content. Thereafter, codes were analysed and placed into categories of meaning according to Dexter's (2008) four categories: *setting the direction, developing people*, *developing the organization,* and *developing teaching and learning*. The school leaders' comments are reported as School Leader and number, (*SL1-SL32*).

Results

In this section, the school leaders' understanding of digitalization and digital competences needed for leading digitalization will be presented according to Dexter's (2008) four categories: *setting the direction, developing people*, *developing the organization,* and *developing teaching and learning*.

Setting the Direction

The school leaders' comments in this category create a picture of digitalization as a complex area, which in turn makes leading for digitalization complex. For the school leaders, digitalization covers a broad number of different themes in which they are responsible for initiating, implementing, maintaining, documenting and leading for digitalization. In this category, three subthemes are found: *teaching for the future, more efficient school organization and leading for digitalization.*

The school leaders see the importance of digitalization for preparing students for the future: "That we prepare the students for technology in the information society and how they can use it in the best way" (SL6). This involves using digital tools for developing teaching for students and "supporting all students despite their difficulties" (SL7). One school leader expressed this responsibility: "That I am responsible for developing and leading the work with digitalization for both students and teachers" (SL5). More efficient school administration is expressed as “finding efficiency/critical review of what we do on the intranet for achieving sustainable management of documentation” (SL9) and “less paper, maybe faster work” (SL10). This also involves implementing digital tools for “pedagogical documentation, pedagogical planning, etc.” (SL28).

For the school leaders, leading for digitalization involve school development “to drive school development… to work for the school of the future” (SL25). Here, the school leaders also see that the work with digitalization is closely intertwined with digitalization as expressed in steering documents and course plans. One school leader expressed this as: “Seeing that the school works with the digitalization [aspects] which are necessary. Programming is only one small part of digitalization; there are many other aspects as well. The students must learn to use digital tools in all their subjects” (SL32). School leaders also express the need for “more knowledge about the steering documents” (SL21). One school leader, for example, sees the need for this knowledge for the continued work in the school: “I need to gain knowledge about what this means and how we can plan the implementation at the school” (SL24).

Developing People

In this category, developing people, the school leaders’ survey comments are related to the need for professional development that is needed for both the school leaders themselves as well as for the teachers in the schools. The subthemes in this category are: *professional development for leading for digitalization* and *professional development for teachers*.

In regard to their own professional development 20 (64 %) of the school leaders, involved in this study knew of the National Agency for Education’s module *Leading Digitalization*. The remaining 12 (27 %) were not familiar with the module. For those participating, the working with the module is seen as a form of professional development in leading for digitalization. This module was seen to be supportive: ”[I] am studying with the National Agency for Education, their module, which I think is a good base for me to implement this [digitalization] in my schools” (SL7), and ” I think that the National Agency for Education’s material on digitalization is going to help me” (SL24).

Many of the school leaders also noted the importance of deep knowledge in the steering documents and course plans as a necessary form of professional development. This was often related to their own needs for professional development: “professional development in the new knowledge requirements” (SL14), as well as the need to “update myself in the new knowledge requirements in the courses that have been changed” (SL18). Another school leader expressed the need for more personal knowledge from an educational perspective as well as from the student perspective: “more digital competence about education as well as the student’s view of digitalization” *(*SL6). Another school leader expressed the need for professional development in digitalization itself: “in order to lead digitalization, I must have knowledge about the concept” (SL2) as well as what digitalization would mean for “teachers’ work, technology, functions, etc., at the school” (SL23). Although most school leaders see a need for professional development, a few of them are not clear about what professional development is needed, e.g., "don't know" (SL3). One school leader expressed not seeing "any need at this point in time" (SL11).

For the school leaders, another important aspect of professional development is the need to provide good conditions in digitalization for teachers. Teachers need to deepen their competence in order to develop new forms of teaching and learning which comprise digitalization. One school leader commented upon digital competence and the "courage" (SL19) to use digital tools for his/her own use and in turn for teacher' use. This school leader also found that, while there is strong technical development, "method and pedagogy were behind" (SL1) and therefore the need for professional development for teachers. The school leaders also see "basic digital skills" (SL27) as important. It is important that the teachers receive "the right professional development based on their level of knowledge" (SL30). According to the school leaders, teachers need support to "see the advantages and adapt their work methods" (SL26). This involves seeing the possibilities of digitalization. One school leader explains digitalization as a resource: "Digitalization is a hidden resource in school and must begin to be used to its full potential" (SL25).

Developing the Organization

In this category, developing the organization, several subthemes were seen: *accessibility, new technology, administration* and *forms for sharing*. One central aspect, which is evident in this as seen in the school leaders' comments, is access to technology as a resource.

Accessibility to technology is seen as important for developing the organization: "That computers and other ICT-tools are necessary tool for teachers and students" (SL3). Here, the school leaders mean that accessibility is important for compensation: "Compensating children and families who do not have technology at home" (SL31). Accessibility to technology is also found to be important from the perspective of equity. According to one school leader this is construed as: "All teachers and students have the same basic foundation. Those who want to get a bit further must have the possibility to do so" (SL12).

Beyond accessibility, new technology is also seen as an important condition for developing the organization. New tools are necessary: "Tools to facilitate meetings, not necessarily physical meetings. Platforms for information and dialogue, joint Office 365 groups, and changes in textbooks" (SL2). Another school leader expressed this as the need for "infrastructure, e-mail, learning management systems" (SL13). The new technology also involves managing inventory "checking the accessibility to computers/tablets" (SL14) as well as issues of "digital work environmental issues" (SL13).

Developing Teaching and Learning

In this category, developing teaching and learning, a central aspect is the support of new forms of teaching. Three subthemes are seen: *creating* *conditions for new forms of teaching and learning, sharing information* and *collegial learning*.

According to the school leaders, important aspects in developing teaching and learning through digitalization involve supporting teachers' work, "giving teachers' the conditions to [develop teaching] through equipment and knowledge, professional development, for example online courses" (SL8). The school leaders also see digital tools as a form of "extending/strengthening pedagogy" (SL21). Developing teaching and learning also involves supporting development of teaching with higher level of digitalization: "for example, (distance, flex-distance, remote) in order to be able to simplify work (communication, assignment and study materials) as well as taking advantage of more possibilities (multimedia, images, film)" (SL19).

The work with developing teaching and learning comprises making internal work for teachers more efficient and flexible as well supporting support teachers' collaborative work. This involves supporting collaboration and spaces to share materials: "that the teacher can share information and materials with each other" (SL19).

