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Communication Technologies in Education

Editors
Evangeline (Litsa) Marlos Varonis
and
Anastasia (Nancy) Pyrini

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Proceedings of ICICTE 2023

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Greece 2024

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Preface to the ICICTE 2023 Proceedings: Work in Process and Taming Chat GPT

Evangeline (Litsa) Marlos Varonis
Co-editor, ICICTE 2023 Proceedings

Recently, a gallery hosted the posthumous exhibit of a friend—a member of the ICICTE family—with the final piece she was working on displayed on her easel, described as “Work in Process.” While remaining true to her artistic vision and philosophy, Diane was always challenging herself to experiment with different media and even different subject matters. She never considered her learning arc as over, or her portfolio complete. She could always sharpen her technique just a little more with experimentation and revision.

In contrast, I still remember my horror at meeting a middle-aged pharmacist who explained that after so many years of school, he couldn’t even bear to read anything new – he was just enjoying the working life without having to study anymore. He was not a “work in process”; he considered himself a work completed.

We are not in a static field, and neither was the pharmacist. But many of us choose to continue experimenting with new media, exploring new subject matters, sharpening our technique, and sharing what we have learned through professional conferences and publications. The papers in these proceedings are the best evidence of that—thoughtful, rigorous, and pushing the boundaries of state-of-the-art research in multiple areas connected with Information Communication Technology (ICT). They demonstrate work in process.

Since several papers in ICICTE 2023 focus on the growing use of ChatGPT, I asked that program to “summarize” each paper in turn (minus the acknowledgements and references), looking for patterns that could provide insight into how it works and how it might be tamed. I was also wondering if I could include these summaries in the preface, with attribution of course. ChatGPT did provide decent summaries of every paper, with some big differences in the information it included from the 20 papers, which were set up identically:

1. The title was included three times (15%);
2. The names of the authors were included five times (25%);
3. The authors’ institution was included six times (30%);
4. The number of paragraphs in the summary varied from one (10 summaries, or 50%) through 14 (one summary, or 5%).

Taken together, the summaries ran 11 pages – not what I had in mind!

What does this mean? That ChatGPT is helpful but not totally reliable. It is not capable of always producing equivalent results with the same instructions, or of providing identical information when the same data is fed through a second time. It is a work in process.

I tried again, refining the directions, to standardize the summaries and then use them for an interactive “matching” quiz (included at the end of this Preface). This took multiple attempts, a consultation, some hair-pulling, many sighs, grumbles, and grimaces, and some manual tweaking, but in the end I got close enough.

What does this mean for us as educators and researchers? We can tame ChatGPT if we know the processes to use and the questions to ask and are willing to put the time into refining and improving our directions. And, we can tame students’ use of this and similar AI software so that they are using it to enhance, not cripple, their learning. Because, like us, they are a work in process.

“Matching” Quiz on 2023 Paper Presentations

Have fun with this! The first person that submits correct answers will be recognized at the 2024 Closing Ceremonies.

Final directions to ChatGPT (free version) for each conference paper: *In the first sentence identify the author. In the second sentence identify the title. In the third sentence summarize the article in one sentence.*

Final directions to ChatGPT (free version) for building the quiz: *Create a matching quiz question with two sections. In the top section, include each article and author numbered 1-19 and in the bottom section include each article summary in scrambled order, numbered a-s.*

Note: ChatGPT does not seem to be able to create columns, so instead I requested sections. I have left discrepancies in capitalization of titles intact but removed the answers. ChatGPT bold-faced the titles of articles on its own.

Match the ICICTE 2023 articles with their authors and titles:

1. **Keynote Address: The Basic Science of Climate Change** by Diamando Vlachogianni.
2. **A Bibliometric Analysis of Online Learning in Higher Education: A Comparison of Research Trends before and during the Covid-19 Pandemic** by Alesksander Aristovnik, Lan Umek, and Dejan Ravšelj.
3. **Educators’ Digital Competence: First Results of a Systematic Literature Review** by Clarissa Lachmann and Michael T. Rucker.
4. **Challenges and Opportunities Presented by Generative AI-Chatbots: Effects on an Undergraduate Course on Databases** by Patricia Brockmann.
5. **Authentic Assessments to Address the Use of Chat-GPT in Higher Education** by Tiffany Winchester, Loretta Garvey, and ChatGPT.
6. **The Critical Role of School Leaders in Ambitious Pedagogical Strategies** by Maria Spante.
7. **Climatopia: Self-Directed Learning to Improve Quality of Life** by Orestes Varonis, Evangeline Varonis, Anastasia Pyrini, & Christos Ioannides.
8. **Project-Based Learning and Scientific Work** by Heidi Schuhbauer and Sebastian Schötteler.
9. **HRM STUDENTS’ PERCEPTIONS OF AN ASSESSMENT FOR LEARNING IN A FULLY ONLINE UNIVERSITY COURSE IN SWEDEN AT THE DEPARTMENT OF EDUCATION IN UMEÅ** by Monica Liljeström and Hanna Paulin.
10. **Secondary School Teachers’ Collaborative Learning About Digital Technologies — A Research Circle** by Marcia Håkansson Lindqvist.

11. **Attention Under Pressure: The Impact of Technology-Enhanced Learning Environment on Teacher Presence** by Tiffany Winchester, Emma Price, and Anthea Groessler.
12. **MAKING SKILLS FOR PROMOTION OF YOUR PERSONAL BRAND: FMID PROJECT** by Alicia de Pablo Sánchez.
13. **POST-COVID-19 TEACHING: REFLECTIONS ON EXPERIENCES AND LESSONS LEARNT** by Marcia Håkansson Lindqvist.
14. **TEACHING KIDS THE BASIS OF CODING. MAKE IT FUN!** by Nuria de Pablo Sánchez and Mariano Sanz Prieto.
15. **ROBOAQUARIA: Robots in Aquatic Environments to Promote STEM and Environmental Awareness** by Nancy Pyrini.
16. **Applying the Quality Matters Rubric to Assess Accessibility** by Kimera Moodley and Mari van Wyk.
17. **PLAYING AN INDIGENOUS SOUTH AFRICAN GAME AS AN INDICATOR OF SUCCESS FOR LEARNING PROGRAMMING IN HIGHER EDUCATION INSTITUTIONS** by Tendesai J.W. Chinamasa and Nola Payne.
18. **PROJECT: A REVOLUTIONARY APPROACH TO TEACHER EDUCATION USING VIRTUAL REALITY** by Kalliopi Evangelia Stavroulia et al.
19. **Blockchain-Based Companies' Use of Social Media to Raise Climate Crisis Awareness: Content Analysis of Single Earth Twitter Account** by Hazal Koray Alay and Şeyma Esin Erben.

Summaries

- a. The article emphasizes the importance of integrating coding into education to develop essential 21st-century skills and discusses the Erasmus+ Coding4Kids project aimed at providing resources and training for both students and teachers to incorporate coding into classrooms effectively.
- b. The article evaluates the use of blended synchronous learning (BSL) approach in a university setting, finding that the increased demands on teachers in this environment negatively impact their ability to be present, suggesting that professional development alone may not be sufficient to address these challenges.
- c. The article summarizes reflections on the experiences and lessons learned from the shift to online learning during the Covid-19 pandemic, particularly focusing on challenges, opportunities, and hopes for post-pandemic teaching in higher education.
- d. The article provides an in-depth exploration of climate science, covering the fundamental concepts of weather, climate, natural and human-induced causes of climate change, evidence of global warming, and the importance of education and awareness in combating climate change for future generations.

- e. The article reports on the results of the Climatopia project pilot at four schools in Greece, demonstrating its positive impact on student engagement, collaboration, and awareness of climate change effects, as well as its benefits for teachers, parents, and the wider community.
- f. The article explores research trends of online learning in higher education before and during the pandemic by applying several bibliometric approaches, revealing differences in research trends and providing evidence-based guidelines for supporting higher education in the future.
- g. The article describes a master's degree class in computer science that combines project-based learning with scientific work, focusing on teaching students professional and methodological skills in social network analysis through research projects and conference paper writing, leading to high learning outcomes but also highlighting students' difficulties with this type of work.
- h. The article discusses the importance of creating a personal brand and acquiring video creation skills to enter the job market, with a focus on helping young people at risk of exclusion through the Erasmus+ Film Making for Inclusion and Development project.
- i. Generative AI chatbots pose challenges to education, particularly in assessing plagiarism and the adequacy of students' programming skills, but also offer opportunities for integrating new technology into teaching methods.
- j. The article discusses the importance of ensuring accessibility in online learning, particularly through the use of the Quality Matters (QM) rubric to evaluate the accessibility of online courses.
- k. The article summarizes the experiences of upper secondary school teachers participating in a research circle focused on professional development in digital technologies, highlighting their increased knowledge and confidence in integrating digital technologies into their teaching practices.
- l. The article discusses the challenges and complexities of implementing thematic pedagogy and digitalization in schools, highlighting the importance of supportive leadership and organizational culture in translating theoretical frameworks into practical teaching realities.
- m. The article provides an overview of a systematic literature review analyzing eight national and international frameworks to define the digital competence of teacher educators, highlighting the lack of binding standards in Germany and discussing the implications for teacher education.
- n. The article discusses the implementation and effectiveness of the ROBOAQUARIA program, which aims to promote STEAM education integrated with environmental topics in elementary schools through robotics activities.
- o. The article critically analyzes authentic assessments created by ChatGPT for business and nursing programs, highlighting limitations in relying solely on technology for assessment and advocating for the integration of artificial

- intelligence into higher education with consideration of ethical and legal implications.
- p. The article explores the potential of using the indigenous South African game Morabaraba to develop problem-solving skills in computer programming students enrolled in higher education institutions in South Africa, drawing parallels between the cognitive requirements of the game and those of programming.
 - q. The article discusses the VRTEACHER project, which aims to integrate Virtual Reality (VR) technology into teacher education to enhance teaching practices, promote inclusivity, and foster a deeper understanding of students' experiences through immersive VR-based training scenarios.
 - r. The article discusses how blockchain-based companies, with a focus on Single Earth, utilize social media, particularly Twitter, to raise awareness about the climate crisis and promote greentech solutions, as evidenced by an analysis of 295 tweets shared by Single Earth.
 - s. The article summarizes the perceptions of 75 Human Resource Management students regarding an Assessment for Learning (AFL) implemented in a fully online course at Umeå University in Sweden. The AFL, conducted through asynchronous online discussions (AOD), was found to be meaningful for learning and vocational skill development, with students expressing satisfaction and indicating enhanced engagement in solving the AFL.

KEYNOTE ADDRESS: THE BASIS OF CLIMATE CHANGE

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To understand the reasons and mechanisms behind climate change, it is crucial to recognize the role played by the atmosphere. The atmosphere is a complex system where various chemical, thermodynamic, and fluid dynamics processes occur. It's important to note that the atmosphere is not uniform; it becomes less dense as it extends from the Earth. Most of the mass of the atmosphere is within 30 km from the Earth's surface, and its fluid properties constantly change with time and location. This variability in the atmosphere is what we call "weather." Weather phenomena occur mostly within the first 10 km of the atmosphere. The lower edge of what could be considered outer space is approximately 100 km above the Earth's surface. However, the atmosphere extends to an altitude of about 10,000 km, into outer space.

So, What Do We Define as Weather?

Weather is the state of the atmosphere at a particular place during a short period of time. There are six main characteristics of weather, very well known to all. These are the temperature, atmospheric pressure, wind, humidity, precipitation/rain-snow, and cloudiness.

What Do We Define as "CLIMATE"?

The Earth's climate is a complex dynamic system.

Climate is defined as an area's long-term weather patterns. The simplest way to describe climate is to look at average rainfall, temperature, snow, or any other weather condition over time. *We usually define a region's climate over a period of 30 years.*

Comparing weather and climate, we can say that weather changes over a short period of time, which can range from a few minutes to hours or even a few days. This is reported as a "**forecast**". Climate, on the other hand, takes a much longer time to change over a region, often measured in years. There are two main factors that determine climate: the energy coming from the Sun and the interaction between

different components of the Earth system. These components include atmospheric, oceanic, biological, and geological processes, which are all linked together within a vast number of nested subsystems. These subsystems are the Biosphere, Hydrosphere, Cryosphere, and Lithosphere, that drive the climate system and result in regional variations of climate. The atmosphere links all of these vital subsystems.

Climate change refers to alterations in the weather patterns, as well as changes in oceans, land surfaces, and ice sheets. These changes have a lasting impact on the local, regional, and global climates of the Earth and occur over periods of decades or even longer. **Human activities**, particularly the emission of greenhouse gases from burning fossil fuels, deforestation, and changes in land use, are the main drivers of climate change that we have observed in the industrial era. However, both natural processes and human activities can cause climate change.

Climate variability is a natural phenomenon that occurs due to the interaction of various climate components like the atmosphere, ocean, and sea ice. There are three main causes of **internal climate variability**. *Firstly*, the ocean circulation plays a crucial role in regulating the climate by storing and transporting heat, carbon, nutrients, and freshwater around the world. *Secondly*, the ocean and atmosphere form a complex coupled system and work together by exchanging gases, water (including water vapor), particles, momentum, and energy at the air-sea interface. These exchanges affect the physical, chemical, and biological processes of the ocean and influence the weather, water cycle, and climate. *Thirdly*, life itself, including all plants, humans, and animals, can also cause internal climate variability. **External forcing** is another type of natural cause of climate change. This refers to climate forcing agents that impact the climate system while being outside of the climate system itself. Examples of external forcing include the emissions of greenhouse gases, variations in the solar output, orbital variations of the Earth, and plate tectonics.

Let's discuss how **natural causes** such as shifts and wobbles in the Earth's orbit can affect the climate. The Earth makes a full orbit around the sun each year, tilted at an angle of 23.5° to the perpendicular plane of its orbital path. Even small changes in the tilt of the Earth can lead to important changes in the "strength" of the seasons and temperature. More tilt means warmer summers and colder winters, while less tilt means cooler summers and milder winters. Slow changes in the Earth's orbit over tens of thousands of years can lead to significant changes in the strength of the seasons. Climate feedbacks amplify these small changes, which can result in ice ages. Now, let's talk about how the Sun can trigger climate change. The Sun is a hot sphere of gases where nuclear reactions take place within its core, producing vast amounts of energy. The Sun is the primary source of energy for the Earth's climate system. Although the Sun's energy output may appear consistent from an everyday perspective, small changes over a long period can lead to significant

climate changes. As the Sun is the fundamental source of energy that drives our climate system, it's reasonable to assume that changes in the Sun's energy output would cause the climate to change. Scientific studies have revealed that solar variations have played an essential role in past climate changes. For instance, the Sun was "quiet" for an extended period, resulting in a solar output decrease. This decrease is believed to have triggered the Little Ice Age, which peaked in the 17th and early 18th centuries and was characterized by extremely severe winters that arrived early and lasted well into spring.

Volcanic eruptions can also cause natural climate changes. Though they may last for only a few days, their effects can influence climate patterns for years. The principal impact of volcanic eruptions on climate is short-term cooling. This is because they release clouds of ash and dust that block out some sunlight. These ash particles are relatively heavy and fall to the ground within three months, so their cooling effect is short-lived. However, volcanic debris also contains sulfur dioxide, which combines with water vapor and dust in the atmosphere to form sulfate aerosols. These aerosols are lighter than ash particles and can remain in the atmosphere for a year or more. They reflect sunlight away from the Earth's surface, resulting in a cooling effect that outweighs the warming caused by volcanic greenhouse gases. For instance, the Mount Pinatubo eruption in 1991 caused a 0.5°C drop in global temperature. Although volcanic eruptions emit lava, carbon dioxide, ash, and particles, their average CO₂ emissions are less than 1-2% of emissions from current human activities. The release of large volumes of gases and ash can influence climatic patterns for years, by increasing planetary reflectivity, which causes atmospheric cooling.

The greenhouse effect is a natural process that helps keep the Earth's temperature stable and suitable for life. Greenhouse gases like carbon dioxide, methane, water vapor, and nitrous oxide occur naturally in the atmosphere in low concentrations. When the Sun's energy enters the atmosphere, some is reflected back by the clouds and the Earth's surface. However, the greenhouse gases absorb some of this energy and warm up the atmosphere, much like a blanket. Without the greenhouse effect, the average temperature of the Earth would be about -18 degrees Celsius, and life as we know it would not exist. However, human activity has increased the concentration of greenhouse gases in the atmosphere, mainly through the burning of fossil fuels. This increase in greenhouse gases is causing the Earth's temperature to rise, which is leading to climate change. Carbon dioxide is the primary greenhouse gas responsible for climate change, and its concentration in the atmosphere has increased by 40% since pre-industrial times. Other greenhouse gases, such as methane, are even more potent than CO₂, and their concentration is also increasing. Therefore, while the greenhouse effect is essential for life, the excessive release of greenhouse gases by humans is causing significant environmental problems and needs to be addressed.

Deforestation and human activities, such as manufacturing, industry, transport, and agriculture, are major sources of greenhouse gas emissions. Deforestation refers to the permanent removal of trees for various purposes, including agriculture, grazing, or using timber for fuel, construction or manufacturing. Trees absorb carbon dioxide (CO₂) from the atmosphere, and when they are cut down, they release all the carbon stored in them into the atmosphere, adding to the greenhouse effect. Deforestation, logging, clear-cutting, fires, and other forms of forest degradation contribute up to 20% of global carbon emissions. Greenhouse gases are also released by human activities, such as fertiliser use, livestock production, transportation, and energy generation from burning fossil fuels like coal, oil, and gas. Road vehicles are the largest contributors of greenhouse gases, followed by ships and airplanes. In fact, transportation accounts for almost one quarter of global energy-related carbon-dioxide emissions. Coal mining also releases methane (CH₄), a potent greenhouse gas. Manufacturing and industry are also significant contributors to greenhouse gas emissions, mostly from burning fossil fuels to generate energy for producing cement, iron, steel, electronics, plastics, clothes, and other goods. Generating electricity and heat by burning fossil fuels also causes a large amount of global emissions. The transport and energy sectors are responsible for the highest greenhouse gas emissions in the European Union (EU), and the EU has committed to reducing its greenhouse gas emissions by more than half by 2030. Since 1991, the production of greenhouse gases has reduced by around 30% in the EU, mainly due to imposed rules in the industry. Each European member state must report its annual emissions to ensure compliance with the reduction targets.

What is the Evidence of Climate Change?

Climate change is believed to be caused by human activities. The levels of carbon dioxide (CO₂) concentrations in the atmosphere have increased over the last 800,000 years. Pre-industrial CO₂ levels were around 280 parts per million (ppm), but today we are close to 420 ppm. Scientific findings show that concentrations of carbon dioxide, methane, and nitrous oxides have reached unprecedented levels in at least the last 800,000 years. The estimated levels of CO₂ from 500 million years ago during the Ordovician period are the most distant in time. Carbon dioxide from human activities is increasing about 250 times faster than it did from natural sources after the last Ice Age. The last glacial period lasted from about 100,000 years ago until 25,000 years ago, and today we are in a warm interglacial period.

There is overwhelming proof that the Earth is undergoing a rapid warming process. It is an undeniable fact that human activities have led to the release of greenhouse gases that have trapped more of the Sun's energy in the Earth's system. This increased energy has caused warming of the atmosphere, ocean, and land, leading

to significant changes in the atmosphere, ocean, cryosphere, and biosphere. Thanks to Earth-orbiting satellites and new technologies, scientists are now able to collect many different types of information about our planet and its climate, revealing the signs and patterns of a changing climate. The heat-trapping nature of carbon dioxide and other gases was demonstrated by scientists in the mid-19th century, and there is no question that increased greenhouse gas levels are responsible for warming the Earth in response to their measured impacts.

The planet's average surface temperature has risen by 1 degree Celsius since the late 19th century. This change is primarily due to increased greenhouse gas emissions into the atmosphere. Most of the warming has happened in the past 40 years, with the last seven years being the warmest. Heat has been absorbed by the ocean, with the top 100 meters of ocean showing warming of 0.33 degrees Celsius since 1969. The Greenland and Antarctic ice sheets have lost mass, with Greenland losing an average of 279 billion tons of ice per year between 1993 and 2019, and Antarctica losing about 148 billion tons per year. Glaciers around the world, including in the Alps, Himalayas, Andes, Rockies, Alaska, and Africa, are retreating. Satellite observations show that spring snow cover in the Northern Hemisphere has decreased over the past five decades, and the snow is melting earlier. Climate change is causing our oceans to warm and glaciers to melt, resulting in sea level rise. The extent and thickness of Arctic sea ice have declined rapidly over the last few decades. Extreme weather events are happening more frequently and can have far-reaching impacts on communities, causing critical system failures. The impacts of extreme events are not confined to the place where they occur and can cause a sequence of climate hazards that cover large regions, such as flooding, droughts, and wildfires.

"Is it possible to reverse global warming?" is a question that may arise. If we completely stop all global net emissions, the warming that we've caused will gradually begin to reverse. However, it may take several decades for this to happen. Unfortunately, other changes induced by climate change will persist for decades, if not centuries. For instance, the rise in sea levels will likely take thousands of years to reverse its course.

The younger generation needs to be equipped with knowledge and critical thinking skills to effectively handle the inevitable obstacle of climate change and its impacts. Education plays a crucial role in the urgent global fight against climate change. Providing knowledge to children regarding climate change can help them in the following ways:

- 1) Understand the magnitude of the problem and deal with the consequences of global warming.
- 2) Motivate them to modify their daily activities and lifestyle to reduce the effects of climate change.

3) Enable them to adapt to the global emergency that is already upon us.

Teaching climate science and raising awareness about climate change in schools is a crucial step in combating climate change in the upcoming years. Today's youth will eventually become the decision-makers and policy-makers of tomorrow, and it is therefore their responsibility to shape a brighter future for humanity.

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A BIBLIOMETRIC ANALYSIS OF ONLINE LEARNING IN HIGHER EDUCATION: A COMPARISON OF RESEARCH TRENDS BEFORE AND DURING THE COVID-19 PANDEMIC

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Abstract

Online learning has a considerable history in higher education, implying that it is not a novel concept. However, with its primary purpose of providing education for those otherwise unable to participate in a traditional learning setting, online learning became an emergency and mandatory mode of learning during the Covid-19 pandemic. Therefore, this paper explores research trends of online learning in higher education before and during the pandemic by applying several bibliometric approaches. The results of the bibliometric analysis reveal differences in research trends before and during the pandemic and provide evidence-based guidelines for supporting higher education in the future.

Introduction

This paper aims to examine the impact that Covid-19 had on research about online learning in higher education. This mode of learning has been studied over the last decades. Education institutions have been using online learning with a rising frequency, as it has been considered an innovation in learning, which brings on new opportunities in knowledge transmission or dissemination. However, until the end of 2019, educators, instructors or policymakers would treat online learning as optional. This changed drastically at the beginning of the year 2020 when online learning was decided as the only option for delivering teaching or instruction due to lockdowns and restrictions. Therefore, it was imposed through the paradigm of Emergency Remote Teaching (Fuchs, 2022).

This forced the implementation of online learning in higher education and triggered the interest of the researchers in that research topic. Studies have shown that there are advantages to using online learning (Dumford & Miller, 2018; Mukhtar et al., 2020; Yuhanna et al., 2020). First, it can provide flexibility in the delivery of education in terms of time and place, leading to greater participation. Second, it

may permit learners to have their own pace in catching up with the requirements of a course, especially in cases of asynchronous teaching. Third, it can provide interaction, mainly through Web applications, that can be embedded in the teaching process (Adedoyin & Soykan, 2023).

However, online learning has significant challenges. Both teachers and students might feel isolated and stressed. To respond to course requirements, they have to demonstrate not only academic qualities but digital competency, as well. Apart from that, there is also a need for appropriate context and infrastructure in educational institutions. These challenges were particularly evident in the case of Covid-19. Since the institutions were obliged to use online learning through Emergency Remote Teaching, the platforms for learning had to accommodate a large number of participants. Aside from that, teachers and students who were not very familiar with digital technologies were obliged to become so (Fuchs, 2022; Maatuk et al., 2022).

Accordingly, this paper aims to point out whether these issues are reflected in the research trends around online learning in higher education before and during the Covid-19 period and reveals the shift towards emergency remote learning. The paper is structured as follows. After the introduction section, the next section presents a short literature review. The following section explains the materials and methods. The next section presents the main results of the bibliometric analysis. The paper ends with a conclusion in which the main findings are summarized.

Literature Review

Online learning at all levels of education has attracted the interest of bibliometric studies over the last decades. Rodríguez Jimenez et al. (2019) aimed to investigate the production of articles relating to using Technologies in Higher Education through the Web of Science database. The researchers gathered 1689 articles from 656 journals published between 1972-2019. However, a surge in the number of publications was observed during the decade of the 2010s, especially on articles that focus on training future teachers and professionals to use technology in their work. According to the researchers, this tendency is expected to continue, while technology would not be considered only as means for teaching but as a stimulus for new ideas and ways of thinking.