In supporting the development of teaching and learning, the school leaders provide examples of different methods for teacher teaching teachers. A central aspect here is "collegial learning" (SL2) as well as "leading teachers' learning processes" (SL4). Methods for supporting collegial learning are "web tools, best practice, and pedagogical cafés" (SL13), giving teachers the possibility to share teaching methods and experiences with digitalization. Collaboration is also suggested within the school, for example, with the school's IT-group. This could involve the opportunity to "test programming" (SL22) as well as "basic and deeper skills in critical review" (SL9).

Discussion and Conclusion

As school leaders set the direction for digitalization, it appears that the role of the school leader as a leader appears to become a more complex task in a complex area. As noted by the school leaders, there are many areas and levels at which the school leader has the responsibility for driving development and for leading for digitalization. School leaders' work in this area involves initiating, implementing, maintaining, documenting and leading for digitalization for themselves, teachers, and students as well as for the schools as organizations. This is done while supporting teachers and students with the accessibility to technology, supporting new teaching methods, more efficient administration as well as driving school development, i .e., a large number of complex tasks on several levels. For these school leaders, digitalization, as a complex concept in itself, appears to increase the complexity of the role of the school leader in leading for digitalization (Dexter, 2008; Petersen, 2014). Setting the direction appears to involve a complex role and the need to prioritize in leading for digitalization.

Another central aspect seen in the survey involves accessibility to technology. Accessibility to technology, according to these school leaders, appears to be a strong condition for supporting the organization in its developmental work.

Technology appears to be a vital aspect for digitalization as the responsibility of the school leader (Dexter, 2008). This is an interesting finding, when considering otherwise reported good accessibility to technology (National Agency for Education, 2013). Despite good accessibility to technology, there seems to continue to be challenges related to technology. This challenge would appear to be of even more importance in schools and municipalities in which students do not have access to computers at home.

The need to develop teachers' and students' digital competence as well as professional development for teachers is reported by the school leaders in this study. Creating supportive conditions for all students to be able to meet the challenges of today's information society is noted as well as the ability to take on a critical stance. Creating supportive conditions for teaching and seeing the advantages of digitalization in the classroom is also put forward for teachers as well as achieving the knowledge requirements in the steering documents. For themselves, several of the schools leaders point out the need for deeper knowledge of the steering documents, as well as knowledge of digitalization. Both of these aspects appear to be an important part of leading for digitalization. The same can be said for creating good conditions for teachers for access to technology, as well as supporting and managing teachers' professional development, including knowledge, and methods for teaching with technology as well as developing teachers' professional stance towards digitalization. For a school leader, supporting teachers' work with digitalization appears to be a strong base for supporting student outcomes (Dexter, 2008). Therefore, there is the need for professional development for school leaders (Grönlund et al., 2014; Håkansson Lindqvist, 2015; Hylén, 2011; Pettersson, 2017).

In developing teaching and learning, the school leaders' work with learning for digitalization can be seen as supporting the work in developing new knowledge and work methods for themselves and for their organizations, which takes time (Grönlund, 2014; Grönlund et al., 2014; Håkansson Lindqvist, 2015; Tallvid, 2015). Further, the work with digitalization is expected to contribute to a larger picture, i.e., school development. Thus, professional development in new areas, such as leading for digitalization, will most likely be necessary. In this study, while a few school leaders are unsure or do not need professional development at this time, very few school leaders note the need for skills for leading for digitalization. Many of the school leaders note the importance of professional development, which entails an increased understanding of the steering documents. A serious concern for school leaders is to deal with aspects of their own professional development as well as teacher professional development in the task of combining their own competences and leading others in the digitalization process (Leithwood & Riehl, 2003, 2005; Leithwood & Jantzi, 2006). Worth noting is that the professional development module in leading for digitalization is voluntary, i.e., based on interest, time and opportunity to complete this programme. This leads to questions regarding which school leaders choose to participate, which in turn restricts these new competences to certain schools leaders in certain school and certain municipalities. This issue then becomes an issue of digital equity as well as gaining adequate digital competence in line with the Swedish

National IT-strategy (The Committee for Digitalization, 2014) and National digitalization strategy for schools (Swedish Government, 2017).

The results of this small study show that school leaders see digitalization as a wide and complex concept that can be related to student outcomes, digitalization in curriculum and course plans, and responsibility for the digitalization of teachers' and students' work in the classroom. The need for professional development comprises their own professional development, teachers' professional development, students' digital competence and digitalization of schools as organizations. Conclusions can be drawn that the role of the school leader is strong in setting the direction, supporting students' and teachers' work with digitalization for teaching and learning. How school leaders prioritize and lead for digitalization and support their organizations in this work, i.e., leading for digitalization, will be of importance for schools' development.

Implications for Practice and Future Research

Regarding implications for practice, how time, resources and professional development are made available to support school leaders in their work with leadership for digitalization will be important. This also concerns the prioritization of digitalization as one of many important areas in schools as organizations. Considering the complexity of school leaders' leadership, future research could involve a deeper study of what professional development could be of interest for school leaders in their leadership for digitalization. Moreover, a critical viewpoint on how school leadership is affected by, and can be employed in, the ongoing digitalization is important to study.

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ORGANIZING DIGITALIZATION IN SCHOOL: HOW A MUNICIPALITY IN SWEDEN ARRANGED FOR NEW CURRICULUM IMPLEMENTATION EMPHASIZING DIGITALIZATION

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Abstract

This study focused on how a municipality in Sweden organized for a new curriculum implementation with the focus on digitalization following the demands from politicians. A compulsory competence development course was initiated for all 40 school leaders in the municipality. The course followed the structure and form provided from the Swedish National Agency for Education. The results showed vast variation among school leaders regarding the understanding of digitalization and how they led processes in their schools. The results call for a thoughtful model of how to capture and act on these differences to secure equal quality of education in the municipality.

Introduction

In Sweden, a new curriculum has been launched that emphasizes digitalization. Digital technologies should be used in learning processes, and digital competence should be developed. The digitalization of schools in Sweden has a long history starting with computer-aided instruction in the 1950's, followed by a range of various projects and initiatives (Willermark, 2018) and now inscribed in today's curriculum. The situation in Sweden shows a scattered picture since previous studies have shown variations between the 290 municipalities. Different initiatives have been created to address this variation. For example, the organization that is in charge of the municipalities, SKL (Sveriges kommuner och landsting), has created an online tool called LIKA where schools can answer a battery of questions linked to digitalization of school. The ambition is to generate survey results that can serve as a measurement of the status of the school. The National Agency of Education has created educational material with the aim to serve schools with a competence development course to investigate the status of the school and to create pathways for development (see SNAE 2017). However, the initiative is linked to how schools act upon these initiatives and how insights and critical thoughts are triggered and handled.

Aim and Objective

This study aimed to provide insight and understanding of how a compulsory competence development course among 40 school leaders in a municipality in Sweden is arranged and supported and what patterns of similarities and differences could be traced and explained. This knowledge is important for further development of the goal of equal quality of education within the area of responsibility of the municipality.

Previous and Related Research

Previous studies claim that it is important to address issues such as culture and structure since the potential of digital technologies to become supportive for learning is closely connected to school context (Grönlund, 2014; Selwyn, 2011; Selwyn & Bulfin, 2015; Tondeur, Devos, Van Houtte, van Brakk, & Valcke, 2009). It is suggested that digital technologies can only transform learning if a school's context changes in a way that supports the transformation (Hammond, 2014; Somekh & Saunders, 2007). Supportive leadership, supportive organizational culture, and collegiality are vital foundations for the professional development of teachers' digital competence and school practice (Deaney & Hennessey, 2007; Schrum & Levin, 2016; Tearle, 2004). As well as teachers needing competence development for developing methods, supportive actions and collaborative practices for students, school leaders need competence development to support teachers in their professional development regarding digitalization of schools (Håkansson-Lindquist, 2015). Vanderlinde and van Braak (2010) emphasized the importance of school leaders to create change through the process of implementing digital technologies in schools. However, despite their key role in the process of the digitalization of schools, school leaders get little training on how to be supportive in their leadership (Kampylis & Punie, 2013).

Methodology

The study builds on a case study approach where the case is the compulsory competence development course following the structure and form provided from the Swedish National Agency for Education for all 40 school leaders in the studied municipality. The reason for using case study methodology is that the particular situation allowed for the close investigation of course activities though participant observation conducted by the author.

Closeness to the actual activities is considered strength in this study since during each session of the course; each and every school leader brought their individual experiences from their own work situation into the discussion. Additionally, closeness to the session allows also for the clarifying of questions.

The role of the researcher was also to ask questions during the sessions as a critical friend without interfering in the structure and process of the session driven by the session group leader. In order to balance the role, the researcher and the session group leader had an introductory meeting where they agreed upon when and how the researcher should and could intervene with questions or remarks.

Each session was 120 minutes. Field notes were taken during each session. Field notes were as detailed as possible in order to capture what school leaders said, how group leaders acted in the sessions to trigger discussion and how school leaders responded to the session in general.

After the sessions, all sessions' group leaders met for 30-40 minutes to have a common discussion to inform each other of what had been discussed in their groups. Furthermore, discussions of groups similarities and differences where brought up. The researcher did also take part in these discussions as a critical friend to ask for clarifications if needed. Field notes were taken also during these meetings.

Brief talks of 10-15 minutes with responsible individuals of the initiative were also conducted after every session to get further information about the next step in the process as well as to capture individual experiences about the session day. Memory notes from these talks were inserted in the research diary afterwards since most of these brief talks were held outdoors while leaving the session site.

In order to get more insight of the ongoing developmental work, apart from the compulsory competence development course in the municipality, the researcher also attended meetings such as network meetings for preschool teachers, first teacher network meetings, an ICT pedagogical network meeting, as well as two meetings with the school developmental board.

Swedish National Agency of Education Material

The material developed by the Swedish National Agency of Education (SNAE) has the expressed ambition to provide a process support to school leaders for increased understanding of the potential of digitalization of schools (see SNAE 2017)

The material contains of six specific parts that in turn have four elements. It is suggested that participants should meet on twelve occasions and each occasion should last for 120 minutes. Between meetings, group members should be allowed for individual preparations and assignments. The recommended duration of the competence development course is 24 weeks.

The six parts are:

1. Digitalization-society and school
2. Digitalization and leadership
3. Chain of effects
4. Digitalization and teaching
5. Digital ecosystem
6. Developmental plan

Before the school leaders come to the specific part, they should have prepared their assignments given to them beforehand. These individual assignments should be discussed together with the other participants in the group they belong to. Then, a group leader should facilitate the discussion further, and later summarize lessons learned.

SNAE emphasises that, “Det är bra om grupperna är blandade så att till exempel skolledare, verksamhetschefer, kvalitetschefer och utvecklingsledare arbetar i mixade grupper. En anledning till det är att förankra arbetet i hela styrkedjan” [“It is good if the groups are mixed so that, for example, school leaders, developmental leaders and quality leaders are involved. One reason for this is to embed the work through the chain of leadership" (translated from Swedish)].

The material from SNAE is thus highly structured regarding both content and form. It is quite time demanding, involving preferably a range of participants from different positions and responsibilities within municipalities in Sweden that intend to use the material.

Municipality Implementation of the SNAE Material

In the studied municipality, all school leaders were expected to participate. In total there were 40 school leaders involved from k-9 schools including special needs schools. The arrangement from the municipality had divided the school leaders into two major groups and then divided them further into smaller groups.

Table 1

Participating School Types and Number of Participants

School Types / Number	School Leaders (1-9 grade) Students, 7-15 yrs.	Pre-school Leaders (K-0 grade) Children, 1-6 yrs.
Number of Groups	4	3
Number of Participants on Average in each Group	5	7

In order to manage the group leader function for each group, the municipality decided to use both its own competence and to hire a private company to assist. The municipality staff became group leaders for the pre-school leaders, and the private company became responsible for facilitating school leaders.

Table 2

Group Leader Organizational Residence and School Type

Group Leader Organizational Residence	School Type
Private Company	School
Municipality	Pre-School

Figure 1 is a depiction of the arrangement of the competence development initiative based on the SNAE material containing the six different parts.

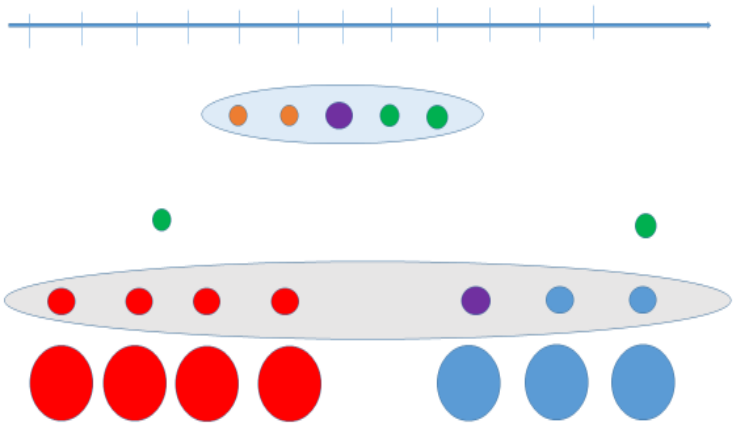

Figure 1. Model for arrangement of the initiative.

The time arrow on top symbolizes the number and patterns of distribution of the sessions, following the SNAE material. The upper circle of dots symbolizes the municipality school board members. The school board consists of the registrar, the school manager, the pre-school manager, the financial officer, the quality coordinator, and the school development manager. The two singular dots symbolize the school manager and the pre-school manager that also are members of the school board.