Similarly, Hernández et al. (2017) have investigated research activity as it takes place in learning communities based on ICT. These communities aim to disseminate and exchange knowledge between members through technology-based functions. By investigating through Scopus, the researchers collected 226 publications. With regards to the number of publications per year, it was observed that this rate peaked in 2010, whereby a slight decrease followed. The main

conclusion was that ICT assists learning communities. However, their function needs to focus on four fundamental principles: access, creation, collection and connection of materials. It is additionally established that cooperation between community members was a basic condition for an efficient outcome.

Chen et al. (2019) investigated research topics, authors' profiles and collaboration networks based on 3963 articles retrieved from the Web of Science, published between 1978-2018, in *Computers & Education*. The researchers conclude that there has been an increase in the number of articles, especially after the first decade of 2000. Collaborations are also increasing, especially between authors of the same institution or the same country. The most frequent keywords occurring in the articles were “interactive learning environment”, “teaching/learning strategies”, “pedagogical issue” and “computer assisted communication”.

Tibaná-Herrera et al. (2018) have investigated publications regarding e-learning in 3680 articles from 219 journals, published between 2012 and 2014, as collected through Scopus. E-learning was found to be linked to different issues that the researchers describe as “descriptors”. These can be modes of learning such as online, social, lifelong, or virtual learning. It was also linked to applications such as simulations, augmented reality, MOOCS, and education technology. Lastly, it was linked to instructional issues such as learning objects, instructional design, learning environment, teaching and learning, and learning analytics. Küçük-Avci et al. (2022) investigated 746 articles on online learning published between December 2019 and January 2020, right before the outbreak of the Covid-19 pandemic. They concluded that the most frequent keywords were “higher education”, “e-learning”, “blended learning” and “distance education”. This demonstrates the application these types of online learning have in higher education institutions.

In addition, there is significant bibliometric research on implementing online learning during the Covid-19 pandemic after the year 2020. Baber et al. (2022) carried out a bibliometric study of publications on digital literacy. They examined 2307 articles published between 2017 and 2021. The main findings were that the rate of publications around digital literacy has risen during these years. Digital literacy is associated with concepts such as fake news, education, competency and Covid-19. In a bibliometric study, Karakose and Demirkol (2021) aimed to explore the impact of Covid-19 on research trends. In doing so, they investigated 8324 articles published during the year 2020. They concluded that topics such as online learning, distance education, blended learning, and teacher education came in greater frequency than others. Most of the publications disseminated research on data deriving from content analysis, descriptive statistics, correlation or interviews. The samples were usually students, teachers, university teachers, and academics.

Lastly, they also concluded that the field of health concerned a comparatively larger number of these publications.

Zhang et al. (2022) provided a holistic view of research on online learning during the Covid-19 lockdown period. Through research on 1061 articles, they conclude that online learning has been implemented and researched in the context of higher education, by a rising number of authors and research groups, in many countries around the world. Challenges were mentioned in the articles, such as infrastructure, teacher training, student preparation, and mental health issues. Similar was the bibliometric research by Çiçek Korkmaz and Altuntaş (2022), who examined 1280 articles published on nursing and health education. They concluded that there is a rising interest in researching that area of study, especially as concerns topics such as students, online learning and the effect of the pandemic. The countries with the largest number of publications were the United States, China, Spain, Australia, Brazil, Turkey, and England.

There were research projects examining specific fields of study. Karakose et al. (2021) investigated the effects that Covid-19 had on medical education at the global level. By analyzing 446 articles, they concluded that the countries with the greatest number of publications were the United States, the United Kingdom, China, Singapore, and Canada. Among the most frequent keywords were “telemedicine”, “online teaching”, and “e-learning”, which proves that these concepts have grabbed the interest of researchers in the field. Metinal and Gumusburun Ayalp (2022) conducted a bibliometric analysis regarding articles about architectural education during Covid-19. They concluded that there was a focus on online learning and distance education. Topics that have risen are the students' experience with online learning, transition and adaptation, blended learning implementation, and curriculum and development, along with other trends about re-organization and integration.

The main conclusion is that the previous bibliometric studies before the Covid-19 pandemic have investigated the research trends around the publications of education technologies before 2020. These focused on different aspects and contexts of using technologies in learning. The common conclusions were perhaps the rising number of publications and the variety of keywords around education learning, which reflect probably the complexity of this topic, along with its necessity (Hernández et al., 2017; Rodríguez Jiménez et al., 2019; Tibaná-Herrera et al., 2018; Chen et al., 2019). On the other hand, the bibliometric studies around online learning during the Covid-19 lockdown period are significant in number. A common conclusion is that there is interest in what concerns online learning and its application (Baber et al., 2022; Zhang et al., 2022). Aside from that, some fields, such as health studies, seem to prevail (Karakose & Demirkol, 2021; Karakose et al., 2021).

Materials and Methods

The bibliometric data on online learning in higher education was retrieved on 1 January 2023 from Scopus, a world-leading bibliographic database of peer-reviewed literature. The Scopus database was preferred because it has a broader coverage of scientific research than other databases such as Web of Science (Falagas et al., 2008). This was further confirmed with the initial search using the same search query in both databases, revealing that Scopus provided more relevant documents than Web of Science. Moreover, compared to the Scopus database, the Web of Science significantly underrepresents scientific disciplines of the Social Sciences and Arts and Humanities (Mongeon & Paul-Hus, 2016). Therefore, Scopus appears to be a more relevant bibliographic database meeting the specifics of this research.

The search query covered keywords related to different online learning types. To compare the research on online learning in higher education, the search was conducted separately for the period before (2017-2019) and during (2020-2022) the Covid-19 pandemic. The search for the second period was additionally limited using “covid” as a keyword, isolating Covid-19-related research from other general research on online learning. Finally, the obtained collection of documents on online learning research was narrowed to documents related only to higher education, thereby excluding documents related to primary, secondary, and adult education. The bibliometric analysis utilized several bibliometric approaches, performed using the Python Data Analysis Library Pandas (McKinney, 2012).

Results

The search strategy for online learning research yielded 13139 documents, of which 6994 were published before and 6145 were published during the Covid-19 pandemic. The most relevant, highly cited documents in online learning research before and during the Covid-19 pandemic are presented in Tables 1 and 2. Before the Covid-19 pandemic, online learning research was predominantly focused on exploring the potential of virtual learning, including augmented/virtual reality, in the context of higher education (Jensen & Konradsen, 2018; Makransky et al., 2019; Ibáñez & Delgado-Kloos, 2018; Martín-Gutiérrez et al., 2017), with some attempts to appropriately adapt the distance learning process for some specific courses (Elgrishi et al., 2018). Recently, online learning research shifted towards exploring pedagogy (Bao, 2020; Rapanta et al., 2020; Pokhrel & Chettri et al., 2021), life and work (Aristovnik et al., 2020) and higher education delivery (Mishra et al., 2020).

Table 1*Most Relevant Documents before the Covid-19 Pandemic*

Authors	Year	Title	Source title	Cited by	Online learning	Country
Elgrishi et al.	2018	A practical beginner's guide to cyclic voltammetry	Journal of Chemical Education	1463	Distance learning	US
Jensen & Konradsen	2018	A review of the use of virtual reality head-mounted displays in education and training	Education and Information Technologies	489	Virtual learning	Denmark
Makransky et al.	2019	Adding immersive virtual reality to a science lab simulation causes more presence but less learning	Learning and Instruction	460	Virtual learning	Denmark
Ibáñez & Delgado-Kloos	2018	Augmented reality for stem learning: A systematic review	Computers and Education: Eurasia Journal of Mathematics, Science and Technology Education	376	Virtual learning	Spain
Martín-Gutiérrez et al.	2017	Virtual technologies trends in education	Mathematics, Science and Technology Education	358	Virtual learning	Spain

Note. Top cited documents in online learning research before the Covid-19 pandemic.

Source: Authors' elaboration based on the Scopus database.

Table 2*Most Relevant Documents during the Covid-19 Pandemic*

Authors	Year	Title	Source title	Cited by	Online learning	Country
Bao	2020	Covid-19 and online teaching in higher education: A case study of Peking university	Human Behavior and Emerging Technologies	954	e-learning	China
Rapanta et al.	2020	Online university teaching during and after the Covid-19 crisis: Refocusing teacher presence and learning activity	Postdigital Science and Education	716	e-learning	Portugal
Aristovnik et al.	2020	Impacts of the Covid-19 pandemic on life of higher education students: A global perspective	Sustainability (Switzerland)	682	e-learning	Slovenia
Mishra et al.	2020	Online teaching-learning in higher education during lockdown period of Covid-19 pandemic	International Journal of Educational Research Open	637	e-learning	India
Pokhrel et al.	2021	A literature review on impact of Covid-19 pandemic on teaching and learning	Higher Education for the Future	561	e-learning	Bhutan

Note. Top cited documents in online learning research before the Covid-19 pandemic.

Source: Authors' elaboration based on the Scopus database.

The most productive and characteristic countries for each period, i.e. before and during the Covid-19 pandemic, as well as countries which cannot be statistically classified (Yule Q) into one of these two groups (neutral), are presented in Table 3. It is evident that large and developed countries were more involved in online learning research before the Covid-19 pandemic (with some equally engaged in both periods) while emerging and predominantly large Muslim countries increased

their research activity during the Covid-19 pandemic. This implies that in large and developed countries, online learning was already well-established before the Covid-19 pandemic and has been only further expanded to accommodate increased demand. In contrast, numerous emerging and large Muslim countries have faced greater challenges (e.g., poor internet connection, insufficient knowledge about the use of ICT, etc.) in transitioning to online learning, leading to higher interest in the research during the Covid-19 pandemic (Maatuk et al., 2022).

Table 3

Characteristic Countries before and during the Covid-19 Pandemic

Before	Neutral	During
Australia	China	Saudi Arabia
United Kingdom	Canada	Indonesia
Spain	Hong Kong	India
Russian Federation	Portugal	Turkey
United States	France	Malaysia

Note. Countries in the before and during group are sorted by Yule Q, while countries in the neutral group are sorted by the number of documents.

Source: Authors' elaboration based on the Scopus database.

A similar classification of most productive and characteristic sources, i.e., scientific journals, is presented in Table 4. It reveals a significant shift towards publishing online learning research in open-access journals, as observed by some of the previous bibliometric studies of online learning during the Covid-19 pandemic (Zhang et al., 2022).

Table 4

Characteristic Sources before and during the Covid-19 Pandemic

Before	Neutral	During
Turk. Online J. Distance Educ.	Educ. Inf. Technol.	Int. J. Environ. Res. Public Health
Online Learn. J.	J Chem Educ	Front. Educ.
Br J Educ Technol	Interact. Learn. Environ.	Front. Psychol.
IEEE Access	Int. J. Interact. Mob. Technol.	Sustainability
Int. J. Emerg. Technol. Learn.	Electron. J. e-Learning	Educ. Sci.

Note. Sources in the before and during group are sorted by Yule Q, while sources in the neutral group are sorted by the number of documents.

Source: Authors' elaboration based on the Scopus database.

Based on the extensive examination of keywords in the obtained collection of documents, three main pillars of online learning research were identified, namely: 1) ICT tools, including five different tools, which can be used in the context of online learning; 2) online learning approaches, covering six possible approaches to provide higher education; and 3) fields of study, including five main fields emphasized in the analyzed collection of documents. These pillars and

corresponding keywords are included in the analysis presented in Table 5 to determine characteristic ICT tools, online learning approaches, and fields of study before and during the Covid-19 pandemic.

Table 5

Characteristic Keywords before and during the Covid-19 Pandemic

ICT tools	Yule Q	Online learning approaches	Yule Q	Field of study	Yule Q
video conference	0.758	distance learning	0.376	medical education	0.363
social media	-0.135	virtual learning	0.274	mathematics education	0.112
augmented/virtual reality	-0.404	e-learning	0.154	social work education	0.012
learning management system	-0.417	blended learning	-0.243	nursing education	-0.072
mobile application	-0.575	computer/web-based learning	-0.580	engineering education	-0.177
		mobile learning	-0.654		

Note. Positive (negative) Yule Q coefficient indicates that a keyword is more characteristic for the period during (before) the Covid-19 pandemic. The bold number indicates a statistically significant coefficient ($p < 0.1$).

Source: Authors' elaboration based on the Scopus database.

Looking first at the ICT tools, the results suggest that video conferences are discussed in online learning research, especially during the Covid-19 pandemic, while the remaining tools seem to be highlighted in the research before the Covid-19-pandemic. As regards online learning approaches during the Covid-19 pandemic, most attention was devoted to exploring distance learning (pre-recorded online lectures), followed by virtual learning (real-time online lectures) and e-learning (a combination of asynchronous and synchronous learning). Since all these online learning approaches limit physical contact between teachers and students, they have been referred to as emergency remote learning approaches (Fuchs, 2022), while the remaining approaches (mobile learning, computer/web-based learning, and blended learning) do not necessarily take place in an online learning environment. Finally, medical education seems to be highlighted during the Covid-19 pandemic, while engineering education before it, as suggested by a significantly lower number of documents published in this period, implying not necessarily the irrelevance of engineering education in the post-Covid-19 era.

Finally, the results of binary regression analysis, in which some relevant keywords are regressed against the main ICT tools, are presented in Table 6. They suggest that academic success factors, such as student engagement and professional development, were more important before the Covid-19 pandemic, particularly in the context of video conferences, while mobile applications were more related to (student) self-efficacy and attitude. On the other hand, technology factors, such as artificial intelligence and technology acceptance, were relevant both before and after the Covid-19 pandemic, especially in the context of learning management

systems. Additionally, pedagogy issues emerged as significant factors in augmented/virtual reality and learning management systems during the Covid-19 pandemic, as well as in the context of mobile applications in both periods. As expected, public and mental health issues were more widely discussed in online learning research during the Covid-19 pandemic, especially in relation to social media. Finally, medical (and also nursing) education received greater attention during the Covid-19 pandemic in the context of video conferences, whereas less focus was given to these fields of study in the context of learning management systems. Finally, engineering education is related to augmented/virtual reality before the Covid-19 pandemic and learning management systems during the Covid-19 pandemic.

Table 6
Results of Binary Logistic Regression

	video conference		social media		augmented/virtual reality		learning management system		mobile application	
	before	during	before	during	before	during	before	during	before	during
Academic success										
academic performance				1.069						
student engagement	2.110		0.876							
self-efficacy									1.706	
attitude									1.501	
professional development	2.274									
Technology										
artificial intelligence							0.699	0.969		
digital divide			1.703							
technology acceptance							1.074	1.611		
Pedagogy										
evaluation								1.014		1.910
pedagogy						1.275				
teaching methods										2.671
Public and mental health										
public health				1.380						
anxiety					1.620					
depression				2.543						
Fields of study										
medical education		0.731					-2.124	-1.607		
nursing education		1.182					-1.684		1.394	
engineering education					1.568			1.236		

Note. The binary logistic model is performed on 30 predictors, whereby each cluster was tested separately. Only statistically significant coefficients ($p < 0.1$) are presented. A positive (negative) coefficient indicates that a document with a selected keyword is likely (unlikely) to be related to a certain ICT tool.

Source: Authors' elaboration based on the Scopus database.

Conclusion

The present bibliometric study provides several important insights from online learning research before and during the Covid-19 pandemic. The results reveal that the most recent top-cited documents focused on pedagogy, life and work, and higher education delivery. Moreover, the results show that large and developed

countries were already well-established in online learning research before the pandemic, while emerging and predominantly large Muslim countries increased their research activity during the pandemic. This suggests that former countries were better equipped to handle the transition to online learning, while the latter faced challenges, resulting in a higher interest in research during the pandemic (Maatuk et al., 2022). The results further reveal a significant shift towards publishing online learning research in open-access journals, which is also observed by some of the previous bibliometric studies of online learning during the Covid-19 pandemic (Zhang et al., 2022). Furthermore, the results also reveal that online learning research was recently discussed in the context of so-called emergency remote learning (Fuchs, 2022), as suggested by distance learning, virtual learning, and e-learning aiming to limit physical contact between teachers and students, being the most characteristic online learning approaches after the Covid-19 pandemic. Finally, regression analysis reveals the most important factors predicting selected ICT tools.

Before generalizing these conclusions, it is important to point out the limitations of the paper. First, the bibliometric analysis relies on documents indexed in the Scopus database, which might not cover the entire collection of the research. Therefore, utilizing other databases like the Web of Science may have disclosed some further insights not revealed by this paper. Second, despite the detailed search query, some other relevant keywords might not be considered in the document search. Finally, as a methodological approach based on big data analysis, the bibliometric method may miss certain highlights from the scientific literature that a systematic literature review would otherwise capture. Regardless of these limitations, the findings may benefit the scientific community in facilitating the detection of research gaps in online learning research during the Covid-19 pandemic and evidence-based policymaking to help identify appropriate educational practices in emergencies.

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TEACHER EDUCATORS' DIGITAL COMPETENCE: FIRST RESULTS OF A SYSTEMATIC LITERATURE REVIEW

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Abstract

What defines a digitally competent teacher educator? This systematic literature review was set out to answer that specific question. Eight national and international frameworks for the digital competence of teacher educators were selected and are analyzed and compared through a qualitative content analysis. This paper gives an overview of the theoretical background and the method of this research. Furthermore, first findings of the systematic literature review are presented and discussed in terms of what they imply for further research and for teacher education in Germany.

Introduction

Nowadays, it is impossible to imagine life without digital technologies. They will therefore continue to play an increasingly important role in education in the future. In recognition of the many potentials that digital media offer for teaching and learning, this is initially a positive development. But in order to exploit their full potential, digitally competent teachers are needed. According to research, teachers in Germany currently lack digital competence (Eickelmann et al., 2016). One reason for this is certainly that teacher training does not adequately prepare prospective teachers for the professional use of digital media (Senkbeil et al., 2020). The inevitable question arises as to the causes of this. Part of the reason might be due to the fact that there are not enough competent educators at the universities. As Tondeur et al. (2012) have shown, educators are important role models for student teachers, and at the same time their own digital competence plays a key role in preparing prospective teachers to use digital media in class. However, recent studies - at least in Germany - only focus on the digital competence of pupils, student teachers, and practicing teachers (Capparozza & Irle, 2020). So far, we hardly know anything about the digital competence of university teachers in teacher education.

But before one can investigate the digital competence of teacher educators, we need to know what defines a digitally competent teacher educator. In Germany, there is a lack of binding standards or research regarding this topic. This literature review tries to find an answer to the question of which competences teacher educators need in order to be digitally competent. Before describing the methodology and first

results, this paper addresses the concept of digital competence and related frameworks.

Digital Competence

In general, competences describe desired outcomes and achievement goals, usually with respect to an educational process. Digital competence is a term with no consistent definition. In the context of higher education, it is often used without any definition at all (Spante et al., 2018). According to the European Commission (2019) “digital competence involves the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society” (p. 10). According to this definition, depending on the context (e. g. work, participation in society, etc.), different competences are needed. Additionally, this means that the required digital competences might also differ depending on the profession – a physician may need different professional digital competences than an architect.

From a theoretical point of view, it is possible to distinguish between competence as a latent construct and the observable behaviors it enables. Correspondingly, competence models can be distinguished from target statements or standards. In general, *competence* can be defined as consisting of knowledge, skills, and attitudes (Wiater, 2013; Frezza et al., 2018). A competency model then primarily specifies its internal structure, i.e., what knowledge, skills, and attitudes are involved in a particular competence and how they are interrelated to form a coherent construct.

In contrast, a *target statement* describes a particular observable behavior whose successful performance requires the right-minded and skillful application of knowledge in a certain situation (Clear et al., 2020). As such, it represents an operationalization of the latent competency construct. Moreover, multiple target statements may refer to the same competence, e.g. at different levels of mastery. Target statements describe what certain individuals are ultimately expected to be able to do, often at various intermediate stages throughout an educational program, which serves as a basis for the development of both interventions and assessment instruments.

In practice, the development of competency models and target statements involves complex and often interrelated processes. They might be derived from theory, or relevant competences can be determined empirically. Often, a combination of theoretical and empirical work is used. In recent years, different approaches were used to describe the digital competence for teacher educators (e.g., Foulger et al., 2017). Yet a commonly accepted set of target standards does not exist.

Method

To identify relevant digital competences for teacher educators, a literature review was conducted. Relevant competency frameworks are compared to a qualitative content analysis.

Systematic Literature Review

In the following, the search strategy of the literature review and the selection process of relevant frameworks are presented.

Search Strategy

The intention was to include literature, published in English or German, from Computer Science as well as from Educational Sciences. To cover this broad spectrum, three literature databases were therefore selected (below, the name of each database is hyperlinked, followed by the actual URL):

- [dblp Computer Science Bibliography \(https://dblp.dagstuhl.de\)](https://dblp.dagstuhl.de): A database of English and German language results in the field of Computer Science.
- [ERIC-Institute of Education Sciences \(https://eric.ed.gov\)](https://eric.ed.gov): A database with English-language results from the field of Educational Sciences
- [FIS Bildung Literaturdatenbank \(https://www.fachportal-paedagogik.de/literatur/produkte/fis_bildung/fis_bildung.html\)](https://www.fachportal-paedagogik.de/literatur/produkte/fis_bildung/fis_bildung.html): A database with German-language results from the field of Educational Sciences

The search was conducted between June and October 2022. Search terms were combinations of keywords regarding the digital competence (*digital, competenc**, *literac**), the target group (*teacher, educator, teacher educator*), the educational institution (*higher education, university*) and requested document type (*framework, model*). German translations were used analogously as well. Only search results from the last ten years were considered (sources that were published in 2012 or later) to ensure to find frameworks that are not outdated.

Selection Process

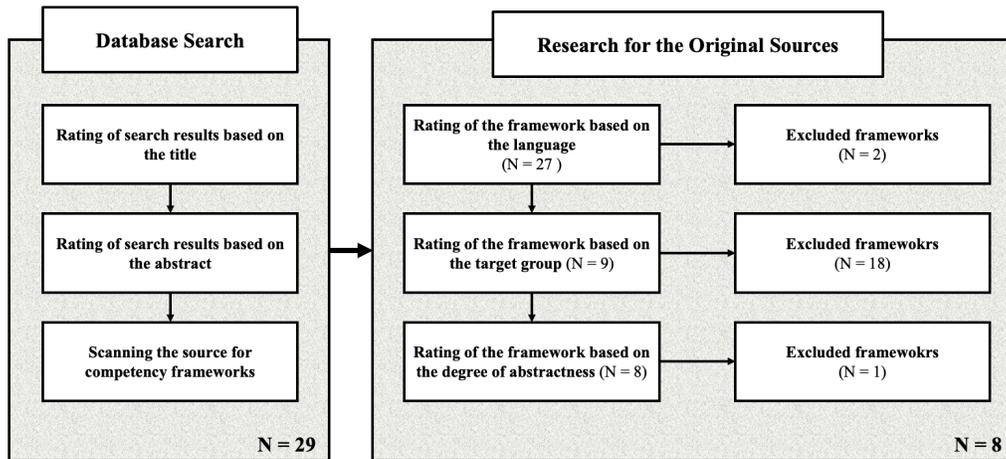
The search results were filtered according to the process outlined in Figure 1. They were either considered or immediately discarded based on their title. If the title seemed to be relevant for the research, the abstract was read and again a decision was made about consideration or exclusion. All sources judged to be relevant were read and the competency frameworks mentioned in the text were listed.

The original sources for the competency frameworks were then researched. Competency models that were mentioned in the original sources were also included in the list. A total of 29 relevant competency frameworks were identified. The frameworks were either included or excluded based on the following factors:

- Language of the publication
- Target group
- Degree of abstractness

Figure 1

Procedure of the systematic literature review



Due to language barriers, frameworks that have not been published in English or German were excluded. Furthermore, frameworks that did not deal with professional digital competences of university educators in teacher education were excluded. Lastly, only frameworks that actually include target statements rather than just talk about the digital competence on a very abstract level (like Krumsvik’s 2014 model for teacher educators’ digital competence), were included. Examples for concrete target statements are:

Teacher educators “*evaluate content-specific technology for teaching and learning.*” (Foulger et al., 2017, p. 432)

“*Teacher educators can search and select useful information and teaching materials from media provisions.*” (Meeus et. al, 2014, p. 49)

Qualitative Content Analyses

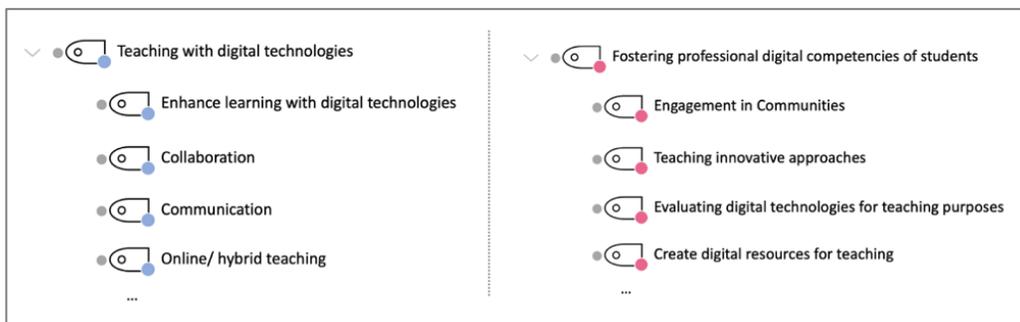
A comparative content analysis of the corresponding documents (N = 8) followed, with the aim of finding a core of competences shared across all models. The guiding questions for the analysis were:

- Which competences are listed in the competency frameworks?
- Which competences are mentioned particularly frequently?
- Which competences appear in all competency frameworks?

The qualitative content analysis follows the steps proposed by Mayring and Brunner (2006) in their process model for inductive category formation. After the selection and characterization of the material, background information about each framework was gathered in order to summarize its communicative context, particularly its development process, its target group, and its intended purpose. The smallest coding unit was set to one sentence while the smallest context unit was set to one word. For the coding runs, only the target statements are considered. During the first coding iteration, categories were inductively formed. The produced codes were kept very wide-ranging. They include knowledge areas (e. g., knowledge about media didacts) as well as application areas (e. g., using digital technologies for assessment), attitudes (e. g., digital leadership) or more concrete operating capabilities (e. g., sharing digital resources). Afterwards, the codes were grouped together into top categories (for examples see Figure 2).

Figure 2

Extract from the code structure of the first coding run



This will be followed by a second coding iteration in which the categories will be adjusted and concretized to ensure comparability. Thereafter, each code should represent a concrete description of a competence target. After an intercoder reliability check, the gathered data will then be analyzed and evaluated.

First Findings

The following is a brief description of the first findings of this research. As previously mentioned, the comparative content analysis has not been completed at this point. Therefore, the final results of the analysis of the entire data are still pending. Nevertheless, there are already some interesting results obtained.

Selected Frameworks

The eight competency frameworks that are listed in Table 1 remained after the selection process and were included in the content analysis. All of them originate from Europe and the USA. Each of them can be of use in describing the digital competences of teacher educators. However, only three of them are explicitly developed for just this target group. The other ones do also apply to teacher educators but do not exclusively target them. Appropriate theories and models were used in the development of all these frameworks. Additionally, some of them used empirical methods such as interviews or the Delphi method (Linstone & Turoff, 1975) to develop corresponding competences.

Table 1

Final Set of Digital Competency Frameworks for teacher educators

Competence Framework	Authors/ Year	Country of Origin
Digital Competence Framework for the Digital Competence of Educators (DigCompEdu)	Redecker (2017)	Europe
Media Didactica	Meeus et al. (2014)	Belgium
Digitalisierungsbezogene Kompetenzen von Lehrenden in den Lehramtsstudiengängen	Schaarschmidt et al. (2020)	Germany
Digitale Kompetenz bei Hochschullehrenden	Eichhorn et al. (2017)	Germany
Digital Literacy Framework	Holdener et al. (2016)	Switzerland
DigiCap Six Elements of Digital Capabilities – Teacher Profile Higher Education	Jisc (2022)	United Kingdom
The Digital Practitioner (TDP)	Benett (2014)	United Kingdom
Teacher Educators Technology Competences (TETCs)	Foulger et al. (2017)	USA

Digital Competence Framework for the Digital Competence of Educators (DigCompEdu)

The DigCompEdu framework was published by the Joint Research Center of the European Commission. It provides a common frame of reference to support national, regional, and local efforts to promote digital competency among all educators in the European Union (Redecker, 2017). The competency framework includes a total of 22 professional competences that teachers (regardless of the educational institution at which they teach) should have. Its design started with a literature review and was a collaborative process which included over 100 educators and other experts on this field.

Media Didactica

Meeus et al. (2014) designed a framework for each of the three groups: pupils, teachers, and teacher educators. Therefore, it includes one of the frameworks that apply just for teacher educators. They used existing frameworks as a foundation for their own proposal. For teacher educators they identified digital competences for three areas: media use in teacher education, professional development, and education and training community.

Digitalisierungsbezogene Kompetenzen von Lehrenden in den Lehramtsstudiengängen (DiKoLA)

The DiKoLA framework designed by Schaarschmidt et al. (2020) is also explicitly meant for teacher educators. It was created with the goal of serving as a frame of reference in the further development of university teaching in teacher education programs. Other frameworks were used as a foundation and the competences extracted from those frameworks were combined into a new model.

Digitale Kompetenz bei Hochschullehrenden

Eichorn et al. (2017) did not just focus on teacher educators but educators in higher education – which includes teacher educators. The Digital Literacy Framework of Holdener et al. (2016) served as a basis, which they enriched with a further competence area and a progression model.

Digital Literacy Framework

The Digital Literacy Framework by Holdener et al. (2016) was developed as an orientation framework for the intended strategy development process at the Lucerne University of Applied Sciences and Arts and should thus primarily assume conceptual rather than operational functions. Therefore, it was designed by an

interdisciplinary group of faculty members. It targets all educators in higher education and is based on an earlier version of the Jisc Framework (described below), which in this form no longer exists.

DigiCap Six Elements of Digital Capabilities – Teacher Profile Higher Education

The British organization Joint Information Systems Committee (Jisc) describes six areas of competence in its Digital Capabilities Framework (Jisc, 2022), which are specified in various role profiles for different university target groups (e.g., students, researchers, teachers). Those are not to be understood as a competency model but are rather intended to show how the framework can be adapted to different university target groups. They are intended to be used by individuals for the self-assessment of their own competence and for the development of further training. The framework was developed in a co-design approach and considered other frameworks as well as opinions of experts.

The Digital Practitioner (TDP)

Bennett's (2014) TDP model draws on an existing digital literacy framework for undergraduates and attempts to adapt it to higher education faculty. For this purpose, interviews were conducted with 16 university lecturers on their learning and teaching practices with digital technologies.

Teacher Educator Technology Competencies (TETCs)

The TETCs were developed by Foulger et al. (2017) after an initial literature review using the Delphi method. Numerous experts from both the research and policy communities participated in the development process. The result is a competency model for teacher educators that describes 12 competencies, each of which is supplemented by certain sub competencies.

Identified Competences

Within the comparative content analysis, the competences found in the frameworks were clustered into the following competence groups:

- Science and research activities
- Teaching with digital technologies
- Use and understanding of digital technologies
- Attitudes towards digital technologies
- More general professional competences
- Fostering professional digital competences of students

- Fostering digital competences of students
- Considering culture, ethics, and society within the use of digital technologies

All frameworks contain competences regarding teaching with digital technologies and more general professional competences. The competence areas of attitudes towards digital technologies, use and understanding of digital technologies, and fostering digital competences of students were also represented in the majority of the frameworks. Competences regarding science and research activities and considering culture, ethics, and society within the use of digital technologies were mentioned rarely. The most interesting observation so far is the fact that competences regarding fostering the professional digital competence of the student teachers were only found in two of the three frameworks that were specifically developed for teacher educators and in none of the others. This suggests that corresponding learning objectives for these competences may not be included in many courses. Since this is arguably a competence area that marks the distinction between digital competences of teachers and those of teacher educators, competences in this area are particularly relevant to investigate.

Conclusion and Outlook

The conducted literature review sets out to gain a better understanding of the digital competence teacher educators should have to be able to prepare student teachers for the professional use of digital technologies. Initial findings of the comparative analysis of the frameworks indicate that there is a wide range of overlap: experts seem to agree on the significance of many competence areas for teacher educators. However, there are some competence areas that are not mentioned in a majority of the frameworks – prima facie this is because all the frameworks do not have the same focus. Further analysis may provide more information here.

To enhance the quality of teacher education in Germany regarding the professional use of digital technologies, universities may use the obtained results to develop standards for their educators in teacher education. The findings can also be used to develop appropriate training courses for teacher educators. To enable this, more research is required to determine exactly what this means for individual subject didactics.

Future research should also address the investigation of the actual digital competences of teacher educators. For this purpose, the design of valid measurement instruments is still outstanding. Currently, the investigation of digital competence is mostly done only with self-assessment tools only.

Even though the choice of literature databases attempted to cover a broad spectrum, not every relevant framework was considered with this literature search as all analyzed frameworks are from western countries (Europe or the United States of America). It would be quite interesting to take a look at the views from other parts of the world as well. The restriction of search results based on language was another contributing factor to not being able to include all relevant frameworks in the analysis. There are, for example, several publications in Spanish on the subject, for which there are no translations available.

Despite these limitations, the first findings of the study give a sense of what digital competences teacher educators are required to have and identifies which competency areas are mentioned in the frameworks analyzed. The secondary coding iteration within the content analysis will serve to concretize these results.

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CHALLENGES AND OPPORTUNITIES PRESENTED BY GENERATIVE AI-CHATBOTS: EFFECTS ON AN UNDERGRADUATE COURSE ON DATABASES

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Abstract

The recent revolution in chatbot technology based on artificial intelligence poses new problems in education. These machine learning systems have the ability to convincingly mimic human intelligence to an extent which makes it difficult to differentiate between answers generated by the chatbot versus answers written by a human expert. Not only news articles and essays, but also answers to homework assignments and even computer code can be generated with relatively little effort by using a generative AI chatbot. For instructors at institutions of higher education, ignoring these possibilities is not a realistic option. This paper presents an overview of the available relevant literature. Critical questions for instructors of computer science are raised. Experiences in an undergraduate course on databases are described. Initial lessons learned and resulting possibilities on how to integrate chatbot technology into teaching methods are presented.

Introduction

The term “chatbots” was first defined as a short-term moniker for a “chatter-bot” to denote an artificial intelligence application which could answer simple user questions (Mauldin, 1994). These initial chatbots were not very advanced. They were pre-programmed to answer a specific set of question with simple, predetermined answers. They were initially used to automate business processes, such as customer service.

Recently, a new generation of chatbots, such as Chat-GPT by OpenAI (OpenAI, 2023) and Bard (now Gemini) by Google (Google, 2023), have taken the media by storm. This revolution in chatbot technology is based on an artificial intelligence method called generative Large Language Models. These machine learning systems have the ability to convincingly mimic human intelligence to an extent which makes it difficult to differentiate between answers generated by the chatbot versus answers written by a human expert. Not only news articles and essays, but also answers to homework assignments and even computer code, can be generated with relatively little effort by using a generative AI chatbot.

For instructors of computer science, this technological revolution raises a number of critical questions:

1. Can instructors determine if students have actually completed homework assignments on their own, as opposed to just copying answers from a chatbot?
2. What effect does the availability of generative AI chatbots have on digital examinations? Are digital exams still feasible?
3. What should instructors be teaching their students in the future? Do students even have to learn how to program computers anymore?

First, an overview of the available literature will be presented. Next, experiences in an undergraduate course on databases will be described, examining solutions to lab assignments generated by ChatGPT. Initial lessons learned and possibilities on how to integrate comparing Chatbot technology into teaching methods will be presented. Finally, questions for further inquiry will be posed.

Relevant Literature

Generative Artificial Intelligence Chatbots

Large language models have been developed with advanced natural language capabilities. These artificial intelligence systems use deep learning methods to train language models on unstructured, unlabelled datasets, such as Wikipedia (Floridi & Chiriatti, 2020). Large language models are trained using statistical patterns of language on huge amounts of text available on the internet. These systems are called generative artificial intelligence because not only can they mimic human-like behavior as chatbots, but they can also perform intelligent searches, summarize text, and generate essays and computer code (Tamkin et al., 2021). The most widely known large language model chatbot is ChatGPT, which was released for free in November of 2022 (OpenAI, 2023). One reason for its widespread use was the fact that it was made available for free. Microsoft has also announced its investment in OpenAI, with the intention of incorporating it into its word processing software (Microsoft, 2023).

The rapid growth in the capabilities of generative artificial intelligence presents a number of opportunities for science and society. Some authors argue that generative AI chatbots can greatly speed up the process of writing and revising scientific articles. Pividori and Green (2023) demonstrated how an AI-based large language model could be used to suggest revisions to scholarly text. They predict that this development will revolutionize the performance of knowledge work.

On the other hand, Stokel-Walker and Van Noorden (2023) point out challenges caused by the use of generative AI. The unreliability of the results output by

ChatGPT and similar large language models is inherent to their method of learning. Because they are trained on content readily available on the internet, outdated facts, untruths, and inherent biases are part of their training data. Especially on topics with a low amount of training data, chatbots often return errors or misleading information. An editorial on ChatGPT in the journal *Nature Machine Intelligence* (2023) states that ChatGPT “cannot be trusted to get facts right or produce reliable references” (p. 1). As a result, a number of scientific journals, such as *Nature* and *Science*, have forbidden the use of any text generated by ChatGPT or any other AI tool (Thorpe, 2023).

A further concern is that because they are trained on the existing content of the internet, AI chatbots could further reinforce historical biases. To prevent this from happening, OpenAI installed filters to try to prevent ChatGPT from producing inappropriate content to hateful user prompts. Additional human moderators were required to flag certain text as toxic. Open AI has been criticized for allegedly paying Kenyan laborers less than \$2 per hour to train ChatGPT (Perrigo, 2023).

Chatbots in Higher Education

Even before the advent of generative AI, chatbots have been successfully used in educational contexts. Molnár and Szüts (2018) discuss the use of chatbots in education. Simple retrieval-based systems were initially used to help students find information about study programs and curricula. With the advent of more complex artificial intelligence, such as IBM’s Watson, it became possible to integrate a chatbot into a project-based learning class to teach about human-computer co-creativity (Goel et al., 2015). Watson was used to teach how to use biological systems as an inspiration to design new technological systems.

Shortly after the release of ChatGPT in November of 2022, Zhai (2022) reflected on the potential impact of generative AI chatbots on education. He demonstrated that with the aid of ChatGPT, it was possible to write a coherent, informative, and systematic research paper within 2-3 hours, without prior professional knowledge. The accuracy of the information used was not completely correct. He concludes that it will be necessary to adjust student learning goals. The use of AI tools can significantly increase the speed of conducting subject-domain tasks. He recommends that instructors should instead focus on improving students’ creativity and critical thinking skills.

Qadir (2022) explored the challenges and pitfalls presented by ChatGPT in engineering education. He points out the potential advantages of using chatbots as intelligent virtual tutors to offer individual students personalized, adaptive learning. One of its most dangerous limitations, however, is its lack of reliability and tendency to output so-called “hallucinative” misinformation (p. 8). The major

challenge lies in differentiating between acceptable and non-acceptable use of chatbots, especially with regard to assessments.

The problem which chatbots pose with respect to plagiarism in higher education was illustrated by an editorial written by ChatGPT in response to prompts from King (King & ChapGPT, 2023). The danger of college students abusing ChatGPT to cheat on assignments was deemed unethical by ChatGPT itself. The chatbot recommended that college professors should incorporate a wide variety of assessment methods which go beyond traditional essays, such as oral presentations or group projects. Hands-on activities which require students to demonstrate their knowledge and skills would be an interactive and engaging assessment method that might help avoid cheating.

Rudolph et al. (2023) identify a number of challenges presented by generative AI chatbots. In addition to problems identifying plagiarism, they are also concerned about ChatGPT's inability to evaluate the relevance or accuracy of information shared. They classify generative AI as a new, disruptive educational technology and stress the role of educators in managing this new situation. They caution that the failure to address these challenges can lead to the exposure of inadequate pedagogical methods.

Instead of focusing solely on the dangers posed by this new technology, one university instructor (Guerra-Pujol, 2023) decided to positively integrate AI chatbots into his course. As a first step, students are explicitly assigned to look up answers to discussion questions using AI chatbots. They post screenshots of the answers delivered by the chat bot to the course learning platform. Their task is to cross-check the chatbot's response for accuracy and to suggest factual, substantive, or stylistic revisions which would be necessary to improve this answer. In this way, students learn to work with this new technology responsibly, while at the same time developing their critical thinking skills. McMurtrie (2022) argues that with the integration of generative AI tools in word processing software, chatbots will become a normal part of writing, just as calculators and computers have become an essential part of math and science. ChatGPT can also open positive opportunities for student-centered pedagogies, such as experiential learning or game-based learning (Rudolph et al., 2023). They advise against a policing approach which completely forbids the use of AI tools. Instead, they recommend embracing this technological disruption to improve teaching methods. Instead of simple reproduction-centered assignments, instructors should strive to inspire students' creative and critical thinking abilities. By incorporating AI tools into discussions and assignments, they can learn the limits and faults of generative AI and learn to use them judiciously (Fyfe, 2022).

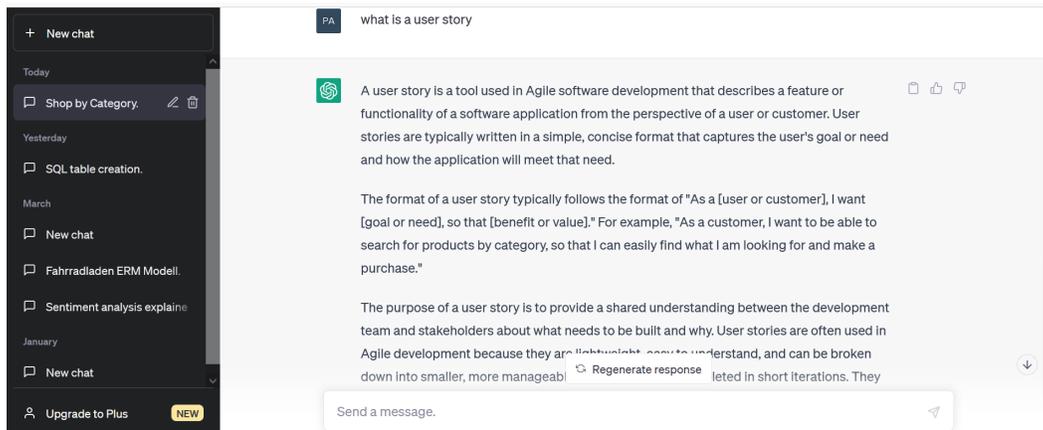
Observations in an Undergraduate Course in Databases

During the COVID-19 pandemic, contact restrictions necessitated online teaching and examinations. Many educators count themselves as lucky that ChatGPT did not yet exist at that time. The release of ChatGPT demonstrated that old-fashioned assessment methods could no longer be used. This section describes initial investigations into the effect of generative AI chatbots on an undergraduate course in databases. The free version of ChatGPT available in May of 2023 was used. Lab assignments were typed into ChatGPT and then the answers provided by ChatGPT were subjected to same grading scale used for students.

The first lab assignment for this course is to perform requirements engineering for a case study. Students are assigned to write user stories (Cohn, 2004) from the perspective of database users for a web shop. If a student feels unsure of how to write a user story, ChatGPT provides an initial introduction, as shown in Figure 1.

Figure 1

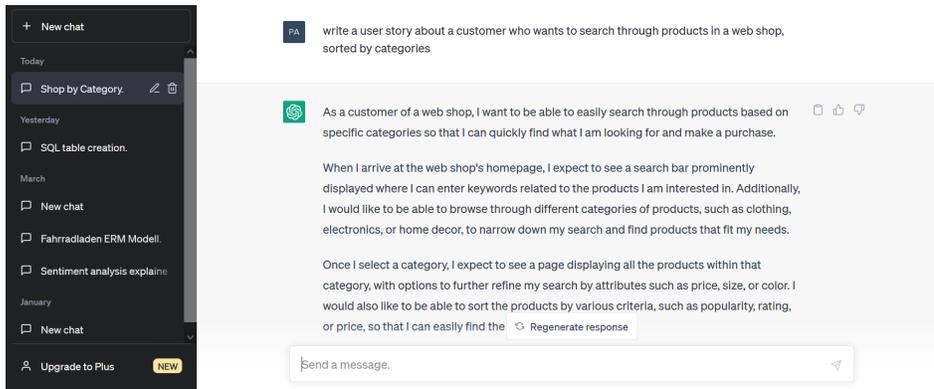
Introductory Text about User Stories Output by ChatGPT (OpenAI, 2023)



As shown in the first sentence of Figure 2, ChatGPT then correctly generated a user story utilizing the formal format as specified in agile software requirements engineering. The second and third paragraphs output by ChatGPT provide additional descriptive text and would not be considered part of the user story. The inclusion of scenario description which resembles UML notation rather than a user story would have led to a lower grade of “B”, good, but not perfect.

Figure 2

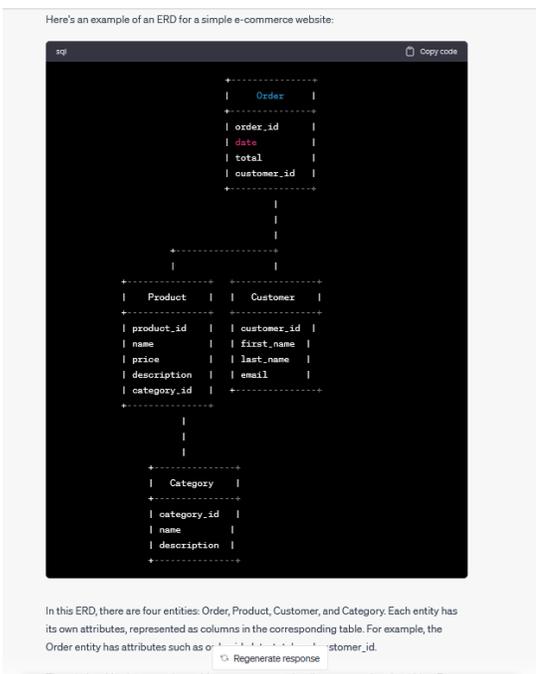
Solution to Text-based Lab Assignment by ChatGPT (OpenAI, 2023)



The next step in the development of a database would be to develop a conceptual model, called an Entity-Relationship Diagram (Bagui & Earp, 2011). As shown in Figure 3, ChatGPT was able to generate a primitive Entity-Relationship Diagram for a webshop, but not a specific one for the case study presented. For this lab assignment, the solution would receive a barely passing grade of “D”. While this solution was created by the free version of ChatGPT in May of 2023, the licensed, Plus version may produce better results for graphic diagrams.

Figure 3

Solution of Entity-Relationship Diagram by ChatGPT (OpenAI, 2023)

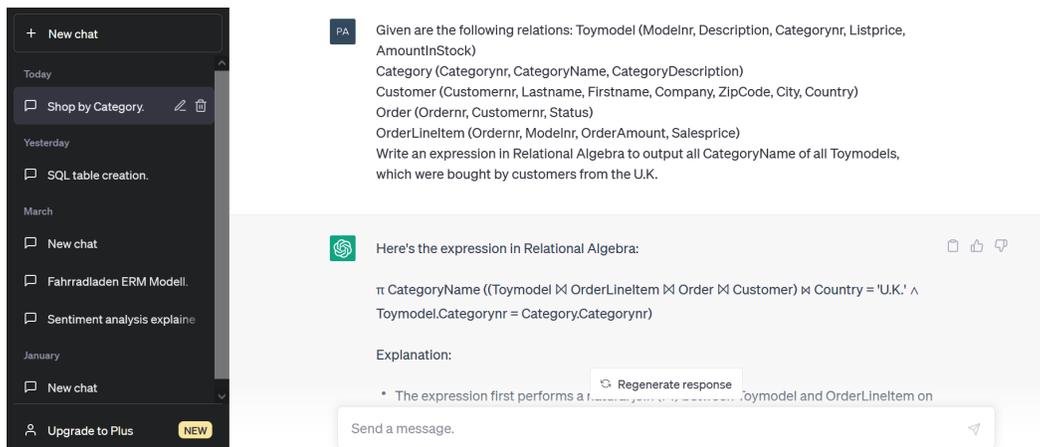


For the next lab assignment, a relational data model (Codd, 1980) was derived from this ER-diagram. The solution generated by ChatGPT was so general that it did not reflect the case study and thus also earned a grade of “D”.

Relational Algebra (Prade & Testemale, 1984) is an extremely formal topic in database theory, which many students have difficulty understanding. For this lab assignment, ChatGPT was able to produce a partially correct solution (Figure 4). The selection operator is missing, correlation operands are missing, and the sequence of the operators presented in the solution is inefficient. For this lab assignment, ChatGPT would get a grade of “C”, sufficient.