The small dots linked to the bigger ones symbolize the private company group leaders for school leaders (four) and municipality group leaders (three) for the pre-school leaders. The circle around the smaller dots symbolizes the group that met to discuss after each session to share their experiences and thoughts. One of these participants was also a member of the school board.

The biggest dots symbolize the group of the different school leaders and pre-school leaders that met on a regular basis. The number of participant in each group varied between three to ten people, and varied also from time to time during the course.

Results

So far, four parts out of six of the SNAE material has been accomplished. During the process, some particular observations have begun to stand out as suggested patterns in the municipality on the level of arrangements, on group level and on school types. The results are presented within three categories of specific patterns that have been interpreted as particularly pertinent in the specific case.

Observations from Four Sessions

In the first category, on the level of arrangement, some tensions surfaced. In the second, differences among school and pre-school leaders has begun to show up. And finally, differences have been seen regarding use of digital technologies and rationales for using them depending on what school type one is responsible for.

Identified tensions in the arrangements – Private company and municipality staff. The arrangement of dividing the responsibility for groups has gradually proven to be quite tricky to handle. On one hand, people were hired to be group leaders of the specific competence development initiative due to shortage of staff in the municipality, but on the other hand, the lack of previous knowledge about the school leaders has been troublesome for the hired staff.

The group leaders from the private company have naturally no prior knowledge of how individual school leaders work and function as leaders. Now they were supposed to drive group discussion where each school leader should be quite prepared and engaged. If not, the competence development initiative becomes a superficial arrangement rather than an organizational development process.

In some of the groups of school leaders, the level of ambition and preparedness was quite low. During the summarizing discussions after each session, these issues gradually surfaced. The staff from the municipality tried to help out and give advice, and the private company staff tried to both adhere to these suggestions and challenge taken for granted views from the municipality staff, using their benefit as providers of an outsider's perspective.

In spite of the openness in the after session discussions, sometimes there was a cautious approach towards how to present what had been going on in the groups. It was as if there was a wary atmosphere present. The actual cause for this is still not clear, and perhaps that will change in the upcoming sessions. It is still unclear where this will lead; however, it appears that it could have something to do with the division of the residential organization for the group leaders which needs further investigating. For now, it is a hypothetical suggestion.

Identified differences among school and preschool leaders. The groups were pre-defined by the responsible staff for the arrangement of the initiative. School leaders worked in groups with little previous connections whereas pre-school leaders had worked in groups in previous initiatives in the municipality regarding collegial collaboration and learning. Because pre-school leaders had participated in different groups, these previous collaborative practices seemed to have influenced the ongoing process in a positive way during the competence development initiative and the work with the SNAE material. Pre-school leaders were more often prepared than school leaders. To date, pre-school leaders have engaged more actively in the process than school leaders, specifically in preparedness and engagement linked to the actual content of the session. One possible explanation for this is that pre-school teachers do not need to create a sense of belonging to the group whereas school leaders do. They can use previous group processes and pre-established trust, important for group growth, to move further in their collegial learning during the sessions (Vrieling, van den Beemt & de Laat, 2016).

Yet another observed difference was that the responsible pre-school leaders followed only one of the groups whereas the school leader was required to move between groups during sessions. These practices have different strengths and weaknesses. To follow one group only has the strengths of covering the dynamic developmental process that occurs in that particular group. However, at the same time, that approach misses the diverse group dynamics that can be captured by moving between groups.

Differences regarding use of digital technologies and rationales from using them. The third category focused on school leaders' tendencies to talk about the municipality leadership and digital systems compared to pre-school and special needs school leaders' tendencies to talk about the children and what tools they need in order to learn and grow. In this regard, another observed difference was that school leaders had a tendency to talk about problems with specific systems and the lack of support from the municipality. Pre-school and special needs school leaders had a tendency to talk about how to learn when being a novice and suggested methods and approaches involving the children for developing exploratory spirit among the staff.

Observations from the Group Leader Sessions

During the four summarizing discussions, a comment made in the various groups each time concerned insufficient information flow between school leaders and the school board. They described that insufficient information flow as a gap. However, the group leaders that meet and summarize the sessions have not really found the best way to present the information gathered during the sessions to the municipality school board. The gap then persists and ways for overcoming this gap are still under discussion.

Analysis and Discussion

The municipality driven initiative to have all school leaders taking part in the SNAE developed competence development course is half way completed. During the process, differences and tensions have surfaced. The suggested arrangement from the SNAE in relation to the mix of participant has been modified due to the priorities of the municipality. However, there has been an expressed concern that all the various participants are not fully engaged in the process. For equality purposes, the identified differences and tensions create further questions regarding reasons for variation as well as the need for variation.

In spite of this ambitious approach to provide support to school and pre-school leaders to develop leadership linked to digitalization that seldom happens according to the literature (Kampylis & Punie, 2013), it is clear that it is a hard task to achieve. Even in a municipality that has taken previous research into consideration when focusing on school and pre-school leaders, proven so important for school development (Håkansson-Lindquist, 2015), issues still remain.

In this municipality, previous competence development activities and how they were arranged, seems to have influenced actual engagement in this particular process. For example, it seemed like pre-school teachers had the advantage of having worked in groups before, compared to school leaders. The kind of students one was responsible for, pre-school children, children with special needs or school children, influenced how they addressed and talked about digital systems and tools for learning. Furthermore, the notion of management, control and support have permeated the discussions among school leaders. Perhaps it is linked to how they need to report activities in a range of systems for measurement reasons compared to pre-school leaders who have fewer systems to report on; also it may be linked to school leaders having previously gotten access to technologies for other reasons than curriculum driven demands. One of the process leaders from the municipality suggested these as a possible explanation, and they are well worth investigating further. These suggestions also make the link to contextual factors adding yet another example about the role of structure and culture in the situation and the importance for such an understanding of how change can occur (Selwyn, 2011; Selwyn & Bulfin, 2015; Tondeur et al., 2009) and thus may explain the differences surfacing in the sessions.

However, this study has only been able to detect variations and suggest some patterns that have emerged during the competence development course. Variations have been shown. Challenges remain. One needs to ask what types of variations are acceptable and even welcome, and what types of variations need to be addressed and taken care of? What contextual awareness and understanding exist in the municipality and how will that awareness influence further steps in the process? The next step in the study will address these issues to support further development for equal quality of education focusing on digitalization within the area of responsibility of the municipality.

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INTEGRATING INDUSTRY TRAINING AND SUPPORT IN THE LEARNING MANAGEMENT SYSTEM

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Abstract

Teaching state of the art software engineering practices on advanced cloud platforms is a challenge in terms of costs and barriers associated in making such industry platforms available to students and in terms of the advanced training that is required to support the students on these platforms during a one term course. We report on a partnership between IBM Canada and the School of Computer Science at the University of Windsor that enabled the students both the access and training in the Bluemix platform through transparent integration into the LMS platform. The students gained much experience that enabled them to be placed in advanced and competitive internship positions after completing their course work.