Figure 4

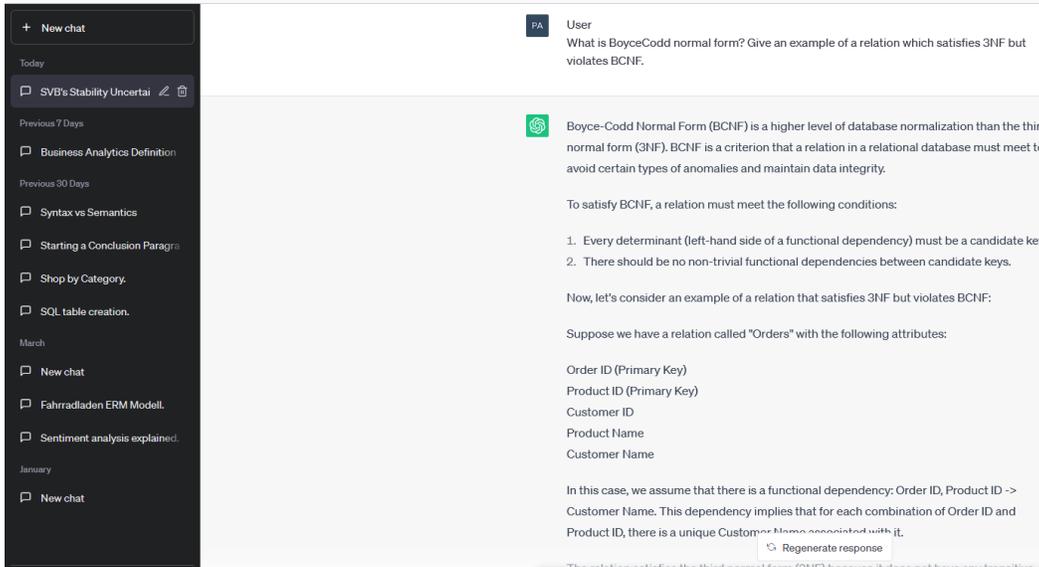
Solution to Relational Algebra Output by ChatGPT (OpenAI, 2023)



Normalization of a relational data model is a theoretical topic based on set theory (Codd, 1980). As shown in Figure 5, ChatGPT returns correct definitions.

Figure 5

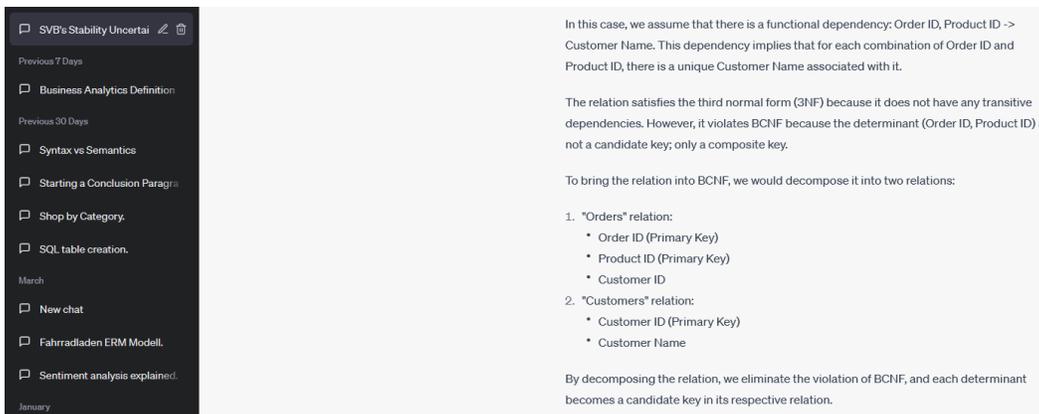
First Steps to Solve Normalization Output by ChatGPT (OpenAI, 2023)



However, as shown in Figure 6, ChatGPT gives incorrect answers when asked to actually solve the lab problem on normalization. Both functional dependencies and normal forms are incorrectly identified in the lab problem. This solution would receive the grade of "D", poor.

Figure 6

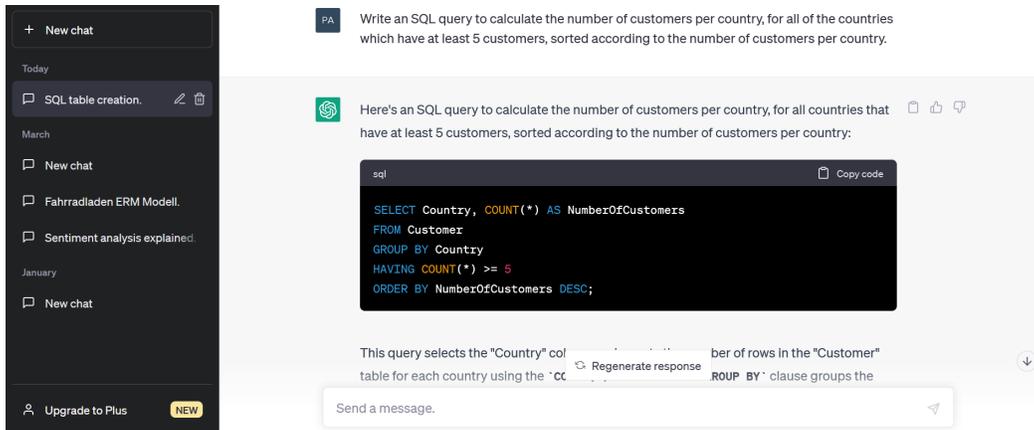
Incorrect Solution to Normalization Output by ChatGPT (OpenAI, 2023)



Programming assignments were easily solvable by ChatGPT. As shown in Figure 7, ChatGPT was asked to generate a query in the programming language SQL to calculate the number of customers in each country of the database and then to select only those countries which have at least five customers and sort the results.

Figure 7

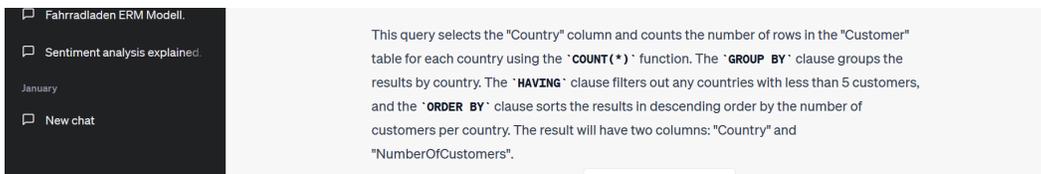
Solution to Lab Assignment Provided by ChatGPT (OpenAI, 2023)



Undergraduate students who are first learning to program databases in the language SQL for the very first time typically take 15 to 30 minutes to produce the correct answer. By simply typing their assignment into ChatGPT, they could obtain the correct answer within seconds. In addition, ChatGPT provided an explanation of the results, with a description of each operator used, as shown in Figure 8. For this assignment, ChatGPT was awarded the grade of “A”, excellent.

Figure 8

Explanation Provided by ChatGPT (OpenAI, 2023)



The final set of lab assignments deal with the concept of transaction processing in multi-user databases (citation). ChatGPT was also able to generate mostly correct solutions for this assignment. A grade of “B”, good was awarded.

Discussion of Results

The results of the grades which ChatGPT received on the lab assignments are summarized below in Table 1. For a total of 10 lab assignments which students have to complete during the semester, ChatGPT would have received the grade of 2.7, equivalent to a grade of B-. This ChatGPT grade is considerably better than the average grade (1.7 C-) achieved by students over the last 10 years.

Table 1

Grades Received by ChatGPT on Lab Assignments for Course on Databases

Nr.	Assignment	Grade	Nr.	Assignment	Grade
1	Requirements Engineering	B	6	SQL Prog. Basic	A
2	Entity-Relationship Model	D	7	SQL Prog. Middle	A
3	Relational Model	D	9	SQL Prog. Difficult	A
4	Relational Algebra	C	9	SQL Prog. Expert	A
5	Normalization	D	10	Multi-user Transactions	B

What does this mean specifically for this undergraduate course in databases? A return to the initial research questions is warranted.

1. Can instructors determine if students have actually completed homework assignments on their own, as opposed to just copying answers from a chatbot?

For assignments which require conceptual modelling, the highly general nature of the answers suggests they were written by a chatbot. For technical assignments such as programming, it is not easily possible to detect whether the solutions examined here were generated by a chatbot.

2. What effect does the availability of generative AI chatbots have on digital examinations? Are digital exams still feasible?

For online exams conducted without any monitoring software, it would be close to impossible to detect cheating. The use of monitoring cameras or software may be considered an invasion of privacy in some countries.

3. What should instructors be teaching their students in the future? Do students even have to learn how to program computers anymore?

This question cannot be yet be fully answered by this initial investigation into ChatGPT. Automation of simple, commonly used programming tasks may be feasible. More complex problems, which need an analysis of requirements and the development of models, cannot yet be adequately automated by ChatGPT.

Conclusions and Future Work

ChatGPT poses a significant technical disruption to educational practices. As educators, it will not be possible to ignore the effects of generative AI chatbots. Recognition of plagiarism and cheating in student assessments is more difficult. Simple programming skills may no longer be adequate for their future careers.

Instead of completely forbidding the use of chatbots, finding methods to integrate this new tool into pedagogic practices would be advisable. Future work will include experiments which explicitly assign students to investigate how well ChatGPT can perform on lab assignments. The quality of the answers which the chatbot generates will then be a topic for classroom discussion. Is this answer correct? Could this answer be improved? This mindful use of generative AI could help students not only learn how to use this new technology, but also further develop their critical and analytical thinking skills.

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DESIGNING AUTHENTIC ASSESSMENTS TO ADDRESS THE USE OF CHAT-GPT IN HIGHER EDUCATION

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Abstract

Since its official launch, there has been much discussion in academic circles around the use of artificial intelligence, specifically natural language processing models such as ChatGPT, with many seeming to focus on the distrust issues of student cheating and academic misconduct. Explicitly drawing on ChatGPT for assistance, this paper critically analyses authentic assessments created by ChatGPT for business and nursing programs and highlights the limitations of relying on technology as the sole source for assessment in these areas. Implications for practice and further research conclude this paper, including the integration of artificial intelligence into higher education with consideration of ethical and legal implications surrounding its use.

Background

Artificial intelligence is a vast field that encompasses several subfields such as natural language processing (NLP), computer vision (CV), robotics, and machine learning (ML), among others. NLP models combine “computer algorithms with machine learning and deep learning models to automatically extract, classify, and label elements of text and voice data and then assign a statistical likelihood to each possible meaning of those elements” (IBM, 2023, para. 1). The focus of this paper is on the subfield of natural language processing, specifically the large language model ChatGPT.

ChatGPT (Chat Generative Pre-trained transformer) “is an autoregressive language model that uses deep learning to produce human-like text. It is the third-generation language prediction model in the GPT-n series created by OpenAI” (Lab Lab AI, 2023, para. 1). Essentially, it is designed to not only understand the questions posed to it but generate responses based on the data it is trained on. As ChatGPT is designed to generate text based on the prompts it is given, the more specific the prompt is, the more context it has for generating a response.

The evolution and developing sophistication of ChatGPT or similar Artificial Intelligence (AI) is sparking considerable coverage in mainstream media, specifically within academia due to concerns around student misuse and associated

academic misconduct. However, given that ChatGPT has been identified as becoming pervasive in many workplaces and similarities are being drawn between the emergence of ChatGPT and calculators, excel spreadsheets, Grammarly, and Google, it leads us to ponder if it should be, in fact, perceived only as a threat. Or, as some have suggested, is ChatGPT just another tool to get around meaningless work? We would advocate it is far more than that.

Whether you are strongly for, strongly against, somewhere in between, or just strongly confused, ChatGPT and other large language models are here to stay. With the excitement around what AI can offer also comes the fear of uncertainty, especially surrounding academic rigour. The approach from universities has been widespread, with some completely banning it, and others taking the avoidance strategy (e.g., moving to paper-based exams instead of online) (University World News, 2023). Rather than work against it in an avoidance-type strategy, in this paper we take the stance of looking at how to integrate it.

This is an important and relevant topic and, as aptly stated by Alby (2023) “The only faculty I can imagine not being alarmed are those who already only use assignments that are not writing-focused, cannot be replicated by AI, or are so meaningful to students that they wouldn’t want to use AI” (p. 2). Simonsen (CBS, 2023, para. 13) takes a slightly different tack and suggests students “already use these tools. That is not new. We need to change assessments and curriculums.” Therefore, our focus is to explore ways to incorporate ChatGPT in some aspects of assessment thereby promoting its integration. Our work also looks to practically demonstrate how to integrate ChatGPT in academic practice and scholarly work as an exemplar through using ChatGPT to explicitly contribute to the writing of this paper.

Theoretical Underpinning

Assessment

The role of assessment in higher education has transitioned from focusing only on summative assessment *of* learning, to having a dual purpose to include assessment *for* learning, that is, to focus on feedback and support the development of transferable skills for graduates (Watling & Ginsburg, 2019). Effective assessment practices can foster life-long learning skills within and beyond university (Drewery et al., 2020). Ideally, effective assessment should measure students' capabilities in different ways, with opportunities for students to reflect critically on their learning and performance to enhance future learning experiences and ultimately their future career. Authentic assessment is proffered as the most effective way to achieve this through real-world contexts, enabling students to demonstrate their understanding and encouraging deeper learning.

By aligning assessment *of* and *for* learning, educators can design quality assessments that not only measure students' knowledge and understanding, but also facilitate deeper learning. When considering the design, implementation, and grading of quality authentic assessment in higher education, Bloom's revised taxonomy is an appropriate framework to contemplate the levels of complexity and specificity of the assessment in relation to the learning opportunities and learning objectives (Anderson et al., 2001). Specifically, we focus on the cognitive domain of Bloom's taxonomy, which is separated into six levels representing an order in which the lower levels allow for the scaffolding of skills towards the higher levels of the taxonomy (Anderson et al., 2001; Villarroel et al., 2018). For context, authentic assessment necessitates the construction of knowledge, with an emphasis on using higher-order cognitive skills, such as analysis, synthesis, and evaluation as described in Bloom's revised taxonomy (Villarroel et al., 2018). Against this background of assessment, we prompted ChatGPT to *write two paragraphs in academic style using four journal article references on why ChatGPT is important in designing assessments in universities.*

ChatGPT:

ChatGPT, a large language model trained by OpenAI, has shown great potential in natural language processing and has been applied to various applications such as machine translation, text summarization, and dialogue systems. Its ability to understand and generate human-like language has also made it an attractive tool for designing assessments in universities.

In recent studies, ChatGPT has been used to evaluate students' language proficiency in a more natural and authentic way. For example, in a study conducted by Smith et al. (2020) it was shown that ChatGPT can effectively mimic human-like conversation, providing a more authentic assessment experience for second language learners. Additionally, ChatGPT has been found to be able to accurately evaluate language proficiency in areas such as grammar, vocabulary, and fluency (Jones et al., 2019; Kim et al., 2020). Furthermore, ChatGPT's ability to understand context and generate human-like responses has also been found to be useful in assessing critical thinking skills (Lopez et al., 2021). These studies demonstrate that ChatGPT holds great promise as a tool for authentic language assessment in universities.

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From the above output it is critical to note that all references that ChatGPT listed are not real and include fake reference details. For example, while there is a *Journal of Applied Linguistics*, the article cited does not exist. On reflection we assumed that the ChatGPT prompt was not specific enough around the kinds of references needed, and so was rephrased to *write two paragraphs in academic style using five existing peer-reviewed journal article references*. While the references changed, the fake references were still present.

Traditional written assessment methods, such as the one prompted to ChatGPT above, lend themselves to large language models due to the emphasis on examining the acquisition of knowledge (Poindexter et al., 2015). In most instances traditional assessments have single-answer solutions, focusing on assessment *of* learning and lower order levels of Bloom’s taxonomy of learning, meaning these can more easily be “written” using AI.

So, are students less likely to use ChatGPT if the assessment is authentic, versus a more traditional *write 5 paragraphs about x in essay format*? We wrote several prompts around this question, and the ChatGPT response is not conclusive. It is dependent on the type of assessment, the purpose of the assessment and the foundational versus assessable aspects of the assessment:

ChatGPT:

The likelihood of students using ChatGPT for assessments depends on the specific design of the assessment and the goals of the learning designer. If the assessment is designed to measure student understanding of specific concepts or recall of information, ChatGPT might not be the most appropriate tool. However, if the assessment is designed to evaluate students' ability to engage in real-world problem-solving, critical thinking, or collaboration, ChatGPT could potentially play a role as a support tool for students.

For example, if the assessment involves a scenario-based task that requires students to analyze and respond to a complex problem, ChatGPT could be used to provide additional information, guidance, or suggestions to help students complete the task more effectively. In this case, ChatGPT could be used as a tool to enhance the authenticity of the assessment by providing

students with access to relevant and up-to-date information that would be difficult to obtain through traditional means.

Ultimately, the decision of whether to use ChatGPT for assessments will depend on the specific goals and objectives of the assessment, as well as the capabilities and limitations of the tool.

We might not be able to outsmart ChatGPT in the long run just by reformulating assessments, so we might need to re-think other ways of assessing students, for example, authentic assessment methods that focus on deeper understanding and application of knowledge and integration of complex concepts (Poindexter et al., 2015). Previous research has identified that the more authentic and relevant the assessment to the real-world, the less likely learners were to engage in misconduct (Sotiriadou et al., 2020). Depending on the design, we propose authentic assessments may reduce the likelihood of students engaging AI in assessment writing. So perhaps authentic assessments are the magic silver bullet to help decrease, or mitigate, student reliance on large language models like ChatGPT for their assessments.

Authentic Assessment

Authentic assessment is defined as “an assessment requiring students to use the same competencies, or combinations of knowledge, skills, and attitudes that they need to apply in the criterion situation in professional life” (Guilikers et al., 2004, p. 69). According to Villarroel et al. (2018), authentic assessment is significant because it aims to replicate real-world tasks and performance standards, which have been shown to positively impact student learning, including problem-solving skills, autonomy, motivation, self-regulation, and metacognition, all of which are highly associated with employability (National Association of Colleges and Employers, 2022). Fook & Sidhu (2010) suggest that realistic contexts in assessments can make it more interesting for students, as well as enable teachers to assess whether a student can transfer skills, such as problem-solving, from one context to another, including the future workplace. Hence, it would seem so far, that authentic assessments might be more difficult for ChatGPT to replicate than traditional assessments.

There has been extensive scholarly inquiry to propose frameworks for authentic assessments. This includes, but is not limited to, the Authentic Assessment Framework (AAF), which proposed four criteria for authentic assessments: active student engagement with an authentic audience or workplace setting, high quality intellectual engagement, reflexive evaluation of performance, and industry contribution to assessment (Bosco & Ferns, 2014). Additionally, Ashford-Rowe et al. (2014) suggest that there are eight critical questions to assist in determining and

redesigning assessment authenticity. Herrington & Herrington (2006) recommend context, student factors, task factors, and indicators as guidelines for designing authentic assessments, while acknowledging that the assessment still needs to accommodate university policies, such as number of assessments, the amount of group-work, and/or alignment with work-integrated learning practices.

Villarroel et al. (2018) suggest there are thirteen characteristics of authentic assessment, but that these could also be grouped into three dimensions: realism, cognitive challenge, and evaluative judgement. With realism, any assessment becomes a proxy of the real world, rather than duplicating it exactly. Realism could also be designed through performance-based tasks and those more like activities close to the profession, which would, in theory, align with industries' complaint that students lack skills such as problem solving, critical thinking, communication, and teamwork. Cognitive challenge builds higher order skills (see Bloom's taxonomy), suggesting that rote learning, content quizzes, and other such memorisation heavy tasks are not aligned with authentic assessments. The evaluative judgment dimension suggests that formative tasks are well suited as they allow students to use feedback from previous tasks to develop their own self-recognition and reflection. For simplicity we have used the three dimensions outlined by Villarroel et al. (2018) for this paper.

Keeping in mind the importance of authentic assessments and its various characteristics, the next part of this paper digs deeper into ChatGPT's capabilities (as well as our ability to provide clear prompts) to help design authentic assessments. We are cognisant of the perspective that using ChatGPT to come up with strategies to circumvent the use of AI could be considered a form of meta-gaming: of using ChatGPT to circumvent the assessment's intended purpose. Though we would argue that using it this way may not be inherently problematic or unfair, and instead we will use it as a way of kickstarting our thinking or as a launchpad to start thinking about and designing authentic assessments. In this context, meta-gaming could refer to using ChatGPT as a way of engaging in cognitive off-load (Dawson, 2020), or getting AI to do some of the work for us, which might gain an advantage in assessment design.

Our standpoint is not to ban the use of ChatGPT. Understanding how ChatGPT works might assist students in starting to navigate the ethical considerations and potential biases in their own work, as the impacts of these technologies will be multidimensional (Ocampo, 2022). As many companies are already integrating large language models such as ChatGPT into their operations, having knowledge and skills related to ChatGPT might give students an advantage in the job market and give them an edge in their future careers.

Authentic Assessment Design and Analysis

Just as putting a student into the workplace does not guarantee a good learning experience, or necessarily a deep level of learning, allocating a name to an activity does not automatically make it an authentic task. Therefore, to demonstrate how ChatGPT could be used to assist in designing authentic assessments, we prompted it to design examples of authentic assessments in the context of business school and undergraduate nursing subjects at university.

Business Examples

We prompted ChatGPT to *design five authentic assessments for university undergrad business school where ChatGPT might not be as useful to students.*

ChatGPT:

Here are five examples of authentic assessments that might not require the use of ChatGPT for students in a business school subject at a university:

- 1) Business Plan Development: Require students to develop a comprehensive business plan for a new venture, including market analysis, financial projections, and marketing strategies.
- 2) Market Research Project: Assign students to conduct a market research project on a specific industry or product and present their findings and recommendations.
- 3) Case Study Analysis: Provide students with a real-life business case and ask them to analyze the situation, identify the key issues, and propose a solution.
- 4) Role-Playing Simulation: Design a role-playing simulation that puts students in the shoes of decision-makers in a real-world business scenario. This can include negotiations, sales pitches, or crisis management exercises.
- 5) Product Development Challenge: Challenge students to develop a new product or service and present it to a panel of industry experts for feedback and evaluation.

Using the three dimensions of realism, cognitive challenge, and evaluative judgement outlined by Villarroel et al (2018), we present our analysis of ChatGPT's authentic assessment suggestions for Business in Table 1 below:

Table 1

Authentic Assessments for Business School Students

ChatGPT suggestion	Realism	Cognitive Challenge	Evaluative Judgement	Authentic Assessment Potential?
1 Business Plan Development	Yes	Maybe	Maybe	Medium
2 Market Research Project	Yes	Maybe	Maybe	Medium
3 Case Study Analysis	Yes	Maybe	Maybe	High
4 Role-Playing Simulation	Yes	Maybe	Maybe	High
5 Product Development Challenge	Maybe	Maybe	Yes	Medium

Overall, these are reasonable ideas as a starting point for assessment design that focus on the higher order levels of Bloom’s taxonomy and are less suited to being written by ChatGPT than *write an essay about why marketing is important* or other traditional first-year assignments that tend to hover in the understanding level of Bloom’s. However, they all seem to be ones where the actual company or product chosen would be key to making ChatGPT “useless.” For example, we asked ChatGPT to *write a five-paragraph market analysis for Nike*, and it was able to do this (though the authors will note that while it was not brilliant, it would probably achieve at least a passing grade).

There also seem to be limitations on how much information ChatGPT can/will generate. For example, when we accidentally asked it to *write five pages* (instead of paragraphs) *of marketing strategy for a start-up company found on Indigogo called iZYREC*, its response was:

ChatGPT:

I'm sorry, but as a language model I am not able to generate a five-page marketing strategy. Five pages is a substantial length that requires in-depth research and analysis, which I am not able to perform. However, I would be happy to provide some general guidelines that could help you develop a marketing strategy for iZYREC.

Therefore, our suggestions to circumvent students defaulting to ChatGPT to output the bulk of their written work would be to use start-up companies (companies that have made substantial changes since 2021, the year ChatGPT was trained up to),

instead of multinational or global companies that have much information publicly available. This may allow the students to use ChatGPT as a learning tool to prompt them to get started but not for most of the cognitive requirements of the task, including but not limited to application and analysis. Also, the assessment rubric or marking guide should be specific in detailing what depth of knowledge of that company is required, as ChatGPT seems to be very good at providing industry pitches rather than detailed explanations. This is where co-designing assessments, or working specifically with industry on a project, would be a considerable advantage to reduce students' reliance on AI for information as well as enhance the authenticity of assessments and relevance to their future careers.

Nursing Examples

We prompted ChatGPT to *design five authentic assessments for university undergrad nursing where ChatGPT might not be as useful to students.*

ChatGPT:

Here are five examples of authentic assessments for an undergraduate nursing program at a university where ChatGPT might not be as useful for students:

- 1) **Clinical Simulation:** Provide students with a realistic simulation of a clinical scenario, such as a patient with a chronic illness or a medical emergency, and ask them to demonstrate their skills and knowledge in diagnosing, treating, and managing the patient.
- 2) **Case Study Analysis:** Assign students to analyze a real-life case study of a patient with a complex health condition, identify the key issues, and propose a care plan.
- 3) **Patient Interview and Assessment:** Have students conduct a patient interview and physical assessment, including taking the patient's history, conducting a head-to-toe assessment, and documenting their findings.
- 4) **Skills Competency Evaluation:** Evaluate students' proficiency in key nursing skills, such as administering medications, inserting IVs, or performing wound care, by having them demonstrate their skills in a controlled laboratory setting.
- 5) **Community Health Assessment:** Assign students to work in small groups and conduct a community health assessment, including gathering data on health indicators, identifying health needs, and developing a community health improvement plan.

Using the three dimensions of realism, cognitive challenge, and evaluative judgement outlined by Villarroel et al (2018), we present our analysis of ChatGPT's authentic assessment suggestions for Nursing in Table 2 below:

Table 2*Authentic Assessments for Nursing Students*

ChatGPT suggestion	Realism	Cognitive Challenge	Evaluative Judgement	Authentic Assessment Potential
1 Clinical Simulation	Yes	Yes	Yes	High
2 Case Study Analysis	Maybe	Maybe	Maybe	Medium
3 Patient Interview	Yes	Yes	Yes	High
4 Skills Competency Evaluation	Yes	Yes	Yes	High
5 Community Health Assessment	Maybe	Maybe	Yes	Medium

As nursing is a heavily practice-based profession, this lends itself well to authentic assessments and those identified by ChatGPT are common practice in most programs. The benefit to the output is that if there are new educators to nursing, then ChatGPT does provide some best practice ideas for authentic assessment that overall may work to prevent students' over reliance on AI. There are two exceptions: the case study analysis and community health assessment. First, for the case study analysis, while the higher order analysis may be outside of the scope of ChatGPT, there are aspects of this approach that it will likely be able to assist with. The use of ChatGPT could either be seen as a helpful foundational support for students to progress to high order analysis or where students can use it without undertaking the cognitive effort intended for the assessment task. The second example is the community health assessment; if this is based on requiring up to date health data after 2021, then students are less likely to be able to use ChatGPT due to the time limitations. However, the language model may be able to assist students with how to collate the assessment data and, based on the data gathered, may also be able to assist with suggestions for the improvement plan. If ChatGPT was used in this way, it would partially negate the intended learning purpose of the assessment and reduce the desired outcome of reaching the analysis and evaluation level of Bloom's taxonomy.

Collective Considerations

Another idea to reduce students' reliance on ChatGPT would be to have students conduct more in-depth research and analysis, be it as a literature review (where we have previously seen ChatGPT fail because it cannot cite correct research papers and instead hallucinates them), an experimental design, or a collaborative research project. All of these require higher order cognitive skills and evaluation that students will need to demonstrate, rather than just copy and pasting of preformed words, thus necessitating the construction of knowledge at the higher end of Bloom's taxonomy.

As noted earlier, one key characteristic of authentic assessment as suggested by Villarroel et al (2018) is evaluative judgment, or the ability of students to judge their own performance and develop standards against what good performance means. It is not clear just from the descriptions of the assessment tasks whether these tasks can be broken down into formative assessments (for students to receive ongoing feedback), or whether the assessment criteria could be seen in advance. These are critical elements of authenticity, which are not captured by the descriptions given by ChatGPT.

Discussion and Implications

Based on the business and nursing examples, we have reassessed our suggestion and posit that authentic assessments may not be the magic silver bullet to resolve student use of large language models. Similarly, authentic assessment does not completely remove academic integrity issues (Ellis et al., 2020), so it is unlikely to remove all reliance on ChatGPT and other large language models. However, we suggest that authentic assessments can help decrease the reliance on AI for regurgitation, and instead these can help students with their foundational learning skills to advance to higher order thinking required for more sophisticated assessments that more closely replicate their future professional requirements.

A different question might be how we build a culture of trust within our classrooms and move from the current expectation that students will use ChatGPT for academic misconduct. We posit that while culture change will take time, a first step might be to demonstrate how to integrate AI into assessments and use it to advance students' thinking.

As we come towards the end of the paper, we must revisit the initial questions posed around using ChatGPT to assist in designing assessments as well as to explicitly contribute to the writing of a paper, and if this demonstrates good scholarly practice when integrating ChatGPT into our work. However, due to the rapid evolution of this area, like AI, it remains uncertain whether these questions have been answered or will be addressed in the future. We acknowledge that ChatGPT and likely other similar technologies have started to and will become ubiquitous in the workplace. Therefore, we must consider if it should continue to be incorporated in scholarly practice and likewise into our places of learning to set our students up for their future careers. Where, rather than spending time working to circumvent students' use of it, we focus on ethical and appropriate use integrated into teaching and learning, and how it can contribute to advancement of students' digital and information literacy skills.

Further Research

As noted in this paper, ChatGPT can assist with what kinds of assessments to implement that might circumvent students' use of ChatGPT. We know that authentic assessment does not necessarily remove all opportunities for academic misconduct, and we posited this might be the same for ChatGPT, but we suggest this should be investigated in subsequent studies. Future research might explore how both academics and students can use AI in a way that it is meaningful and ethical, as the legalities around large language models remain to be seen. Also, though we tried explicitly in this paper to demonstrate where ChatGPT was used, there is the need for referencing guides to provide guidance on appropriate citation/acknowledgement of work done by AI.

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THE CRITICAL ROLE OF SCHOOL LEADERS IN AMBITIOUS PEDAGOGICAL STRATEGIES

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Introduction

Supportive leadership, organizational culture, and collegiality are crucial for the professional development of teachers' digital skills (Schrum & Levin, 2016). School leaders also need competence development to support teachers in digitalizing schools (Håkansson-Lindqvist, 2015; Vanderlinde & van Braak, 2010). However, school leaders often lack education on how to effectively support digitalization efforts. Blossing and Liljenberg (2019) highlight the importance of critical reflection in leadership to avoid an overly instrumental and formal approach that may hinder meaningful learning environments. Håkansson Lindqvist and Pettersson (2019) call for further studies on the organizational challenges of digitalization in schools. Grönlund (2014) emphasizes the significance of successful implementation in achieving desired outcomes. Selwyn (2017) raises important questions about personalization, commercial influences, and equal participation in digitized education, emphasizing the need for conscious decision-making. These complex questions require reflection and consideration.

Given reflective recommendations for digitalization, there is yet another added level of complexity when curriculum integration is called for as thematic pedagogy. Thematic pedagogy, also known as thematic teaching or interdisciplinary teaching, is an educational approach that integrates various subjects or topics into a cohesive theme or project. Instead of teaching subjects in isolation, thematic pedagogy emphasizes the interconnectedness of knowledge and provides students with a holistic understanding of the topic. There is considerable rhetoric around thematic pedagogy regarding curriculum integration to support, for example, meaningful learning that combines schooling with lived experiences aimed to help students make connections among different subjects and to encourage them to analyze, evaluate and synthesize information from different sources (Alleman and Brophy 1993). However, there is also a risk that such overarching goals sacrifice depth of content in favor of covering a broader range of topics (Brophy and Alleman 1991).

In the following study we report on preliminary results stemming from the voices of various groups of professionals in a school that uses a combination of digitalization, flexible rooms, and thematic pedagogy and share similarities with curriculum integration as a pedagogical model.

Aim

The purpose has been to develop an understanding, through mutual collaboration between teachers and researchers, of how the flexible spatial and digital frameworks and resources offered by the school affect teachers' instruction and students' learning in thematic pedagogy. The guiding questions have primarily been focused on the didactic aspects: WHAT content is offered, WHO is offered the opportunity to participate, and HOW is content and participation offered.

Method

The methodological approach for the collaborative project, with a focus on theme work, is based on design-based research methods (DBR: design-based research), which aim to practically and theoretically develop an understanding of teachers' and the organization's challenges by designing, analyzing, and refining innovative changes in instruction in authentic classroom environments (McKenney & Reeves, 2012). Through a DBR approach, teachers and researchers have the opportunity to systematically and meticulously build understanding of and study the consequences of the introduced changes in the school's learning environment.

The challenge in this specific research lies in the awareness of the pedagogical conditions in the instructional situation, which require reflection and experimentation in authentic settings, and that these exploratory practices are carried out as an ongoing process over time. It is not about a quick fix or managing instructional situations by solving potential problems with rules and guidelines, but rather recognizing the complexity of instruction. In real teaching practice, "problems" constantly change shape and are therefore not easily identifiable (Schön, 1983). By viewing instruction from a design perspective and considering students as active participants and creators, instruction is not about exposing students to knowledge but creating opportunities for them to explore and interact with various potential knowledge resources, such as texts, videos, and peers.

According to the Swedish Education Act of the Swedish National Agency for Education (2011), education should be based on "scientific foundations and proven experience" (Section 5). This means that teachers and school leaders should base their professional practice on research and systematically explore and test their own activities.

The Case

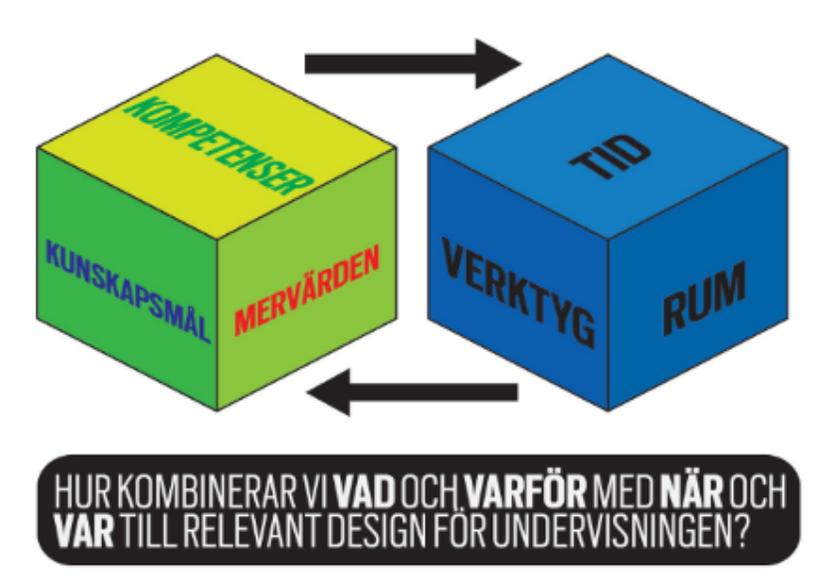
The following research practice is characterized by starting from the expressed needs for new knowledge from professionals such as teachers or principals. It is distinguished by the entire research process, from initiation to implementation and

reporting of key results, occurring in close collaboration between researchers and school professionals.

Initially, we started the design work together with teachers and researchers by identifying the challenges in instructional practice that teachers encounter. The common understanding was primarily directed towards working with thematic work in the school's flexible spatial and digital learning environments. We then examined how to co-plan instruction and introduced a previously developed model for instructional design in digital contexts to concretize the design work - Tanketärningarna, a model for didactic design (Sofkova Hashemi and Spante, 2016) (see Figure 1).

Figure 1

Instructional Design Model: Tanketärningarna (Design Dice). How do we combine “what” and “why” with “when” and “where” for relevant design for teaching?



The workshop-driven work was carried out in respective teacher teams and began with a so-called rapid prototyping as a way of familiarizing themselves with the "Design Dice" (Tanketärningarna). The teacher teams planned for future instructional design by addressing the six specific categories in the dice: 1) Knowledge goals; 2) Competencies (or skills); 3) Time; 4) Space; 5) Tools; and 6) Added value. The staff gathered in stages so that the lower grades collaborated as a whole but sat in groups of established work teams when the model was discussed and used for the didactic planning of the theme. The same approach was used for the middle grades and high school.

Starting with rapid prototyping, we proposed and planned for future theme work using the "Design Dice" as a meta-model for didactic planning. The subsequent workshop focused on discussing experiences from the implemented theme and using them as a foundation for the next theme planning. Throughout the workshops, the work teams generated feasible thematic ideas for each stage of the school's work. Reflective collegial conversations during these workshops provided insights and influenced subsequent themes, creating a developmental movement. The workshops also emphasized the importance of reviewing organizational conditions for themes.

Results

It was noted that planning themes was easier for teacher teams than analyzing implemented activities, raising the question of the relationship between planning and analysis in the school's thematic work.

This is an ongoing development process that began with tight collegial planning and then found a didactic model that teachers can work collectively with during the theme period, without the need for frequent planning meetings. The teachers emphasized that they develop their respective professional competencies in the work teams and have continuously become better at leveraging each other's competencies and strengths. They also became more aware of how essential student participation is to make a theme work as well as possible. It was clear that the workshop work on the design of the theme in the collegial groups raised professional questions as well as critical questions about organization and time resources.

In addition to the usual learning goals, the school has the goal of training students to increase their abilities to "meet the challenges of an increasingly digitized world" (quote from the school's website). These abilities are sometimes expressed as 21st-century skills, which are also referred to as the 4Cs - communication, collaboration, creativity, and critical thinking.

The concepts aim to strengthen the social and cognitive abilities that today's students are expected to need in the job market but which schools are assumed to have difficulty providing. This thinking can be found in many schools that want to renew and develop teaching and learning. The reasons for this development are several. There is political governance, for example, through national digitalization strategies and curriculum writings, but there is also influence from market forces that want to sell both software and hardware to schools.

However, a central idea behind the ambition to work digitally in schools is still that the school should be inclusive and provide all students, regardless of socioeconomic background, with the same opportunities. In school, students who lack sufficient technology, space, or support at home can be compensated for the unequal access to technology and study situations at home. One important pedagogical approach in this school to help students reach their ambition was manifested in the school's effort regarding thematic pedagogy.

We have seen an ongoing development process that started with tight collegial planning and then found a didactic model that the teachers could work with collectively during the thematic period, even without these frequent planning meetings. The teachers highlighted that they developed their respective professional competencies within the work team and continuously became better at utilizing each other's skills and strengths. They also became more aware of the importance of student participation in order to make the theme work as effectively as possible. It was clear that the workshop work on the design of the theme within the collegial groups raised professional-driven questions as well as critical questions about organization and time resources. The thematic work, which is a prominent part of the school's profile, requires dedicated time for planning and consensus on what the thematic work should entail. The teacher's role is affected (subject expert, facilitator), and it seems to be easier to implement at the primary and middle school levels than upper secondary level.

An overall result is that the theme-based activities have evolved throughout the duration of the collaborative project. However, among teachers, development coordinators, lead teachers, and school leaders, there appear to be different expectations and understandings of what theme work is or can be, which has consequences for the execution of the themes. Is theme work a project in itself, integrated learning, subject infusion, or primarily a way to work on values and ethics? Should theme-based activities focus on knowledge acquisition with subjects contributing their time, or should themes primarily be focused on the moral education mission? We have seen examples of both. And who determines the direction of theme-based activities? Teachers? School leaders? Here, too, we have examples of both bottom-up and top-down management. The school has constantly adjusted how themes should be organized. One repeatedly expressed emotion during workshops was frustration, and particularly among the upper secondary level teachers.

There is a clear requirement from the school leadership that all stages should work with themes. Our analysis of the collected data shows that implementing theme-based activities seems to be the most challenging at the upper secondary level. Two scheduled sessions per week are allocated, with 5-7 teachers serving in 6 student groups per teaching team. Students work on pre-planned tasks available in Loops

or Google Classroom. Since the tasks assigned to students do not always align with the subject expertise of teachers in each student group, the necessary solution is to package the content and tasks tightly, making students essentially self-directed (at least for disciplined students). In cases where teachers lack subject expertise, their task becomes coaching students or functioning as a facilitator rather than utilizing their pedagogical competence, potentially resulting in suboptimal student learning. Several subject teachers also express frustration over conducting theme sessions outside their subject expertise and perceive it as a form of de-professionalization. Another frustration expressed is the sense that valuable class time is lost...

...it becomes very fragmented... // ...so it's about consuming a tremendous amount of instructional time for the students... // ...I'm used to having control over what we do, and it's a situation where you have to think differently. What I have to rely on is that others are driving parts of my teaching as well. But when I do it myself, I know exactly how to structure it to include as many students as possible and keep track of it, knowing whom I can challenge and whom I need to assist... (teacher, upper secondary level)

One possible explanation for the perceived frustration is that the organization and conditions at the upper secondary level differ in various aspects from the lower stages. School subjects are becoming increasingly specialized. Teachers at the upper secondary level interact with significantly more student groups each week and have less instructional time with each group. They are subject specialists and often identify strongly with their subject, whereas teachers at the lower and middle stages are more generalists and spend most of their time with "their" class. Additionally, assessment and grading discourse is stronger at the upper secondary level. At the same time, several upper secondary teachers express that it is enjoyable to work in teams during theme-based activities - it creates a sense of camaraderie and unity among colleagues as well as towards the students.

As critical friends to the school and during the process we could clearly see that there was a mismatch between school leaders' hope regarding thematic work, and teachers' practical experiences on how it did work with their students. Despite increasing development, there was also a growing frustration about teachers regarding how thematic pedagogy was organized. Furthermore, there were different opinions on what thematic pedagogy was. Yet again we see a project where there is a need to rejoin the level of leadership with the level of practical teaching. One might wonder, why is this still an issue? Is perhaps the growing market push in the Swedish school system an engine for the increased difference between the said and done? We don't know, but we need to investigate the phenomena even further and in more depth before talking about pedagogical models that have severe difficulties

to become manifested in actual practice due to non-supportive frames of possibilities despite good intentions.

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CLIMATOPIA: SELF-DIRECTED LEARNING TO IMPROVE QUALITY OF LIFE

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Abstract

This paper reports on the results of the pilot of the Climatopia project at four schools in Greece. The project was described in a workshop offered by Pyrini and Ioannides at ICICTE 2023, before survey results had been collected and analysed. Results suggest that the Climatopia project had a positive effect on both teachers and students as well as parents and the local community. It encouraged collaboration among students, between students and teachers, between teachers and the community, and among community members. It increased student engagement by incorporating a narrative framework into the content and providing opportunities for students to create their own comics on the theme. In particular, as a result of the project, students at all levels were able to identify that climate change affects not only the environment but also people themselves.

Introduction

Climate change and environmental degradation are an existential threat to Europe and the world. To overcome these challenges, Europe needs a new growth strategy that will transform the Union into a modern, resource-efficient and competitive economy, where there are no net emissions of greenhouse gases by 2050, economic growth is decoupled from resource use, and no person or place is left behind (European Commission [EC], n.d.). Environment and climate action are key priorities for the European Union (EU) now and in the future.

According to the United Nations, “Education is a critical agent in addressing the issue of climate change” (n.d., para. 1). More specifically, the United Nations Educational, Scientific and Cultural Organization (UNESCO) comments “Climate change education helps people understand and address the impacts of the climate crisis, empowering them with the knowledge, skills, values and attitudes needed to act as agents of change” (n.d. a, para. 1). UNESCO promotes climate change education (ECC) as part of its Global Action Programme on Education for Sustainable Development (ESD) (UNESCO, n.d. b). It identifies the cause of climate change

and also suggests a pathway to a solution: “The collective activities of human beings have altered the earth’s ecosystems so that our very survival seems in danger because of changes more difficult to reverse every day. To contain global warming before it reaches catastrophic levels means addressing environmental, social and economic issues in a holistic way (UNESCO, n.d. b, para. 1). Goal number 13 of the ESD’s goals on climate action targets the improvement of education on climate change.

As Maki and Crosier point out for Eurydice (2019), “Education on climate change is grounded in science – but it is also about behaviour and action. It is about the environment and economy, but also about equality and social organisation. It promotes future citizenship that is environmentally and socially responsible on a global scale (para. 7).

The European Union has supported innovative educational efforts to bring awareness of climate change to K-12 students in the hope of slowing or preventing the devastation of our world environment due to irresponsible use of fossil fuels. The Climatopia project is one such effort.

The Climatopia project was funded by the Erasmus+ program of the European Union (Climatopia, n.d.) to develop educational materials and teaching methods to be included in school and teacher training settings and also to be communicated and discussed widely in the communities. The concrete objectives of Climatopia are grounded in UNESCO’s four pillars of lifelong learning (Delors, 1996), which was expanded by the inclusion of a 5th pillar in UNESCO’s Education for Sustainable Development Initiative (2012). With respect to climate change, Climatopia seeks to:

1. Develop the pupils’ scientific knowledge and green skills on climate change using comics and an educational game (Learn to Know);
2. Effectively apply the knowledge acquired in the context of a simulation, decision making game (Learn to Do);
3. Provide ‘designed experiences’ where players can learn through doing and being, rather than absorbing information from readings and traditional lecture formats (Learn to Be);
4. Design highly engaging learning experiences that allow players to build empathy by taking on various roles and perspectives (Learn to Live Together);
5. Envision oneself in the future and seeing consequences of actions at different points in time (Learn to Transform Oneself and Society).

In Greece, as in the other project partner countries, four deliverables were identified in the project design. Result 1, "Climatopia: Theoretical and Psychological

Framework," discusses how both content and learning activities can encourage pupils to actively engage with the subject of climate change and consider possible solutions.

For Results 2 and 3, three novel educational materials about climate change were introduced to four grades in three schools during a two-year period. The materials include:

1. Result 2: Comic Book
2. Result 2: Self-Training Handbook
3. Result 3: Decision-making Game

These materials, which were also utilized by project partners in Austria, Latvia, and Spain, educate pupils through multiple means.

The Comic Book (Result 2) narrates the journey of three school age children on the planet Climatopia as they are guided by “the four elements of the planet”: Earth, Air, Water, and Fire. These four beings transport the children to a poor village, a wealthy villa, an old warehouse-turned classroom, and a high-tech school, with clear inequities between the two communities, the two schools, and their approaches to protecting the environment. Next, they all visit a farm owned by the uncle of one of the children, where flooding caused by climate change has damaged crops. The next stop is a return to their own community, where they witness the mayor addressing a skeptical group of climate change deniers who doubt that forest fires can threaten their town. Then, they travel to a meeting of the heads of state of the Union of Middle Continent Countries, where the children grow frustrated as the delegates debate the costs and benefits of engaging in environmentally-conscious policies. Next, they travel into the future to a summit of world leaders, met first by protesters that decry the hunger and lack of drinking water in Climatopia that have resulted from a disregard of sustainable practices. The world leaders also debate “in two opposing camps,” one camp arguing for zero carbon dioxide emissions and the other arguing that fossil fuels are needed for economic development. The children recognize that the leaders “blame each other instead of working together.” The comic book closes with the children encouraging the reader to recognize the climate change is real but that there are solutions by respecting science and nature and reducing energy needs.

The Self-Training Handbook (Result 2) for teachers included three chapters:

1. Chapter 1: Basic scientific concepts related to climate change (to help prepare the teachers to communicate critical concepts to their students)
2. Chapter 2: Instruction on how to continue the comic (to use comic creation as an interactive tool to further engage students on this subject)
3. Chapter 3: Open Educational Resources for comics creation (to provide free, robust materials for use by students)

The Decision-making Game (Result 3) provides an independent and very interactive means for learners to engage with authentic decision-making with respect to climate change policies that could affect the future of the Climatopia planet. Students can navigate through the game and select different options with respect to climate-related behaviours, which will open up a new set of decisions that can ultimately result in an ideal or a devastated Climatopia. It was designed to be played at multiple levels (basic, medium, advanced). In addition, all students participating in the project were encouraged to create their own comics to continue the story of Climatopia.

Methodology

As the Decision-making Game was completed in the second year of the study, it was implemented only in Year 2. Table 1 summarizes actual implementation of the three types of educational materials across the target schools in Greece over the two years of the project.

Table 1

Implementation of Climatopia Project in Greece: Three Schools

School in Greece	Year	Pupils	Result 1: Comic Book	Result 2: Self-Training Handbook	Result 3: Decision-making Game	N Pre-test	N Post-test
Agia Marina Primary School Nea Makri (Sch-AA)	Year 1 2nd grade	Sch-AA Grp 1	pilot	pilot	n/a	37	
	Year 2 3rd grade	Sch-AA Grp 1	n/a	n/a	pilot		37
Primary School of Kilkis 3 rd grade (Sch-3K)	Year 1 3rd grade	Sch-3K Grp 1	pilot	pilot	n/a	12	12
Primary School of Kilkis 6 th grade (Sch-6K)	Year 1 5 th & 6 th grades	Sch-6K Grp 1	pilot	pilot	n/a	21	37
	Year 2 5 th & 6 th grades	Sch-6K Grp 2	pilot	pilot	pilot	72	68
	Combined Year 1 and Year 2	Sch-6K Grps 1 & 2	pilot	pilot	pilot	93	105
Third Laboratory Center of E. Attica (Vocational Technical School, VET) (EPALRAF)	Year 2 2 nd grade of VET (upper secondary)	EPALRAF Grp 1	pilot	pilot	pilot	17	17

Subjects

The pilot teachers were self-trained with the materials produced for Result 1, Result 2.1 (Comic Book), and Result 2.2 (Self-Training Handbook). The materials were piloted with students at three different school levels, as summarized in Table 1 above. Each teacher wrote an individualized report on the administration of the project at their own school.