Introduction

One of the key measures for a successful program is the rate of employment of students after graduation. It is a measure of the time it takes them after graduation to land a paying job in their field of specialization, and one can further add the degree of satisfaction they find in their career. Post-secondary institutions, such as the University of Windsor, through its Office of Institutional Analysis, conduct regular surveys and produce a number of statistics to measure the rate of employment of students after graduation.

In line with The Ministry of Advanced Education and Skills Development 2015/16 key performance indicators (KPI), institutions collect data through surveys and make their results publically available. For instance, the most recent published survey for 2015/2016 on the university's institutional analysis site was conducted in 2013 on graduates of Bachelors or First Professional degree programs. Graduates from each group of related programs were asked questions regarding their employment situation at 6 months and 2 years after graduation. For the purpose of the survey the *employment rate* is defined as the number of employed persons, including full-time and part-time employment, expressed as a percentage of the labour force. The labour force in this context is those persons who were employed, or unemployed but looking for work.

The data presented in Table 1 show the results of the survey of graduate employment rate by programs of study six months and two years after graduation. While the data in Table 1 account for all the programs within a program category, there is no specific measure for an individual program. The computer science programs include both cooperative education and traditional programs. A separate analysis indicates the graduates from the cooperative based education programs are able to find employment much sooner in their field. Programs with cooperative education better prepare students for the job market after graduation. Not all programs, however, have this option, and it becomes necessary for educators to find other means for preparing the students to be better prepared for the job market.

Table 1

University of Windsor 2013 Survey of Graduate Employment Rate by Programs of Study Six Months and Two Years After Graduation.

Program	Six Months	Two Years
Agriculture/Biological Sciences	91.70%	86.00%
Business & Commerce	88.90%	95.70%
Computer Science	88.90%	94.40%
Education	84.00%	93.10%
Engineering	84.60%	93.90%
Fine Arts	81.60%	82.10%
Humanities	84.80%	88.10%
Kinesiology/Recreation/Phys Ed	83.70%	82.80%
Law	93.60%	92.20%
Mathematics	80.00%	87.50%
Nursing	88.60%	99.10%
Other Arts & Sciences	90.90%	93.10%
Other Health Professions	*	*
Physical Sciences	*	100.00%
Social Sciences	80.70%	90.60%
Institution Rate	85.50%	92.20%

Source: University of Windsor (2018) MAESD KPI 2015/16

The School of Computer Science at Windsor, Ontario, Canada, introduced in 2014 a new professional master's degree program with the aim to fill a need in the market for skilled computer scientists. The Master of Applied Computing, since its inception, enjoyed a significant increase in its enrolment almost entirely composed of international students. The program involved a series of courses provided over three consecutive terms, followed by a four or six month fulltime internship component. From an educator's perspective the challenge is not in the ability to deliver the courses, rather, it is in the success of the students in landing high quality internships and the satisfaction of the employers and the student interns with the placement. The real test to an education program is, after all, measured in its ability to properly prepare a graduate student for the job market. The more cutting edge the job type and the reputation of the place of employment that the students land for their internship, the higher the quality of the program itself. Furthermore, since the internship is the final component of the program, the students are not mandated to return to campus once they complete their courses. This is even more attractive to employers who like to hire their interns into full employment after their internship term concludes.

This paper describes a course delivery approach that integrates industry partnership into the classroom. The learning management system presents the fundamental platform that enables communication access between students, instructor, graders, and external industry experts. Through careful orchestration of course contents, industry training materials and assessment methods, the student experience was enriched with advanced technical skills that were seamlessly integrated into the course syllabus. Students progressing through the course gain both fundamental and current job trainee type of skills that would otherwise be only made accessible to new employees. This approach positively impacted the internship's placement rate and its quality.

The objective of this paper is to present a summary of the pedagogical innovation in a first term software engineering course and to highlight its impact on student internship placement. The rest of the paper is organized as follows: in the next section the course content and standard delivery approach are presented; next the integration of industry is discussed, followed by a discussion on findings and measurement of outcomes. Finally, the paper concludes with a look into the future as industry continues to evolve.

A Course in Software Engineering

Designing a new university course is a daunting task for any professor. There is no shortage of challenges from deciding on a textbook, to determining the scope and depth of the contents. The course learning outcomes must be clearly defined along with their specific assessment methods, and of course they must align with the approved program learning outcomes. A new graduate course is even more challenging due to its depth in the quality of the contents on the topic been taught. The instructor must present the state of the art on the subject matter and its current form as practiced in industry along with the latest research findings on the topic. A typical university professor who would be tasked to deliver such a course is not necessarily, in fact not likely, to be employed in industry given the time and contract limitations in most education institutions. Transferring such current knowledge to the student would involve the collection of recently published journal articles or in the case of industry, most up to date publicly released technical papers.

Consider the textbook choice where a newly released textbook on the subject matter would be at least two years in the making. Its contents are current in terms of reference to the past few years of knowledge that was culminated in the text. While such a textbook would be a great asset for many disciplines, in computer science however, a new version of a software platform is released in a relatively very short time cycle, rendering the previous version obsolete or unsupported. Take for instance mobile development on the Android or IOS platforms. For instance, while developers are learning to write applications for the IOS 10 which was released on June 13, 2016, IOS 11 was released on June 5, 2017, less than a year later. This is not to mention all the important updates and bug fixes released in between these two major releases. A textbook on Android or IOS would always be obsolete upon its release, or at the very least, lacking of many technical updates (Wikipedia).

A search query on amazon.ca for textbooks on "IOS programming" would reveal over 1000 results with majority of books predating the IOS 11 release date. It is a losing battle for a university professor to settle on a current textbook for such agile technology. The real challenge remains: How can the students be trained with the latest technology and be ready to hit the ground running , so to speak, at their employment placement?

Software engineering is in itself a broad discipline of study that, while relatively new compared to the traditional disciplines, has gained unprecedented popularity over the past few decades aligned with the exponential growth of computer users around the world. A well rounded education program would ensure the student has satisfactory aptitude and knowledge of general concepts in the software development process.

A typical generalized software engineering course would cover various topics on the software production cycle, including requirement analysis, design patterns, agile programming practices, software testing and verification, and other security and deployment considerations. Coupled with the lecture style discussions are lab based exercises that engage the student to develop software through a series of hands-on exercises and assignments. A major project is common in graduate courses where a team of students work together on a relatively major development and demonstration of a software product as a proof of concept on the latest technology platform. Here lies another challenge: which platform would one adopt in a classroom so as to ensure students work on a stable, relevant, state of the art, and, most importantly, well documented and supported platform. The choice of programming language becomes secondary to the choice of the platform architecture. Often, a software product requires the use of multiple programming and scripting languages to bring it up to production levels.