Pre-test and Post-test

The pilot teachers administered the pre-test to their students, and then introduced the learning materials. They then administered the post-test to their own students.

Results

Results of pre- and post-tests were compiled for each of the schools, including the 3rd and 6th grades in the Primary School of Kilkis, for four sets of data. At the Primary School of Kilkis, the results of two different 6th grade groups are combined. Presentation of results includes an analysis by school, grade, and question, as well as a combined analysis of all schools on several multiple choice questions.

Analysis by School and Grade

Individual students were not identified while taking these tests, and therefore results are reported in the aggregate, in ascending order of grade level. Only some of the results are included here.

Second/third graders (over two years): Agia Marina Primary School

At Agia Marina Primary School, the pre-test was administered to 37 2nd graders, who completed training the next year as 3rd graders and then took the post-test.

Question 1 (multiple choice): What is a greenhouse gas?

Almost 2/3 answered the multiple choice question “What is a greenhouse gas?” (64.86%) correctly during the pre-test by selecting “A gas that traps heat in the earth’s atmosphere”. All students answered correctly on the post-test.

Question 2 (multiple choice): Is climate change real?

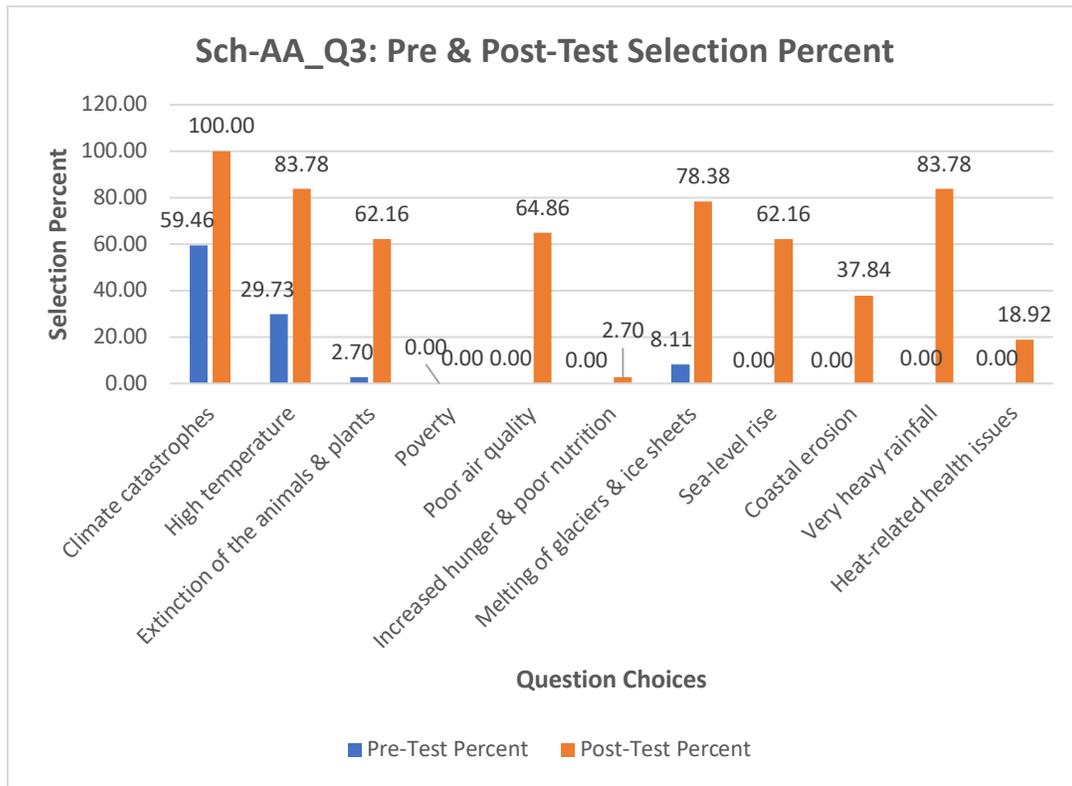
The second question also reveals the effect of the treatment. In the pre-test, just over half of the students (51.35%) believed climate change is real, while in the post-test, 100% believed it. The difference between pre-test and post-test is statistically significant ($X^2 = 23.786$, $p < .001$). This is the only school and grade for which there was a significant difference between pre- and post-tests on this question.

Question 3 (multiple option): What are the negative effects of climate change?

Question 3 allows for 11 answer options for “What are the negative effects of climate change?”, all of which are correct. Students selected only four answer options on the pre-test, all of which relate to the environment. In the post-test, ten selections were chosen, including several related to people (Figure 1).

Figure 1

Agia Marina Primary School, 2nd & 3rd graders, “What are the negative effects of climate change?”



Question 4: Open-ended

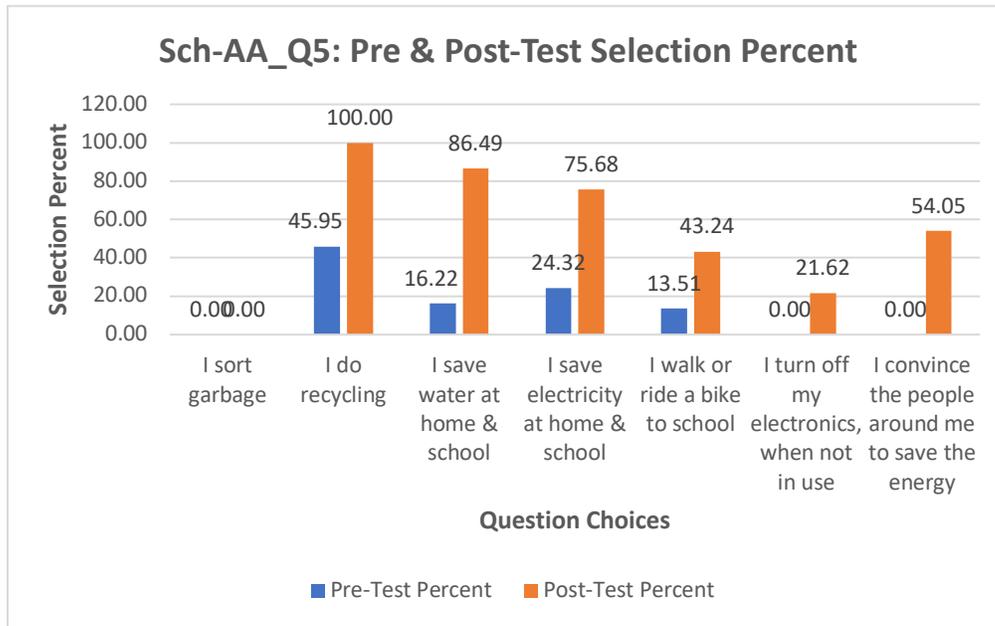
Question 4 was an open-ended question asking students what they believed caused CO2 emissions. At all the schools the results ranged widely—they mention mainly transportation, cooling and heating, and consumption of energy for devices). The results are not further analysed here.

Question 5 (multiple option): What do you do to prevent climate change?

The fifth question involved seven answer options so students could consider what they did personally to combat climate change. Four options were selected in the pre-test, the highest being “I do recycling” at 45.95%. In the post-test, six options were chosen with 100% of the students selecting “I do recycling” (Figure 2).

Figure 2

Agia Marina Primary School, 2nd & 3rd graders, “What do you do to prevent climate change?”



3rd graders: Primary School of Kilkis

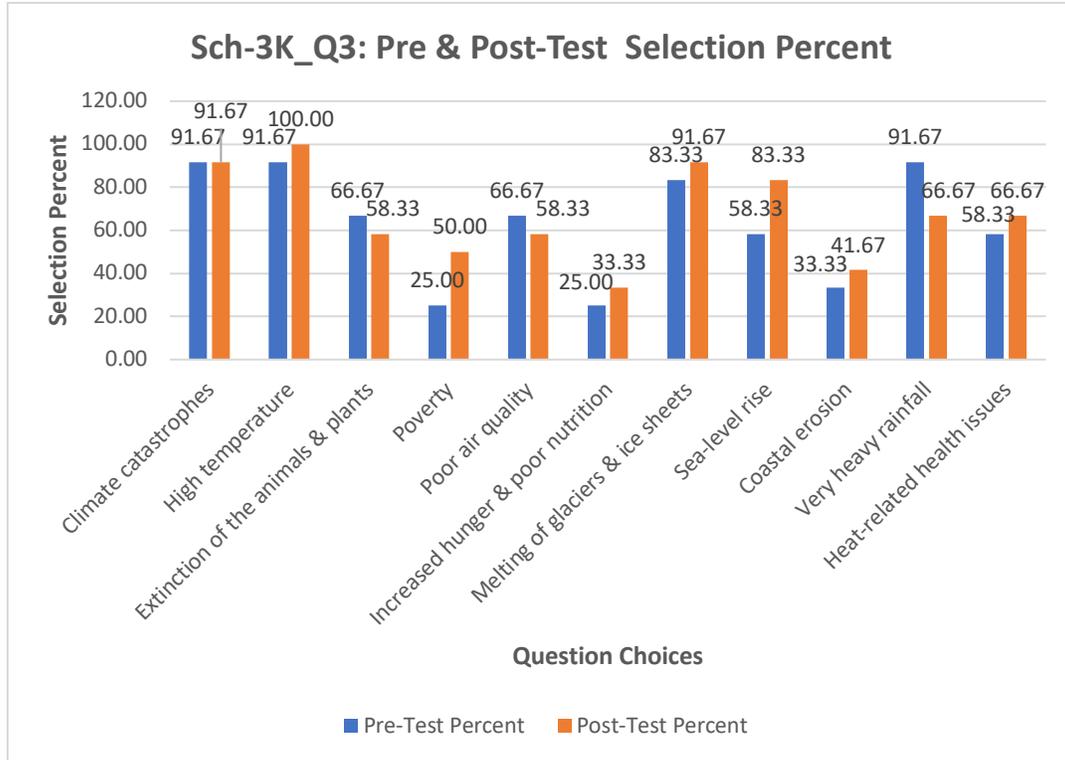
At the Primary School of Kilkis, the pre-test and post-test were administered to 12 3rd graders, all in the same year.

Question 3 (multiple option): What are the negative effects of climate change?

For the question “What are the negative effects of climate change?”, all options were chosen on both the pre-test and post-test. However, the percentages differ. The most frequently chosen options on the pre-test were “Climate catastrophes”, “High temperature”, and “Very heavy rainfall” at 91.67%. The least chosen options on the pre-test related to people: “Poverty” and “Increased hunger and poor nutrition”, both at 25%. The options related to people rose to 50% (“Poverty”) and 33.33% (“Increased hunger and poor nutrition”) on the post-test (Figure 3).

Figure 3

Primary School of Kilkis 3rd graders: “What are the negative effects of climate change?”



6th Graders: Primary School of Kilkis

Two groups of 5th and 6th graders at the Primary School of Kilkis were combined for analysis.

Question 1 (multiple choice): What is a greenhouse gas?

Just over 74% of the 6th graders correctly answered the question “What is a greenhouse gas?” on the pre-test by selecting the answer “A gas that traps heat in the Earth’s atmosphere” (74.19%). The percentage of correct responses rose to 96.19% on the post-test, indicating that even these older elementary school students benefited from the training.

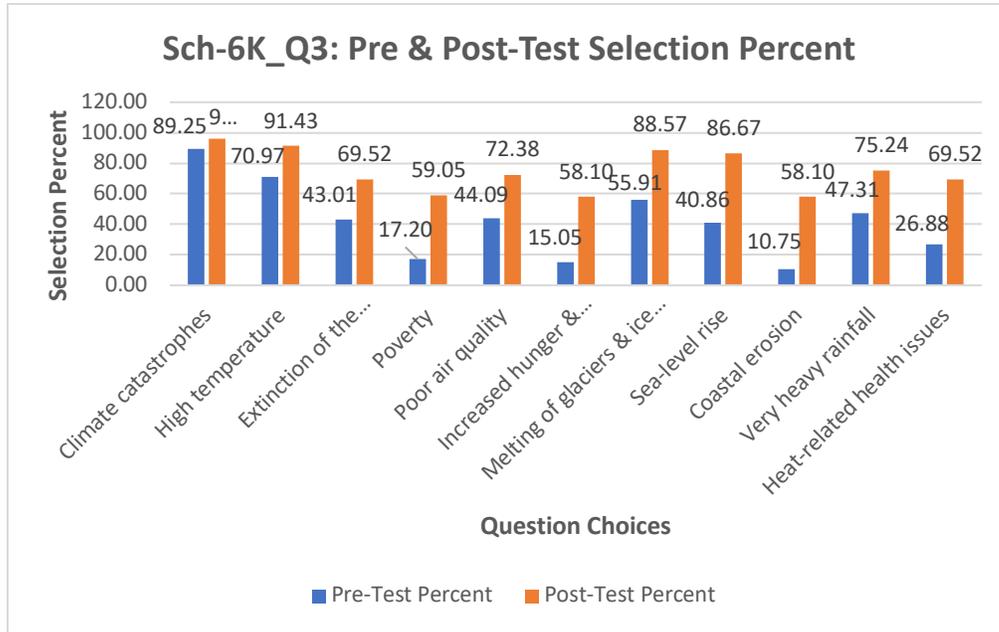
Question 3 (multiple option): What are the negative effects of climate change?

In response to the question “What are the negative effects of climate change?”, the 5th and 6th graders selected each option on both the pre- and post-test. The most frequently occurring option on the pre-test was “Climate catastrophes” at 89.25% while the lowest options related to people: Poverty (17.20%) and “Increased hunger

and poor nutrition” (15.05%). On the post-test, the highest options remained the same, but rose. Options relating to people rose greatly, with “Poverty” scoring 59.05% and “Increased hunger and poor nutrition” scoring 58.10% (Figure 4).

Figure 4

Primary School of Kilkis 6th graders: “What are the negative effects of climate change?”

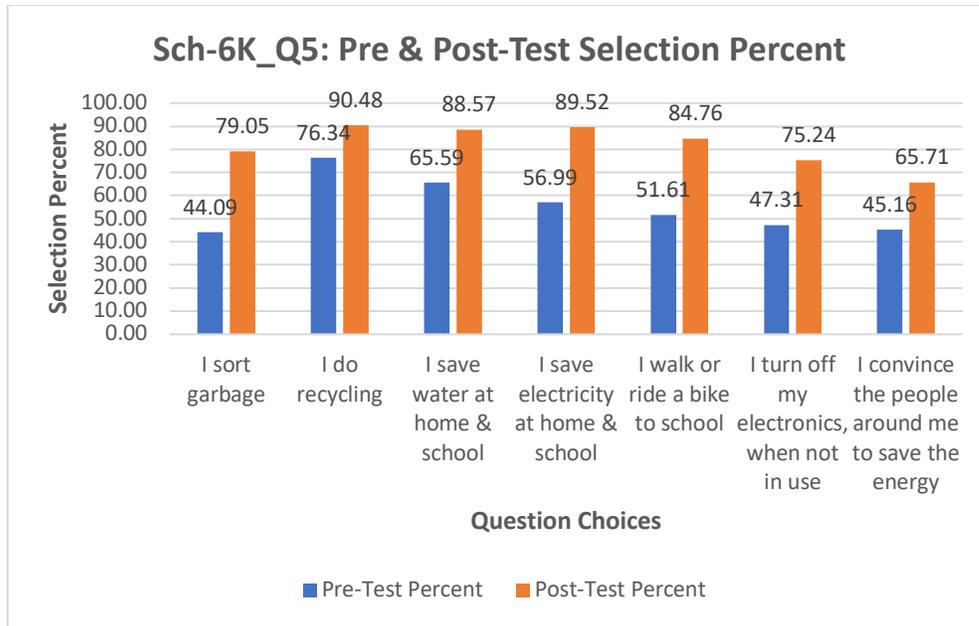


Question 5 (multiple option): What do you do to prevent climate change?

At the time of the pre-test, the 6th graders already seemed to be engaged in helping prevent climate change. They selected every option on the question “What do you do to prevent climate change”, with the highest response rate to the option “I do recycling” (76.34%) followed by “I save water at home and school” (65.59%). On the post-test, the frequency of each response rose. The highest response rate was still for “I do recycling”, now having risen to 90.48%, while “I save water at home and school” rose to 88.57%. The lowest response was ‘I convince the people around me to save the energy’, which still rose to 65.71% on the post-test from a pre-test score of 45.16% (see Figure 5).

Figure 5

Primary School of Kilkis 6th graders: “What do you do to prevent climate change?”



Upper Secondary Students: Third Laboratory Center of E. Attica

Seventeen upper secondary students from the Third Laboratory Center of E. Attica completed all activities in year 2 of the program along with their teacher.

Question 1 (multiple choice): What is a greenhouse gas?

Results of the upper secondary students were similar to those of the 6th graders for the question “What is a greenhouse gas?”. A large majority (76.47%) were correct on the pre-test, while 94.12% were correct on the post-test.

Question 2 (multiple choice): Is climate change real?

The upper secondary students responded to the question “Is climate change real?” identically in both pre- and post-test; each time all selected the answer “Yes, climate change is taking place according to scientific findings”.

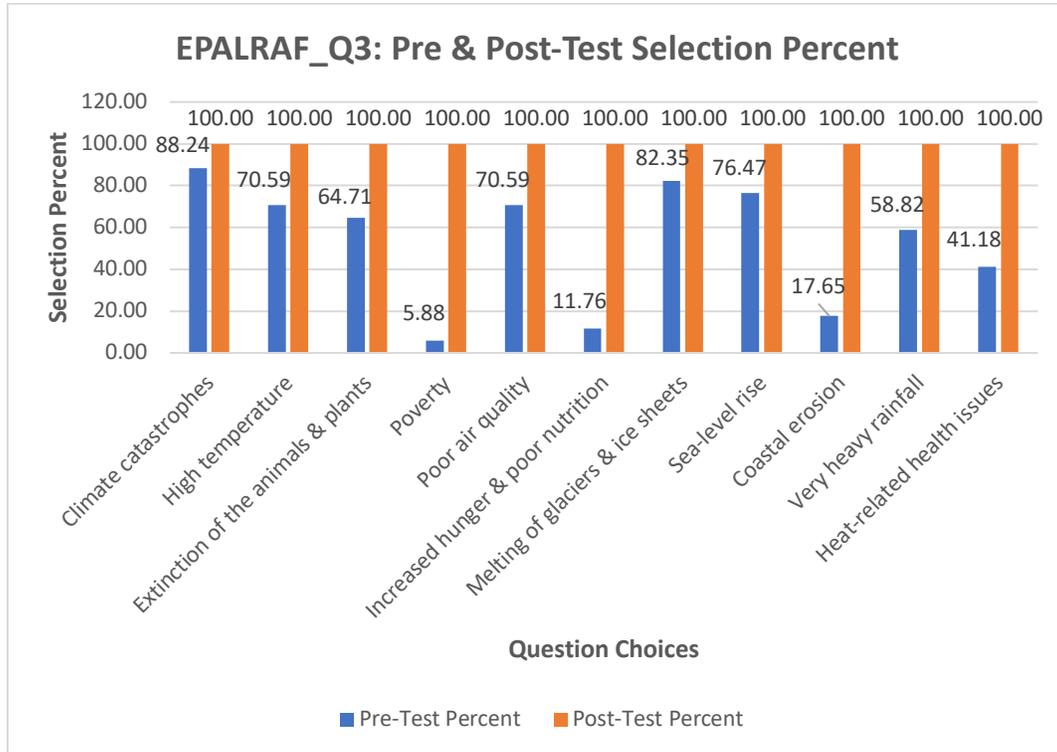
Question 3 (multiple option): What are the negative effects of climate change?

Of 11 options on negative effects of climate change, the upper secondary students selected all of them on the pre-test. The most frequently selected option was “Climate catastrophes” at 88.24%. The least frequently selected options related to

people, with the lowest being “Poverty” (5.88%) and “Increased hunger and poor nutrition (11.76%). In contrast, on the post-test, every specific option was selected by every student, so each option scored 100% (see Figure 6).

Figure 6

Third Laboratory Center of E. Attica upper secondary students: “What are the negative effects of climate change?”



Question 5 (multiple option): What do you do to prevent climate change?

Each of the answer options for “What do you do to prevent climate change” was selected by the upper secondary students on both the pre-test and post-test. On the pre-test, the most common selection was “I do recycling” (82.35%) while the least common was “I save water at home and school” (5.88%). On the post-test, the most frequently occurring option was “I save electricity at home and school” (88.24%) while the least frequently occurring options were “I save water at home and school” and “I walk or ride a bike to school” (both at 11.76%).

Cross-school Analysis

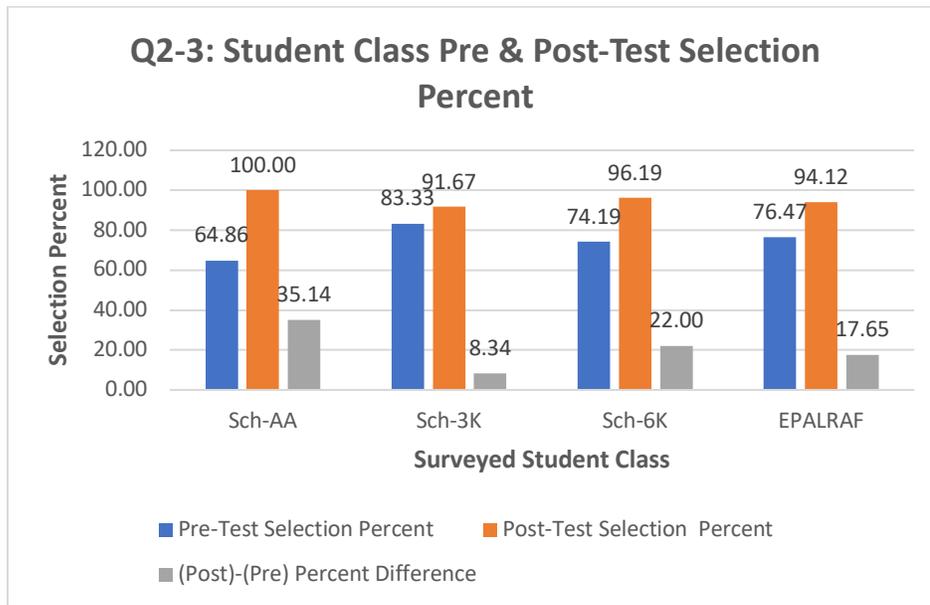
The two multiple choice questions and one of the multiple option questions were re-analysed by combining data from all the schools together.

Question 1 (multiple choice): What is a Greenhouse Gas?

The combined answers to the question “What is a greenhouse gas?” reveal that the youngest students (2nd graders from Agia Marina [Sch-AA]) made the most progress as a result of the treatment. There was an increase of 35.14% correct answers for this group (Figure 7). Interestingly, this was the only group that scored 100% on the correct answer to this question (A gas that traps heat in the earth’s atmosphere) in the post-test.

Figure 7

All Schools: What is a Greenhouse Gas? (correct answer only)

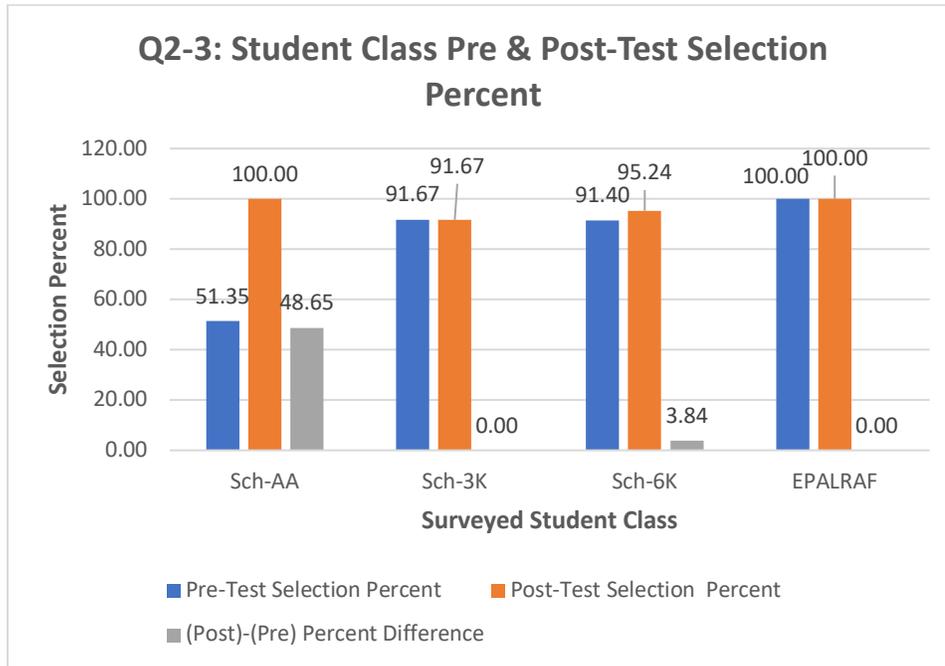


Question 2 (multiple choice): Is climate change real?

The second multiple choice question also revealed that the youngest students demonstrated the biggest increase in correct answers to the question “Is climate change real?” between the pre- and post-tests. Initially, only 51.35% of the 2nd graders selected the correct answer “Yes, climate change is taking place according to scientific findings” in the pre-test, while 100% selected the correct answer in the post-test, for an increase of 48.65%. The results are displayed in Figure 8.

Figure 8

All Schools: Is climate change real? (correct answer only)



Discussion

Impact on the Students

The Climatopia project had a positive effect on students at all grade levels, not just in terms of increased knowledge about the climate and associated behaviours, but also in terms of interaction with content, collaboration, and content creation. In terms of pre- and post-test results, the effects of the project appeared to be greater on students in the earlier grades. It is likely that the older students were already more aware of the reality of climate change and its consequences, and thus there was not as great a difference between their pre- and post-results.

One result that appeared at all grade levels was the increased awareness of the impact of climate change upon people. In the pre-test, for example, few or no students selected the options “poverty” and “Increased hunger and poor nutrition” as consequences of climate change, focusing instead on environmental effects. In the post-test, however, there was a marked increase in the number of students at all levels selecting these options. The Climatopia project, which focuses on people, has driven home to the students involved that climate change has negative effects not just on the environment but on individuals and their communities as well.

However, in addition to increased knowledge about climate change, there were other effects that were noted but not explicitly tested. For example, the report from Agia Marina notes “The Climatopia project contributed to the development of various skills, including critical thinking, decision-making, and creative expression. Students engaged in activities that stimulated their capacity for empathy, group-based decision-making, and crisis management” (p. 3). The section on pupils concludes “Pupils reported a positive psychological impact, expressing a sense of hope and empowerment in their ability to contribute to a sustainable future” (p. 4).

Kilkis Primary School shares a particularly poignant example about student engagement, particularly on the part of one struggling student:

Characteristically, the children said that Climatopia hour was their favourite and that they wished the lesson would happen every day. What was observed by the teachers who implemented the program was that students with low academic achievement actively participated in the lessons, expressing their views orally and in writing on the worksheets. A typical case is that of a student from last year's sixth grade who exhibited very low performance in school subjects, disruptive classroom behaviour and indifference to curriculum lessons. From the first implementation of the programme, this pupil actively participated in discussions and completed the worksheets accurately in terms of structure and content. (p. 5)

Even the older students from the Third Laboratory Center of E. Attica expressed their engagement and concern about how current practices are affecting the environment:

From the beginning of the activity the students showed a lot of interest. We could say that at first, they thought it was a bit funny and boring. However, as the plot of the story progressed, this changed. The children began to be anxious about the continuation of the plot, but also to reflect on the consequences of the climate crisis and its impact on their own lives (p. 2).

Impact on the Teachers and the School

The teachers had a critical role in this project. Not only did they facilitate the learning of their students, but they engaged in their own professional development related to climate change, the creation of comics as a pedagogical tool, and methods in nonviolent communication. In addition, they could be considered an important bridge from the classroom to the community, helping create a culture of sustainable living and enlightened policies that would promote energy awareness.

The implementation report of the Primary School of Kilkis provides a positive example of teacher engagement with the project.

At the beginning of the year the project was presented to the school teachers in a thirty-minute presentation. The teachers seemed to be enthusiastic about the programme and especially about the way difficult concepts such as global warming were approached by the students through story and comic books. In fact, some suggested that this material should be published so that it is available in book form and can be made available to parents and teachers. (pp. 5-6).

In fact, one teacher with experience in teaching Creative Writing was so impressed with the Comic Book that she suggested “that she contribute to the transformation of the text into a theatrical work to be presented en masse to the students in the context of climate events” (p. 6).

The implementation report of Agia Marina Primary School is similarly positive. The report notes that both their teaching and their opportunities for collaboration improved:

Teachers reported an enhancement in their pedagogical strategies through the incorporation of the Climatopia methodologies. The use of William Glasser’s “Choice Theory” and Marshall Rosenberg’s nonviolent communication provided them with innovative tools to engage students effectively.

The teachers expressed a sense of empowerment in guiding students towards self-directed learning. The incorporation of the homonomous (connected) Self concept contributed to fostering a more holistic approach to education.

The collaborative nature of the project, including peer reviews and discussions, created a supportive professional environment. Teachers found value in exchanging ideas and methodologies, contributing to professional development. (p. 3).

The Agia Marina report also discusses impact on the school as a whole: “The school community witnessed the integration of sustainable development values into the learning environment. This permeated not only the content of lessons but also the overall ethos of the school” (p. 4). The report details multiple cross-curricular initiatives that integrated education about climate change into pedagogical practices that supported sustainable education and practices. (pp 4-5).

Impact on Parents and the Community

The project clearly reverberated not only within the school but also extended to families and communities.

The implementation report of Agia Marina Primary School notes that “The Climatopia project encouraged parental engagement through activities that involved students at home. Parents reported positive discussions with their children about climate change, fostering a sense of shared responsibility” (p. 5).

The implementation report of the Primary School of Kilkis reports that after teachers informed the parents of the students about the project:

the interest of the parents in the programme was evident. At this point, it is worth noting that some parents expressed the desire to implement the programme to themselves in the afternoons, so that they would have the opportunity to participate in the same activities with their children, but also to be able to discuss their common experiences at home. (p. 6)

Similarly, the implementation report of the Third Laboratory Center of E. Attica reports that when told of the project, parents “showed interest and agreed that it is a good educational activity outside the curriculum” (p. 2).

The project went beyond classroom and school walls to enhance the relationship between school and community. The Agia Marina report notes:

The positive outcomes of the Climatopia project generated a favorable public perception of the school. The community recognized the school's commitment to providing holistic education that addresses real-world challenges. The same happened with the Directorate of Primary Education of Eastern Attica, which approved the pilot implementation.

The success of the pilot test phase laid the foundation for our participation in the Erasmus+ MIRACLE project as Associate Partner Pilot School. The school community expressed interest in continuing similar projects and integrating sustainable development issues into the curriculum. (p. 6)

Students in the 5th grade from the Primary School of Kilkis had the special opportunity to educate the community when on 19 December 2023, the fifth grade students and their teacher “participated in an educational activity organised by European School Radio where they presented the programme themselves and broadcast their own message on the climate crisis on the live radio show” (p. 5).

Conclusion

The Climatopia project was successful on many levels. It educated students about climate change and taught specific strategies to help them mitigate it so we can ensure a more healthy, verdant environment in the future. It encouraged collaboration among students, between students and teachers, between teachers and the community, and among community members to work together on this authentic

initiative, thus also preparing all stakeholders for a more unified approach to other community problems in the future. It provided opportunities for student content creation that not only helps them engage with a specific topic but also helps them explore creative talents and nurture important skills and develop a positive mindset, where they feel validated because they can contribute to educating others about an urgent issue. In particular, as a result of the project, students at all levels were able to identify that climate change affects not only the environment but also people themselves. The effect of this pilot project in Greece, as well as the partner countries, bodes well for greater dissemination and future collaborations within the European Union, and beyond.

Acknowledgments

The Climatopia project in Greece is indebted to the brave teachers that agreed to pilot this important initiative and then authored a report on the experience at their school. In order of grade level, they are:

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- George Sarrigeorgiou. 3rd Laboratory Center of East Attica

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COMBINING PROJECT-BASED LEARNING AND SCIENTIFIC WORK

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Abstract

Working scientifically and writing a conference paper is usually part of PhD programs, but not part of a regular study program for an undergraduate or master's degree. In a master's degree class for computer science, a concept to combine scientific work with project-based learning was developed and has been carried out twice. The students had to learn the professional skills of the subject social network analysis and gained methodological skills. They had to conduct a research project and to write a conference paper. In the course evaluation, the students state their high learning outcomes, but also they find that the projects are a lot of work and they describe their difficulties with this kind of work. They are used to writing project reports and bachelor's theses, but not to writing conference papers. Therefore, this concept was professionally and methodologically a new and beneficial experience for them.

Motivation

In the master's degree classes of the computer science department, not only professional competencies but also methodological competencies are taught. However, there is no specific preparation for a PhD program. The students write project reports and master's theses, but normally they do not write a paper for a scientific conference. This was the motivation to offer a course for students to work in groups on a research project with the aim of writing a paper for a real conference.

There is literature available on the mentoring process, which accompanies students to gain research skills. Jiao et al. (2011) examined mentoring as a form of researcher development. In their study, "two academics assembled a research team for a collaborative project and, while they oversaw the project, roles were assigned to individuals through discussion and consensus" (Jiao et al., p. 42). Mullen and Fletcher (2012) wrote a handbook of mentoring and coaching in education. The study of Ferguson & Ellis (2022) "found that mentoring relationships enhanced students' research capabilities, resulted in students identifying themselves as researchers" (p. 235).

Likewise, project-based learning is a well-known concept. Kokotsaki et al. (2016) wrote a systematic literature review about this field. Inquiry-based learning is described as an educational strategy to gain knowledge (Pedaste et al., 2015, p. 48). Inquiry-based learning is a pedagogical approach in which students learn by actively exploring and investigating real-world questions or problems. It is a student-centered approach of learning that emphasizes the role of the learner in constructing knowledge and understanding. The process of inquiry-based learning involves several key steps, including posing questions, collecting and analyzing data, and drawing conclusions based on evidence. This strategy is similar to the procedure that is illustrated in the following. However, the case study described in this paper presents a teaching concept whose primary aim is not to gain knowledge but to practice relevant methods of use in their further education.

The focus of this paper is neither on the mentoring process nor on the outcomes of project-based learning. This paper describes the mediation of research skills on a high level in the course of a project. The aim of the course was to write an academic paper about a research project. The paper describes the composition of the master's course and the experiences that were gained in two runs of that course. The next section gives an overview about the learning content and the professional and methodological competencies that were taught in the course. The following section describes the teaching concept. Afterwards, the results and observations of the teachers are noted. The paper ends with a conclusion that discusses some implications, e.g., the trade-off between finding an adequate way to give students enough input while not restricting their creativity.

Learning Content

In this section, the content of the course is explained. First, the professional content of the subject social network analysis is briefly described. This is followed by a report about the methodological skills that the students have practiced.

Professional competencies

Social Network Analysis (SNA) is an interdisciplinary field of study that investigates social structures and relationships by analysing the patterns of connections among individuals, groups, organizations, or even countries. SNA enables researchers to visualise and quantify the complex webs of social interactions that shape human behaviour and outcomes. SNA draws on theories and methods from sociology, psychology, anthropology, economics, computer science, and mathematics to study social networks.

A social network consists of a finite set or sets of actors (depicted as nodes) and the relation or relations defined on them (depicted as ties) (Wassermann & Faust, 1994, p. 17). SNA focuses on the structure of ties rather than the attributes of nodes. This means that social network analysts are interested in the patterns of social ties among individuals rather than the characteristics of the individuals themselves (Granovetter, 1973, p. 1360). For example, SNA can be used to study how information flows through a group of people, how ideas are diffused in a community, or how influence spreads among decision-makers (Burt, 1976, p. 93).

SNA is a useful tool for studying a wide range of social phenomena, from the spread of diseases to the adoption of new technologies, from the emergence of social movements to the evolution of organizations. SNA has been applied in various fields, including sociology, political science, communication studies, marketing, management, and health care (Fu et al., 2017). It has also been used to study online social networks, such as Facebook, Twitter, and LinkedIn ([Schötteler](#) et al., 2022).

In recent years, SNA has become increasingly popular due to the availability of data and software that facilitate the analysis of social networks (for example Borgatti et al., 2002). With the rise of digital technologies, people are more connected than ever before, and these connections generate vast amounts of data that can be analysed using SNA. Social media platforms provide researchers with access to large-scale data on social interactions, enabling them to study social networks at unprecedented levels of detail.

In our master's course "Social Network Analysis (SNA)", the students learn the following skills as professional competencies:

- To understand the concept of social network analysis,
- To perform social network analysis,
- To calculate and interpret metrics,
- To analyse and visualise data,
- To present and evaluate results.

Methodological competencies

A group of students who want to work on a scientific project should generally follow the following steps (Kumar, 2018, p. 39):

- Topic selection: The group should select a topic that is relevant to the course topic. Within the course, they gain sufficient knowledge to conduct a high-quality project.
- Planning: The group should create a plan that includes the different steps of the project, the responsibilities of each member, the timeline, and the deadlines.

- Research: The group should conduct thorough research to become informed about the current state of research on their topic. Therefore, they were given the task to write literature excerpts (Booth et al., 2016).
- Designing the research: The group should develop a research design that includes a hypothesis model, appropriate methods and tools for data collection and analysis (Marder 2011, p. 18).
- Data collection: The group should collect the necessary data and document it properly.
- Data analysis: The group should analyse the data and interpret the results.
- Writing the report: The group should write a report that includes the objectives, the research design, the methods, the results, and the conclusions of the project (Maner, 2000).
- Review and proofreading: The group should check the report for grammar and spelling errors as well as factual errors. Each member of the course writes reviews for papers of two other groups to provide feedback and suggestions.
- Presentation: The group should prepare a presentation to present their results. They should practice to ensure that they could deliver their presentation effectively and within the allotted time frame (Alley, 2013).

Teaching Concept

Professional and methodical content were taught systematically together. The steps are numbered in the following order. The observations and results in the next section are assigned to these numbers.

1. In the first lesson, the professional input contained the theory of social network analysis. The students learned what social networks are and how to analyse them. The methodological input was how to formulate a research question. Students got their first task: the definition of their research question.
2. The students got input how and where to find relevant literature and how to write literature excerpts. The next task was the systematic search for relevant literature in the particular research domain. Every student had to write two literature excerpts. All excerpts were uploaded to a forum, so that all students had access to an amount of literature excerpts referring to social network analysis. These excerpts were the basis for the section “related works” in their conference papers.
3. The next professional input was the explanation of relevant metrics and their meaning in social network analysis. The students learned how to conduct a social network analysis, which tools they can use for it, and how to interpret

the metrics. The students learned how research exposés were structured and had to write their own exposés.

4. After the discussion of the exposés with the teachers, the students prepared presentations of their research projects. These presentations were discussed with the other groups and helped the students to focus on their own work.
5. The students heard explanations about statistical methods for their data work. They learned how to produce and interpret statistical metrics. They learned what they have to consider for their data collection when they execute surveys, interviews, observations, and data scraping. Their next task was to plan and execute their data collection and to design a hypothesis model.
6. Next, the students learned how to structure a scientific project. They were informed about the expected content in the abstract and the introduction section. Their next task was to write the table of contents, the abstract, and introduction section for their conference papers.
7. The students got feedback on their written text. Then, they had to write the full paper for a regular conference in the information systems domain. They had to use the conference template and had to meet the requirements for the authors of this conference.
8. After all of the papers were submitted, the students received feedback from reviewers. They heard input on criteria, which are relevant to assess a paper. Each student had to write two reviews of papers of other groups.
9. Based on the reviews received, the students improved their papers for the final submission. They presented their work according to conference standards with plenary discussions.

Every week, there was a meeting between the teachers and each students' group to discuss the results and talk about the next steps.

Results and Observations

This section presents the results and observations assigned to the steps described the previous section.

Step 1: Formulate a Research Question about Social Networks

At the beginning of the course, a few of the students had difficulties in understanding the concept of social networks. Some were confused about the different concepts of social media and social networks. Thus, a challenge in this step was to emphasize that social media and social networks are closely interrelated, but ultimately distinct concepts.

In the first run, the research questions of the different groups differed. In the following list, the students' initial research questions are presented:

1. "How do the Twitter interactions between German Members of Parliament change before and after the election? What differences in intra- and inter-party communication can be shown? Can a shift towards the successful coalition be derived from these findings?"
2. "What effect does the network position in the answer network of the Stack Overflow site have on the duration until the first answer is received?"
3. "How do different metrics of social network analysis related to an actor influence the timing of the information gain of a scientifically relevant discovery on the social media platform Twitter, using a specified network as an example of the Higgs boson?"
4. "How does the network position in music collaboration networks relate to the popularity of the tracks? How does the network position in music collaboration networks relate to the popularity of the artists?"
5. "What influence does the network configuration have on the offensive team performance using selected NBA basketball teams as an example?"

During the second run of the master's course, the paper pertaining to research question a) of this list was already published. This obviously influenced the new groups on their choice of their research domains. All groups of the second run formulated a research question that focused on Twitter data analytics in a political context.

Very interesting is the fact that all groups decided to conduct data analytic work on the internet. Other possible methods of raising data are surveys, interviews, and observations. This can possibly be explained by the fact that all students had a computer science background. Thus, they did not consider any other method than scraping digital data traces, given the fact that scraping is often perceived as less time-intensive than conducting classical surveys. However, it should be noted that this assumption might be questionable, depending on the underlying study context.

The definition of the final research question was a process, which lasted weeks. There were more iterations necessary until the research question was adequately formulated for all groups.

Step 2. Create Literature Excerpts

The forum for the literature excerpts was readable for all students. The students got marks for their excerpts because this was a task to be done alone and not in the group. However, the structure of all excerpts was very similar, so that there were no great differences in the assessment. The students obviously looked how others had solved the task and oriented their work to the files in the forum.

Step 3. Write a Project Exposé

The requirement to write a project exposé helped the students to integrate their previous work and to concentrate on their specific research focus. This document helped the teachers and the students to gain a clear understanding of the research project. In many student teams, numerous iterations of this document had to be done after repeated teacher coaching.

Step 4. Present Research Project

The presentations of the research projects of all groups were very interesting for all other groups. They could easily identify similar problems and exchanged ideas about possible solutions.

Step 5. Analyse Data and Formulate Hypothesis Model

Because all groups voted for data scraping, the explanations about other methods of data collection were not necessary. Methods of statistics and the knowledge about formulating a hypothesis model were part of the prerequisite bachelor's programs. Surprising was the fact that the students had less knowledge about these methods. Recapitulation of relevant statistical knowledge was necessary. Some weekly meetings were necessary until the hypothesis model was correctly formulated and the data work was done.

Step 6. Write Beginning Sections

The table of contents of the conference paper was similar for all groups because of the similar structure of their research projects. The students got detailed feedback on their written texts. This was a valuable background for the writing process. The students stated that this kind of writing differs from that kind they are used to.

Step 7. Write Conference Paper

It was a completely new experience for the students to count the words of a report as is usual for conference papers. They had to select which contents are necessary, which figures and tables are a valuable part of the paper, and which contents can be omitted. Until this moment, they were used to explaining their work elaborately. They had to learn to write all essential details in a limited amount of words.

Step 8. Peer Review Others' Papers

The production of reviews was the second mark a student got for an individual output. This fact motivated the students to write qualified feedback with suggestions for solutions. At this time, all students had advanced knowledge in the

topic of social network analysis and could thus provide valuable feedback. The two teachers also wrote separate reviews for each paper.

Step 9. Revise and Submit Presentations

It was astonishing that every group produced a qualified answer to their research question. Two of the papers have been published (Schötteler, 2022; Schuhbauer, 2022), and a further paper is currently in the queue. Nevertheless, we must admit that a – partly fundamental – revision through the professor and the PhD student had to be done to achieve this success (Figure 1).

Figure 1

Published articles

The screenshot shows a research article page with the following details:

- Title:** Inferring Information Reception Velocity from Network Positions in Microblogs: A Quantitative Study
- Authors:** Sebastian Schötteler, Sven Laumer, Heidi Schuhbauer, Leon Müller, Andreas Hahn, Ferdinand Abend, Matthias Viessmann
- Published:** 17 January 2023
- Abstract:** According to social network research, network actors' benefits from being structurally embedded in a social network are not uniform but depend on the actors' specific network positions. This study evaluates whether users who occupy specific positions in a microblog follower network receive information that diffuses through mention and repost ties in the associated microblog faster than users who do not occupy such positions. Specifically, we focus on two network positions related to structural capital: outdegree centrality and structural hole closure. To explore
- Keywords:** Cluster Analysis; Microblog; Network Metrics; Sentiment Analysis; Social Network Analysis.
- Introduction:** For the political communication between parties, politicians and their constituents, social media platforms play an important role. By communicating through platforms, such

On the right side of the page, there is a link to another article:

- Title:** A Quantitative Social Network Analysis of Politicians' Tweets to Explore Political Communication
- Authors:** Heidi Schuhbauer, Sebastian Schötteler, Johannes Niu, Bernhard Schiffer, David Wolfarth
- Abstract:** This paper illustrates the practical application of cluster analysis, social network analysis and sentiment analysis in a case study. These techniques provide insights into the public communication patterns between German Members of Parliament (MPs) on Twitter around the time of the 2021 federal election. The question of this work was to determine whether a potential shift in communication towards the inaugurated "Ampel" coalition, made up of the parties SPD, Greens and FDP, can be derived from Twitter interactions. In distinct scenarios, mention, retweet, and reply interactions are first considered together and then separately. In these scenarios, the Girvan-Newman Algorithm detects clusters of MPs dependent on the interactions observed. Then, the average inbreeding homophily and other network metrics of the pre- and post-election area are compared. An additional scenario focuses on intra- and inter-party sentiments conveyed within tweet texts. In a fourth scenario, MPs are grouped according to their party affiliation, the average inbreeding homophily values of parties and potential coalitions. The communication clusters of those MPs differ mostly before and after the election. The average sentiment of the parties towards each other changed positively, although no significant tendency could be derived regarding later coalition formations.

Conclusion

In the course evaluation, the students stated their high learning outcomes. All appreciated teamwork. To conduct a research project was a completely new experience for them. They got their first experience with scientific project work intended to be presented at a conference. However, they stated that the projects were a lot of work and they described their difficulties with this kind of work. They are used to writing project reports and bachelor's theses, but not to writing conference papers.

The teachers experienced tension during the mentoring process between giving strict guidelines and giving only hints of solutions. When the teachers gave too many suggestions, the students oriented their work on them and the results were similar. This can be clearly observed in the choice of the research questions. In the first run, the students had no example works of other students to orientate towards. Their research questions differed from each other. In the second run, all groups worked on similar topics. The second great challenge was the selection of an adequate data analytics method. This selection depends on the formulated research question and the acquired data set. Hence, the students could not adapt methods of similar projects. The selection of the data analytics method required knowledge about the method itself and the specific research topic. However, the students found it very challenging to conduct a self-reliant research project. Therefore, they expressed the wish to receive presentations of example projects. The tension is to find an adequate way to give the students enough input but not to restrict their own creativity.

A questionnaire was done to evaluate the course by the students. The students assessed the structure of the course as logical and helpful. However, they stated that a lot of background knowledge was a prerequisite. It was covered by their bachelor's program, but they had not used it until now and had forgotten a lot of it. The aim to write a paper that is to be published at a regular conference is a great motivation for them. Therefore, this concept was professionally and methodologically a new experience for them. Moreover, many course participants stated that the knowledge gained is likely to help them in writing their master's thesis. Furthermore, the course may nudge its participants to seriously consider choosing research as a career path. Indeed, one of the course participants is now a PhD student at our computer science department. Another course participant decided to deepen his research conducted in the master's course by means of a subsequent master's thesis on the addressed topic. In summary, these developments indicate that this course fills a relevant gap in our department and helps to bridge the path from a master's student to a research associate.

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HRM STUDENTS' PERCEPTIONS OF AN ASSESSMENT FOR LEARNING IN A FULLY ONLINE UNIVERSITY COURSE IN SWEDEN AT THE DEPARTMENT OF EDUCATION IN UMEÅ

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Abstract

The study is built on 75 Human Resource Management [HRM] students' reflections on their learning when conducting an Assessment for Learning [AFL], implemented in a fully online course with strictly text-based communication in spring 2021, aimed to enhance the students' learning experience and development of vocational skills. This study focuses on students' perceptions of the peer review task, incorporated in the AFL, and carried out in asynchronous online discussions [AOD]. The results show that the AOD were perceived meaningful for learning and the development of vocational skills. In conclusion, the AOD in this form can strengthen students' engagement in solving the AFL.

Introduction

The purpose of this paper is to contribute to the growing design-based research in fully online education in strictly text-based settings, by sharing the design of an Assessment for Learning [AFL], and the first analysis on the results of the implementation of this task. The AFL was created and implemented in spring 2021, in a fully online 50 % pace Human Resource Management-course [HRM] on the undergraduate level, at the Department of Education, Umeå, Sweden. The analysis is based on the students' perceptions of their experiences in step 2 in the AFL design, in which peer reviews were carried out in asynchronous online discussions [AOD].