The Latest Technology: A Moving Target

One of the most difficult aspects of teaching advanced software programming remains to be mainly in debugging, particularly using the latest technology platforms, whether it is a combination of a new platform or compiler. Programmers spend the majority of their time debugging the code after spending relatively less time writing it. This is a documented fact in early classical software engineering projects, and, sadly, remains the case in modern software engineering projects. In spite of all the advancements and enhancements in tools and their capabilities, bugs remain in software projects.

Take for example a classical UNIX system where the programmer is to write some advanced scripts to automate some tasks for the users. While there are well known scripting languages, say C-Shell or K-Shell for instance, we identify stark differences between different versions and system implementations. For example, an HP UNIX does not handle commands the same way a Digital Alpha Server would. Some commands may not be supported while others are supported but require different usage because their implementation requires different parameters. Here lies the challenge to the programmer to identify these differences that deviate from the published (and obsolete) reference manual, which is now a useless document that fails to provide the programmer with accurate and correct instructions on using the commands for the particular underlying system and specific version installed.

Cloud Computing

The cloud computing architecture is taking the world by storm. The days of writing software for a desktop platform are long gone. In recent years, with the ubiquity of the Internet and particularly its speed and reliability enhancements, modern software development often involves a multi-machine or distributed platform. A *cloud* in the context of software can be thought of as the collection of hardware distributed across some geographic locations that work collectively on providing a service to users.

(See “Harness the Power of IBM” (https://onthehub.com/ibm/) and “What is Cloud Computing?” (https://www.ibm.com/cloud/learn/what-is-cloud-computing).

Such commonly used cloud systems include storage systems such as Dropbox or Google Drive. Beyond storage, these services can be very useful and diverse, take for instance Google Mapping where a programmer can write minimal code to tap into their application-programming interface (API) and enhance the application being built with advanced mapping features.

Of course the risks for a software developer here are high. Consider the security aspect involving the collection and interception of data between the client and the cloud. This, however, is not of concern in this context where we would focus on the development and education. In order to teach the development of software that make use of this technology remains a big challenge. With the frequent updates of the cloud service, the software written by application programmers can break down if it is not updated accordingly to support the recent changes. The best source for documentation is no longer a printed textbook, it is now the most recent online documentation presented by the platform developers.

Microservices Architecture

Service-oriented architecture (SOA) is a loosely coupled architecture that provides various services due to cover the requirements of the organization and business. SOA aims to make the software more reusable (Newman, 2015) and is composed of some services that have been aligned with the business (Daya et al., 2015). SOA requires the services of a service provider as a style of architecture. In addition, SOA characteristics can be determined by the collection of principles, patterns, and criteria of its architecture. These characteristics can consist of the modularity, encapsulation, loose coupling, separation of concerns (SoC), reusability, and composability. Moreover, it can be thought of as a middleware solution that has been optimized to support the service assembly, orchestration, monitoring, and management.

In Microservices architectural style, the software application has been divided into several smaller services. These services are responsible for doing their tasks as well as possible. They also interact with the language-neutral APIs like REST. Furthermore, a service can be deployed as a separate entity on the platform as a service (PaaS) or can be a process for operation system. Moreover, they are able to alter independently, without any needs of customer intervention (Newman, 2015). The IBM Bluemix Microservices architectural style is used for developing applications. Bluemix provides platform as a service (PaaS) along with containers and virtual machines (Daya et al., 2015).

Agile computing methodology aims to reduce the complexity of planning while maintaining a key focus on the value of the customer and harnessing a positive climate for participation and collaboration (Stober & Hansmann, 2010). IBM Bluemix DevOps is capable of developing, tracking, planning and deploying the software as a software as a service (SaaS) (Daya et al., 2015). It works on the cloud and can support continuous delivery. It can handle the accessibility of requirement applications. After an application is built, it can be deployed onto the IBM Bluemix cloud platform. (Note, at the time this paper was being written the name of the platform was changed to IBM Cloud, a simple proof of how fast paced technology can be). In addition, it simplifies the movement of the code to running applications. It provides the ability to track and plan as another service making the IBM Bluemix DevOps capable of doing agile planning (Daya et al., 2015). The stories and tasks creation is supported by the IBM DevOps Track and Plan via using the tools of agile planning. By connection of the track and plan service to plans and code, the plans synchronize with the development team's progress.

From Industry to Classroom: Shifting Directions

Cost of technology in the classroom is a burden on the education system and a major challenge that educators have to take into consideration when designing the practical aspects of their course. It is for instance not feasible to expect a student to develop a class project on a commercial platform when the access to such a platform is cost prohibitive.

Now assuming the cost barrier can be overcome by an agreement between the industry partner and the institution, where students and faculty are presented with free limited access to the technology. What the next challenge would be is how to train students on such platforms especially if these are highly agile. The faculty member must depend on the training materials presented by the industry partner that are publically accessible. While textbooks are useful for presenting a historical review of the technology, they fail to meet their goal in being current manuals to assist users on a current platform.

Figure 1 illustrates how a typical university or educational institution would set up a computer lab. First the server is acquired and maintained to support the software configuration or platform that is desired by the unit to be used in the classroom. Next a physical lab is created with a number of workstations that are regularly supported and kept up to date for students to use. The students would use the software on the workstations and the development tools that are installed in order to access the server and work on the practical aspects of the course and the subject matter under study. This is a common and classical configuration found in many universities and institutions to this day. The main drawbacks of this platform are the fact that a technical support staff on hand is always required to deal with the ongoing maintenance of this lab and server. It is very common to see the software and hardware slide into obsolete or outdated versions due mainly to time and cost of upgrades. The frequency of upgrades is sometimes too high that a typical lab would end up being outdated and its maintenance costs could exceed the abilities of the institution.

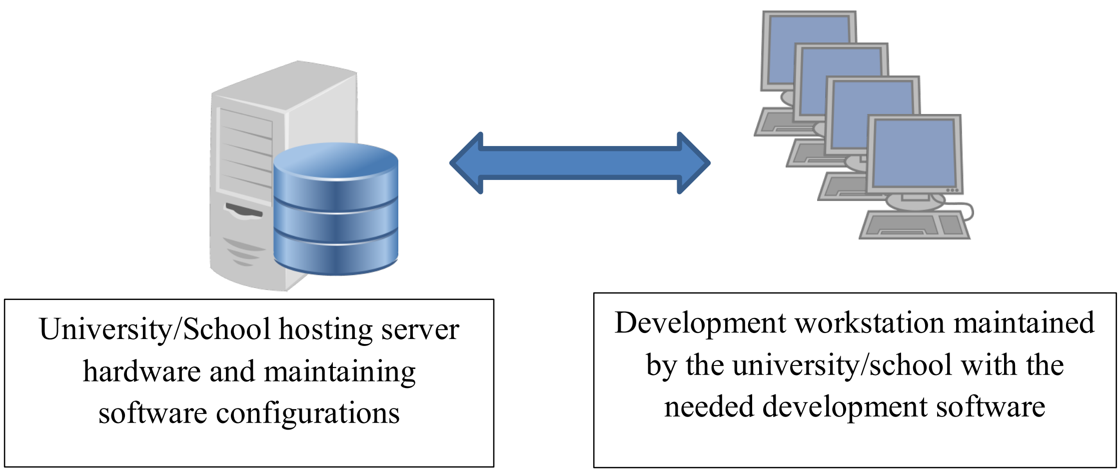

Figure 1. A traditional classroom configuration using traditional server client architecture.

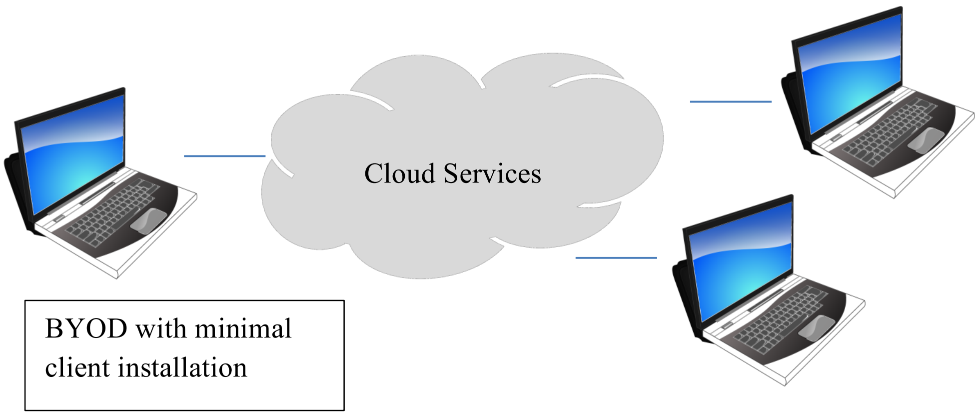

Figure 2. A modern classroom with no need for a centralized server and students bring their own devices (Bring Your Own Device – BYOD) that require very minimal client software installation and guaranteed to have the most up to date software pushed from the cloud upon connecting.

The new cloud technology platform enables a different type of access to services as presented in Figure 2. Here the server or servers are in the cloud. The student lab can remain either the classical classroom with workstations or following the trendier bring your own device (BYOD) lab. Here the institution invests in the purchase of services from the cloud and in the high-speed network connectivity and removes the costs of acquiring and maintaining servers and workstations.

The drawbacks of the configuration presented in Figure 2 relate to the fact that the students are distanced from the cloud services in terms of support. When the students started using this platform in the classroom with the aim to get access to the latest technology of a certain product platform, there were serious drawbacks and complaints mainly due to the fact that the platform was frequently updated. That consequently triggered ongoing major upgrades and growing frustrations on the end users who had to frequently update their client software and, often, older hardware devices.

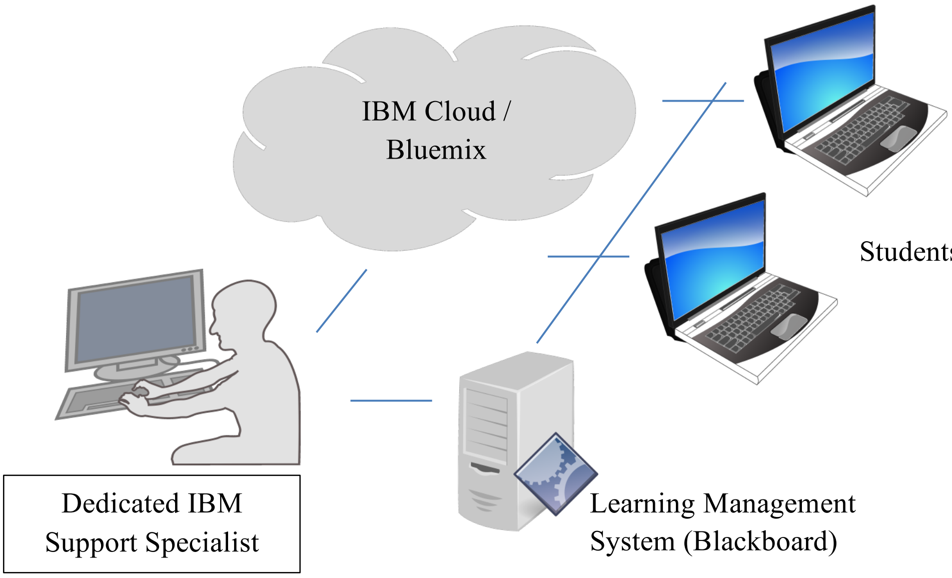

Figure 3. Extended modern classroom by means of seamless integration of the support specialist through the LMS to communicate with students and through the cloud to access code and assist in debugging.

The user frustration in the laboratory stemming from lack of support when dealing with an impersonal setting is a major challenge. Either the traditional educator is removed and students are expected to keep up on their own, or the traditional educator is present but he/she is as clueless to the changing behaviour of the system as the students due to the disconnect between the highly agile industry platform and the training materials presented to the trainer (or lab instructor). The ingenuity of the collaboration to address this problem is in the integration of a dedicated employee, a support specialist, who receives regular training and is within the company's inner circles and privy to the knowledge about all the changes occurring in the system. He or she is a seasoned programmer who is well versed and up to date on the platform's changing features. This person becomes a key in solving the problem of frustration from users due to the agility of the platform and lack of current manuals on the constantly changing technology. Calling or contacting such a person is equivalent to calling tech support on a product. The integrated approach helps avoid long holds or wait times for reaching a contact, having to deal with the service contracts, and adding frustration to students who would rather quit the project or perform poorly than have to pay for premium support services.

The partnership between the industry and the academic institution here flourished when, as shown in Figure 3, the support mechanism was integrated into the course learning management system (LMS). In this particular instance, Blackboard is used as the standard LMS that students and teachers have constant and easy access to. A special user account is created for the industry support specialist and connected strictly to the discussion forum as a moderator. Care has been taken that the support specialist does not gain unauthorized access to sensitive areas of the LMS that are normally only accessible to the instructor, such as the grading section. The specialist can now view the discussion forum, read student questions and respond to them while making the responses visible to the classroom users. It soon turns to a virtual classroom discussion on the LMS that connects the students to their instructor on one hand and to the industry specialist on the other hand. The student gets the best of both worlds: access to the instructor and access to tech support without the hassle of having to leave the LMS.

Teaching Classroom Setup	Traditional Classroom with the School maintaining server, workstations and all software (high cost of maintenance)	Modern Cloud Classroom with students connecting to the cloud based software (cost of software licenses to the cloud; no cost with IBM Academic Partnership agreement)	Modern with LMS Integration with students connecting to the cloud based software and a learning support specialist integrated into the course learning management system
Supporting Resources	Students use textbook resources that are out-dated or incompatible with the software installed on the machines	Students use up to date agile software on cloud resources and self-serve support	Students use up to date agile software on cloud resources and self-serve support
Student Training Challenges	Students complete the course with out-dated skills	Students are challenged with the new technology and frustrated due to lack of support and current resources in an agile development	Students are additionally supported with a live expert through the LMS
Job Readiness Rating	Low job readiness due to gap between software taught in the classroom and the latest industry software	Medium job readiness due to increased exposure to the latest technology but lack of mastery due to poor support	High job readiness due to high aptitude with the latest technology in current use by industry

Figure 4. Comparing different teaching approaches ranging from the traditional classroom to the cloud enhanced and supported model.

The progression of classroom technology and integration of the cloud, BYOD framework, and educators with industry is summarized in Figure 4 that presents a comparison of different teaching approaches ranging from the traditional classroom to the cloud enhanced and supported model. The comparison describes three different tiers of classroom laboratory setup that can be used by the educator and institution. The first involving a setup using a traditional classroom laboratory with server and workstations, which as previously mentioned would require high costs of maintenance. Next up we have access to a cloud platform thereby removing dependency on a local server machine, but that would come at high costs in terms of access to the cloud, unless an academic partnership is forged with industry, and in terms of student frustrations in accessing and gaining technical support on such a platform. The third tier is the targeted ideal where the cloud access is supplemented with integrated technical support right within the LMS platform that the students are accustomed to in their educational institution. Access to the learning specialist within the virtual classroom setting has proven to be a key feature for success of projects. As a result, when comparing the quality of the student projects between a cohort that had access to the specialist and those who did not there was a sharp difference in the level of achievement of the students as well as their satisfaction level with the course. The quality was measured in terms of the project deliverables when presented by the students. The more features they were able to encompass into their project and be able to implement and present, the higher the quality of the work. Furthermore, the end of term student evaluation survey which is a standard instrument for measuring the performance of the instructor and quality of the course overall were compared and there were clear improvement between the time the course was taught without the integrated specialist to the offering when the specialist was introduced. Students have revealed in the survey greater satisfaction with the course and more importantly better understanding of the subject matter.

Here it is important to link what was learned in the classroom to industry. After the completion of the course students are to undergo an internship placement with industry. The university employs a dedicated industry coordinator for the program whose task is to identify industry positions for the students. After the new integrated model was introduced, the coordinator reported back a major increase in the placement of the students in industry, particularly in high quality jobs.

It is worth noting that while students undergo the software engineering course and get initial training on the cloud platform they are also offered online training materials from IBM that if they were to complete they would receive a badge. In turn, students can mention that on their job applications and end up getting selected by industry for internship positions that were otherwise beyond their reach. Their technical training on the latest cloud platform presents the students with a more satisfying experience overall when measured in terms of the quality of training they received on the integrated cloud platform, the quality of the projects they were able to achieve within a course timeline, and the quality of the internship placement they land after the course has concluded.

Going back to the KPI mentioned earlier, it remains to be seen what institutional analysis would report in terms of students' employment rates after graduations. However, according to the high quality and increasing number of placements in internships it is possible to forecast a healthy increase in the employment rates and more importantly in the satisfaction of students with the education that they have received from the institution.

Conclusion

The rising cost of computer laboratory infrastructure and the increasing frequency of software updates present many challenges for education institutions to maintain up to date technology in their classrooms. Educators are presented with the challenges for maintaining current curricula and course contents, particularly training students in up to date software editions. The traditional computer classroom requires the maintenance of server and workstations up to date and in good operating condition, often requiring additional human resources and costs. In a closed classroom setting traditional textbooks fail to deliver accurate and up to date technical content for specialized software. In an advanced software engineering course it is critical for the students to have access to both current and accurate software documentation.

With the advent of the cloud computing and particularly software and platform as service technologies, clients need only a device capable of loading and running often minimal and thin client software to gain access to powerful and current resources that are constantly maintained on the cloud. IBM Canada, through their academic initiative enabled the University of Windsor students and faculty access to cloud services and training materials for enhancing student learning. This service while it provided students access to current industry software and the latest versions, presented several challenges in terms of the difficulty arising from using agile software. Its frequently changing versions and large amount of expectations on the students to read and self-train on several technologies presented some challenges and frustrations. To overcome this learning curve a learning specialist with high technical aptitude from the industry is integrated into the classroom's learning management system software. This enables a high quality learning experience where students are able to get their highly technical questions addressed, thereby mitigating the risks associated with the agile learning environment. The results of this practice unveiled their impact after monitoring the graduating class and their success in internship placement. An 84% placement rate of students in highly specialized and reputable industry institutions confirmed the high readiness of the students going into the job market.

Additional long term studies and enhancements will be considered in order to ensure this model remains sustainable and inclusive of other computer courses such as Internet and Database, and not just software engineering. Similar approaches to partnerships should be considered for other cloud platforms and services from the likes of Amazon, Microsoft and Google. For these to occur, the first challenge is to build the partnership between industry and academia to enable student and faculty access to technology.

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International Conference on Information Communication Technologies in Education

Proceedings

ICICTE 2018 seeks to address the many challenges and new directions presented by technological innovations in educational settings. With the keynote speaker, plenary sessions, workshops, and forums examining the integration of technology into all facets of education, the conference provides participants with a forum for intensive interdisciplinary interaction and collegial debate. Those attending ICICTE 2018 leave with an excellent overview of current thinking and practices in applications of technology to education. Thematic streams include alternative processes, procedures, techniques and tools for creating learning environments appropriate for the twenty-first century.

Conference themes include: Pedagogy in the evolving tech environment, the architecture of learning; accessibility, the evolution of the classroom; instructional design and delivery, evaluation and assessment; strategies and tools for teaching and learning; simulations and gaming; informal, non formal and formal adult education; multi-grade education; open/Distance learning; impacts on educational institutions: effects on faculty, staff, administration, and students; curriculum and program development; teacher training; building communities of teachers/educators; cooperative learning; the internationalization of institutions and of education, political economy and educational technology: Intersections, effects on training institutions and industry; ethical considerations in the use of information technology in teaching and learning; the use of technology in education to promote democratic ideals, technology in creative arts education, ethics, human rights and access to open educational resources, and the application of psychology to learning mediated by technology.

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