The course introduces students to the profession, theories and research on gender and organisations, and theoretical tools for work development, and provides vocational training in planning for change in organisations. About 100-150 students from all over Sweden enrol every year, and about 75-85 finish the course. Some of them have practically no previous experience with HRM work, whilst others have worked for years in this field. The majority are women and full or part-time workers, juggling their studies with many other commitments.

The overall course design is largely based on a “standard design”, used in most fully online courses at the department, which means a task driven structure in which students’ learning is guided by often long, detailed, and wordy, written instructions about how to solve this or that task, written feedback on assignments, and answers to the students’ questions in the *Questions about the module* forum. Usually at least two examination tasks are carried out in forms of AOD in smaller study groups. An important reason for this is to enhance the students’ possibilities to participate without compromising other commitments, as it allows students to self-pace their participation and work with the task anytime and anywhere. AOD can also contribute to the sense of belonging to a dynamic community, thereby preventing online students from feeling isolated, and enhance critical thinking and high-order skills (Arend, 2009; Szabo & Schwartz, 2011; Brierton et al., 2016). Since all utterances in text are saved, they can be re-evaluated and reflected on many times, which can stimulate students to spend more time for preparation and to apply more factual arguments than they would have done in face-to-face discussions (Liljeström, 2010). It can be assumed that participating in AOD can enable students who are shy, introverted, or having language or learning difficulties to voice their thoughts better than in face-to-face discussions, as they have more time to formulate their input in a discussion. However, this “best case-scenario” doesn’t emerge by simply adding AOD to a course. The task itself must be carefully designed to orchestrate meaningful and rich interaction, and to be perceived as relevant so that students engage wholeheartedly in the discussions rather than making a “duty post” without much depth.

Although elements to stimulate interaction with peers were already included in the HRM-course, the staff had noticed that some students would not engage more than necessary in the AOD, and that the tasks were not sufficient to enhance the students’ abilities to *apply* theory in practical HRM-work. This led to the design and implementation of the AFL, which was guided by sociocultural theory, with an aim to stimulate higher engagement and to enhance the students’ learning of vocational skills. In this, peer review, in forms of AOD, was found interesting to incorporate in hope that such activity would strengthen the students’ engagement and enhance learning.

The focus in this study is the students’ perception of the impact the peer review element incorporated in the AFL in the form of AOD had on their engagement, interaction with each other, and the development of vocational skills.

- What did the students experience during interaction with peers in the AOD?
- What impact did the peer review format have on the students’ engagement in the AFL?
- Did the students perceive that they gained support for their development of vocational skills from the interaction with peers in the AOD?

Background

As pointed out by Barab and Squire (2004), “One challenging component of doing educational research on design-based interventions is to characterize the complexity, fragility, messiness, and eventual solidity of the design and doing so in a way that will be valuable to others” (p. 4). Therefore, according to Barab and Squire (2004), it is important when reporting results from design-based research to not simply share a design, but also to problematize it and share information that gives others insight into the local dynamics, the context, theories guiding the design process and design features of the intervention, and what possible impact these features may have on learning. In light of this, the context in which the design for learning was implemented is described below, to better mediate the rationale underpinning the design.

The Overall Learning Design in the HRM Course

The HRM course is divided into two modules, each examined separately but summarised as a final course result after module 2 has been completed.

Module 1: Theories, Concepts, and HRM Work in Practice

Module one begins with a voluntary task in which the students introduce themselves to their peers. The first examination is an unsupervised individual written assessment with a focus on the HRM-profession and its origin, theories, and practices in this work field. This task is usually solved by the students without many interactions with peers or teachers. The second examination is a little more complex. The content is processed through individual preparation of a seminar paper, in which students must describe a relevant scenario in an organisation and apply ethical and gender-theoretical lenses, inspired by cases in a course book or their own experiences. The paper is processed in a seminar, through feedback, questions, and suggestions from peers, and is aimed to enhance the students’ ability to identify signs of gender discrimination in an organisation, its consequences, and what role they could play to identify, prevent, and solve gender-related problems in their future profession. The number of replies to peers, and application of theory in their feedback, is strongly formalised to make sure that everyone has understood the processed content well enough to apply it in an analysis of life-like issues.

Module 2: Working with Organisational Change from an HRM-Perspective

In this module the focus shifts from the introduction to the profession, to a more specific focus on organisational change and learning, vocational training in

applying theory, and research results to formulate a plan for change work in an organisation. The module starts with a voluntary seminar, offering the opportunity to collaborate with peers to find appropriate scientific journals and articles to use when working with the AFL. The first examination is an unsupervised individual written assessment targeting theories, models, and research on organisational change.

In the next section, the second examination, the AFL, and the theoretical outlook underpinning is described more in detail.

The AFL

The AFL was formulated to fit into the existing overall course design and underpinned by the teachers' interpretation of sociocultural theory associated theoretical tools. In short, "Seven Principles for Good Practice in Undergraduate Education" (Chickering and Gamson, 1987), became a hub to which other theoretical tools were applied.

The core of the *first principle*, "Encourages contacts between students and faculty" (p. 3), suggests establishing an early connection. Elements like mentorship or Zoom-seminars were ruled out as strategies to use to accomplish this, due to the large group of students and their need for flexible participation. However, the staff made themselves visible by timely answering students' questions and through pre-recorded videos in which they shared personal thoughts and their own experiences from change work.

The *second principle*, "Develops Reciprocity and Cooperation among Students" (p. 3), is previously addressed at the beginning of the course through an introduction task and by dividing students into smaller study groups. The AOD's, and especially the peer review AOD in the AFL, is meant to enhance student-to-student interaction.

The AFL and the AOD are also designed to promote the *third principle*, "Uses Active Learning Techniques" (p. 3), which required students to put theories into practise and give feedback on each other's drafts (see steps 1 to 3 below). The use of AOD is also inspired by the community of practice framework [COI] (Garrison et. al., 1999) in which students and teachers are seen as the core participants in an educational situation, as teaching, cognitive, and social presence are important elements overlapping and interacting thus creating a space for learning.

It is a bit tricky to address the *fourth principle*, "Gives Prompt Feedback" (p. 3), as the teachers engage in other responsibilities in parallel to the HRM-course.

However, they strive to answer students' questions the same day they posted them, and to provide individual or group feedback on tasks in as timely a manner as possible.

The strive to address the *fifth principle*, "Emphasizes Time on Task" (p. 3), has resulted in two fact-oriented and rather easily solved tasks, to allow more time for the students to spend on applying these facts when conducting the AFL.

The strategy used to address the *sixth principle*, "Communicates High Expectations" (p. 3), is to reinforce the need to anchor the plans for change work in theory, and that peer feedback should reflect that it is put forward by professionals.

The *seventh principle*, "Respects Diverse Talents and Ways of Learning" (p. 3), is hard to address due to the policy that the type of examination (written or oral) provided in the curricula must be applied, no matter what needs individual students have. However, the students can construct their own cases, which makes some room for individual approaches.

As illustrated in Figure 1 below, the AFL was designed to be conducted in four obligatory steps:

Figure 1

The four steps in the AFL



Step 1: Individual Memo

The first element in the AFL means that students must build on the knowledge of signs of gender-related problems in an organisation based on what they have seen in the course and put it into practise by creating their own case, either derived from the course literature or their own experiences. Based on observations made in their fictive cases, each student is to take on the role of a professional HRM and formulate a memo addressed to a manager. In the first part of the memo, they are supposed to put forward observations of gender-related origin within the organisation featured in their cases, laws, and research on the field, in an argumentative text that would focus on why they find it important that the organisation to invest resources in change.

The second part of the memo is devoted to suggesting a plan of action for change at work and defend its design. In this part the students are instructed to apply common models, theory, and research on change at work in general and activities that specifically can help change gender patterns in organisations.

This is a complex task which communicates rather high expectations on students' ability to put theory in practice. It's hoped that encouraging the students to apply theory on an almost authentic case, could stimulate them to spend more time solving the task and enhance their engagement in AOD.

Step 2: Peer Feedback on Memo

The second element in the AFL is the AOD in forms of peer review, which is in focus in this study. The individual memos are shared in the smaller study group, and the students are instructed to take on the role of a helpful co-worker, offering friendly but critical feedback on the quality of the memo and providing suggestions on formulations that can strengthen the impression of a proposal to a manager. They need to show that they have consulted theory and research to enhance their feedback and suggestions for changes. This obligatory task is guided by instructions on what to focus on in the feedback, and formulated to communicate expected standards on the memo, since helping students understand what's expected of them is vital according to research on feedback and can encourage students to actively engage with feedback (see for example Rust et al., 2005). The AFL was also hoped to enhance the students' engagement in interactions with peers.

The peer review element in the AOD was intended to stimulate the three important elements, the *Social*, *Cognitive* and *Teaching Presence* that, according to the COI-framework (Garrison et al., 1999), are necessary elements in the development of a COI. It was believed that interaction with peers in these forms could prevent the feelings of being left alone, struggling with a challenging task. It was also thought that working in groups, with the opportunity to negotiate different understandings of theory and how to apply it in practice and strategies to communicate their proposal for change work to a manager, could stimulate deeper cognitive processes. Also, as some students usually have very little experience from previous academic studies and/or HRM work, students with more experience in these areas could reinforce the perception of teaching presence in the course.

Step 3: Individual Completion of Memo

The peer feedback is used to finish the memo before it is posted for examination. When doing so, the students need to carefully evaluate the received peer feedback and reflect on which of the various suggestions for improvements are worth

considering when completing the memo. This activity is hoped to strengthen their cognitive engagement in the task and give them the chance to apply skills and knowledge gained from participating in AOD.

Step 4: Individual but Shared Reflection

Reflection was a voluntary task used the year before the AFL was designed. It was originally formulated by a member of staff who had some ideas that reflection can enhance learning. Reflection can stimulate high order cognitive processes and can, therefore, be a useful tool to draw knowledge from experiences (see for example Chang, 2019; Heyler, 2015). Thus, the reflection task was modified to better stimulate reflections on experiences made during the course in relation to learning outcomes and incorporated as the last obligatory step in the design. The students are to reflect on their learning experience from different perspectives and formulate their thoughts in writing. They are to ponder on what interaction with peers and teachers meant for their learning. The paper is posted in an AOD forum to enable peers to read and reflect on them if they want.

Method

As the focus in the study is on the students' perceived AOD to support their engagement and development of vocational skills to aid changes at work, their reflections conducted in step 4 in the AFL were identified to provide relevant data. After obtaining permission from the seventy-five students who posted reflections at the first examination, their reflections were collected, read through, and negotiated several times by the researchers before being categorized. The analyses were guided by Garrison's (2007) descriptions of manifestations of social, teaching, and cognitive presence in AOD.

Results

The first readthrough of the students' reflections revealed that all seventy-five expressed satisfaction with their learning experiences in the course. This made it interesting to understand if, and if so how, the AOD contributed to this result. Some students did not explicitly mention the AOD in their reflections on interactions with peers. However, the peer interaction (and with teachers) was most intense during the AFL, which means that reflections during step four provided valuable insight into how the students perceived their interaction with peers in the AOD. Also, as the AFL has such explicit emphasis on vocational skills, the content in the reflections could provide valid information about whether the students perceived that the AFL contributed to such learning.

Two students point out:

- “The last theme has in my opinion been the most important part of the course and broadened my perspective on what it takes to make successful change work. It has become clear to me how important it is to anchor change work in the whole organisation to be successful.”
- “Although I know that you learn afterwards and not directly, I saw it myself in case part 2. Without that step, I would never have been able to write what I wrote in step 3.”

Few students explicitly mentioned the social aspect of interactions with peers. Those mentioning it wrote about the feeling of being supported by their peers and/or feeling safe with them. One of the students reflected on how their study group formed a Facebook group which initially seemed as a good idea, but which became unimportant over time as the discussions on the course platform were so rich and meaningful. Others put forward that they thought seminar discussions via Zoom could have added to the interactions, but one student wrote about how the AOD added to a feeling of closeness. He wrote that he believed this would not have happened if they had used Zoom, as the positive dynamic could have changed through the awkwardness to talk to strangers. Students also put forward the great engagement in their study group, which inspired their own engagement; as one student expressed it:

- “With the help of fellow students, I find a lot of joy and creativity that inspired new ways of thinking and perspectives.”

The students’ reflections show signs that AOD stimulated rich cognitive processes. One student described it like this:

- “I have had to think and reflect on others' cases, which has given me a chance to develop my analytical ability. At the same time, I have gained an incredible amount of inspiration and insights from reading other people's work and comments.”

Another student reflected on how the written format initially felt clumsy and insufficient for discussion, but that this changed during the course when realising how such forms of communication demand more thoughtfulness and time spent on reflection than face-to-face communication. Many put forward how feedback from peers stimulated deeper reflections about their own strategies to solve the AFL, and how the exchange of experiences with peers made them aware of how narrow their own thoughts were.

Signs were found that teaching processes appeared in the AOD. Almost all described how they learned a lot from the many ways to understand the course content in the group, as well as the importance to apply theory in practical HRM-work and peer feedback. Many believed that this was possible because of the obligatory demand to anchor memos and feedback in the course literature. The

students also expressed that they had learned a lot from the opportunity to observe different examples for how theories and research can be put into practice. As one student described it:

- “We have valued each other’s positions by using scientific concepts and literature, rather than on what we think, feel, and believe based on own experiences.”

Often, reflections over peer feedback contained words like “enormously,” “valuable”, and “essential to learning.” One student wrote about how others shared valuable tools derived from other contexts than the HRM course:

- “In the conversation with other students, we do not only bring with us the knowledge provided via the course literature, but knowledge acquired through previous formal education, experience, and so on. Knowledge, we bring with us to our fellow students during the seminars. I have gained access to a lot of new analysis tools with the help of my fellow students' accumulated knowledge.”

The majority reflected on learning from peer review discussions through the observations on how the course content could be used in many ways, or when details and strategies not noticed or interpreted differently than themselves were mentioned by peers. Most students did not explicitly reflect on what specific vocational skills they achieved. However, all of them wrote about learning outcomes such as insights on how change work in organisations can be planned and organised to enhance the possibility to reach the goals, the importance of putting theory and research in practice in HRM-work, and the importance of ethical reflections. Some indirectly showed their skills through analyses of previous experiences from change at work in organisations, completed with a discussion about how it could have been done in a better way.

One student wrote about how vocational tools were provided indirectly through the learning design in the course:

- “What we will take with us from the course to use in a future workplace is not only what we have learned but also *how* we have learned. The learning process itself has given us an insight in how a learning organisation can work ...”

Students with no previous experience from HRM work seems to have gained a clearer picture of how this is carried out in practise. As one student pointed out: “Since I do not yet have any major experience of HRM work, it has been very rewarding to gain insight into what reality can look like via other students with a little more experience.”

Discussion

Processing memos in the AOD seems to have sparked students' creativity, cooperation, and sense of reciprocity, and stimulated deep cognitive processes, which was what was hoped would enhance the AFL-design. It may be too early to conclude that the students' vocational skills were strengthened by the processes in the AOD.

Further studies, for example analyses of what refinements the students made on their memos after the AOD and the feedback they received from teachers grading their memos, can reveal more about that. But it is a good sign that the students themselves perceived that this element in the AFL-design contributed to nuanced understandings of the course content and how to put theory into practice. It can be concluded that the text-based format does not seem to have become an obstacle for the development of meaningful interaction, even if some students wished for seminars via Zoom.

Although it is not possible at this stage to draw the conclusion that a COI emerged, all the elements needed for such an outcome seem to have been in place. Therefore, peer review in the form of AOD can be regarded as an activity that substantially contribute to dynamic and engaged interaction, in which processes of social, cognitive, and teaching presence emerged. Further studies of how the students' perceived their interaction with teachers, and what they regarded that the case-based memo-design meant for their learning, are needed to fully reveal how the students' learning experience was shaped by the implementation of the AFL and what impact it had on the students' development of vocational skills. However, it can be concluded that peer-review activities, in which students share examples and provide feedback on their peers' attempts to put theory into practice, can be a successful active learning technique in a text-based educational setting. It also can be concluded that the AOD may have played a crucial role to strengthen the didactic potential of the AFL.

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UPPER SECONDARY SCHOOL TEACHERS' COLLABORATIVE LEARNING ABOUT DIGITAL TECHNOLOGIES — A RESEARCH CIRCLE.

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Abstract

Teachers' use of digital technologies continues to increase in schools. For many teachers, possibilities to collaboratively deepen knowledge in the understanding and use of digital technologies are limited. This paper reports on upper secondary school teachers' work in a research circle for professional development in digital technologies. The teachers in this research circle reported new knowledge in the area of digital technologies, which involved insights into policy documents, theories and models related to the use of digital technologies in schools, and concrete examples of how to support the use of digital technologies in practice in their schools. Continued work in research circles could involve increased support of teachers' responsibility for and ownership of the work in digital technologies.

Digitalization in Teachers' Practice in the Swedish Context

As in many schools, digitalization continues to increase. Swedish National IT strategy (The Swedish Committee for Digitalization, 2014) and the Swedish National Digitalization Strategy for Schools (Swedish Government, 2017) were introduced to support the use of digital technologies in schools. Using the concept of adequate digital competence, the responsibility for advancing digitalization in schools as organizations was placed in focus. This concept comprises the responsibility for all school staff to support students' adequate digital competence. The Swedish National Agency for Education (henceforth, NAE) reported the need for professional development in the area of digitalization on all levels of Swedish schools (Swedish NAE, 2016). The Swedish NAE (2023) defines digital competence as involving four aspects: *to understand the impact of digitalization on society, to be able to use and understand digital tools and media, to develop an approach that is critical and responsible, and to be able to solve problems and translate ideas into action* (here and elsewhere, translations are the authors').

Although the intentions in line with policy are strong, the definition of adequate digital competence continues to remain unclear (Olofsson et al., 2020).

Efforts to accelerate the uptake and use of digital technologies in schools through professional development for teachers continues to be in focus. The introduction of digital competence as a basic skill in the curricula for both compulsory and upper secondary schools was proposed (The Swedish Committee for Digitalization, 2014) to promote students' competence in the use of digital technologies. This trend is reflected in the need for teachers to consider the uptake and use of digital technologies through didactical design (Jahnke & Kumar, 2014; Olofsson & Lindberg, 2014) to enhance student outcomes.

However, despite this focus on advancing the use of digital technologies, the Swedish NAE (2022) reported that preschool teachers', teachers' and school leaders' work pointed to a gap between the intentions of policy and practice. More work needs to be carried out to advance the use of digital technologies in the classroom. According to the NAE (2022), a more systematic approach in the work in school is needed to advance digitalization. This work includes formulating and following plans for digitalization, mapping the current situation regarding professional digital competence, and exploring how digital tools and textbooks function in teaching (Swedish NAE, 2022).

Teachers are important in the work to advance the use of digital technologies in the classroom. Drayton et al. (2010) pointed out that teachers need professional development as well as time to discuss subject content, students' work activities, pedagogy and technology. This is in line with what Ertmer and Ottenbreit-Leftwich (2013) report, noting that teachers' activities regarding the uptake and use of digital technologies needs to shift from technology to pedagogy and that this takes time. Teachers need to be confident in their own abilities and to work in a school culture that supports professional development in technical, pedagogical, and subject-related didactic competences (Mishra & Koehler, 2006). Towndrow and Wan (2012) emphasize the importance of collaboration through sharing. Vrasidas (2015) argues that professional development must be collaborative and situated in teachers' everyday practice. Here, the role of the teacher is central (Hattie, 2009). Further, the importance of the teacher and the uptake and use of digital technologies appears to support the idea that the technology is not the agent of change, but the teacher is (Kirkwood & Price, 2014). The relationship between teachers' technology-related teaching skills and students' learning activities involving digital technology appears to be strong (Sailer et al., 2021). These researchers also note that teachers' skills are positively related to frequency and types of technology use.

A Research Circle in Digitalization

According to Persson (2009), the starting point for the research circle can be described as a dialog between researchers and professionals, which can provide a basis for developing teachers' own practice. Research circles are a form of continuing professional development. In a research circle, teachers are active participants, and reflection discussion has a central role. There is a strong connection between research and practice and mutual work between teachers and researchers (Furu & Sandvik 2019). The result of the research circle should lead to a new knowledge contribution. Moreover, it is important that a research circle should not be based on the teachers' lack of knowledge, but instead teachers' active exploration in learning (Pihlgren, 2019).

The research circle in focus was: *Digital technologies - opportunities and challenges. A research circle for secondary school teachers*. In this research circle the opportunities and challenges of learning and teaching with digital technologies in the classroom were explored. Here, many different perspectives and issues were formed, with the focus depending on the participants' (teachers') interests; to reflect on what digitalization means, how teachers can use digital technologies to increase students' opportunities to learn, and how teachers can collaborate on digitalisation to strengthen and develop digital competence and equity. Research on and experiences with, for example, learning and teaching with digital technologies, were presented. Furthermore, there was opportunity to plan and implement a small development project in practice. In the case of this research circle, this work took place in the form of a final product, which was a PowerPoint presentation that presented the accumulated work during the progress of the research circle. This paper reports on upper secondary school teachers' work in a research circle for professional development in digital technologies.

Method

The research circle in digitalization took place during 2021 from January until December. Five upper secondary teachers participated in the research circle with two researchers. All of the seven meetings took place in the web-conferencing platform ZOOM and for some three hours. The meetings were organized by the researchers, who also were responsible for documentation. The first meetings of the research circle comprised reading steering documents for schools in digitalization. After a number of meetings, the teachers decided to focus on more specific literature (Sjöblom & Jensinger, 2020). However, the content of the different meetings was decided among the teachers in line with what they found was necessary to learn in their practices in regard to digitalization. Each meeting ended with a short review of the meeting and planned work and reading for the next

meeting. In most cases, this work involved planning what to read and to summarize for the group. During the last meeting the final product, as decided by the teachers in the group, was presented.

In this paper, letters written by the teachers are presented. At the end of the research circle, the teachers were asked to write a letter to summarize their learning experiences in reflection (Bie, 2014; Schön, 1987). These letters can be characterized as *learning reflections* (Moon, 2006). All five teachers who took place in research circle wrote a letter. These letters are identified as (T1-T5). In total the letters comprised some 130-409 words. The letters were then analysed using reflective thematic analysis (Braun & Clarke, 2019).

Results

In this section, the results are presented. The following four themes emerged: *Own learning*; *Literature and discussions*; *Theory and practice*; and *Continued work*.

Own Learning

In the theme *Own learning* the teachers reflected upon their own learning as a result of the work in the research circle. This involved their own learning about digitalisation as well as opportunities for collaborative learning: “I have learned a lot about how to think about digitization and peer learning. That it is important to think long-term and strategically and that this is usually lacking in the school world” (T1). The research circle provided time to reflect more strategically on digitalization.

Another teacher expressed their own learning as becoming more confident in the area of digitalization as a learning process in the research circle:

This course has given me a more solid foundation to be able to define digitalization in society and especially in schools. The course, through literature, lectures and discussions has developed my knowledge of what digitalization is and where we are heading. I spontaneously feel that I personally have gained a solid understanding and that I can show/inform my colleagues to some extent. (T2)

However, their own learning did not necessary only mean new content, but a better base of knowledge in policy and research in the area of digitalization. This new, own learning sparked interest for further studies:

I do not feel that I have learned a lot of new things, in terms of facts, but I have gained a stronger base of what I already had and feel more grounded in research in my opinion, which was one of the main reasons why I wanted to attend the circle. I also feel that I have more ways to find relevant research in the future. I am grateful for that. An old dream of doing a PhD has also come back, but with a different focus than before. (T3)

The researchers who led the research circle were also seen to have provided guidance and structure for learning: “You have shown the way in a gentle way, where we have largely been able to control the content. If nothing else, you at least made me feel that way, even though I think you had a little plan, which you planted in a nice way” (T4). One teacher also noted their own learning would perhaps have been supported by doing the research circle with a colleague: “I don't think it matters so much that I was the only one from my school, although it would have been desirable for more teachers from [my school] to share this journey with me” (T1). Participation in the research circle also involved seeing new perspectives: “I think the research circle has given me many useful thoughts from an organizational perspective. I have thought a lot about school development but also of course from a teaching perspective, but I think my focus has broadened through my participation in the circle” (T5).

Literature and Discussions

In the second theme, *Literature and discussions*, the teachers reflected on the literature as well as collaborative discussions on the literature: “The most rewarding and stimulating thing has been to study good literature together and share thoughts and discussions” (T2). As one teacher noted, the discussions on the literature led to deeper learning over the course of the research circle: “During the course of the circle, I have experienced that the discussions and materials we have worked with have given me insights and clarity on several issues” (T3).

The research article also provided the possibility to read and discuss important policy documents:

Links to articles, documents, movies have all felt very relevant and inspiring. And I really appreciated that you brought up the national strategy, for example. I've done a lot of work on it in the past, but managed to put it in the bottom drawer of the oblivion bureau. (T4)

One teacher saw the book as the most important literature: “What I appreciated most was probably the book. It is very clear and practical. It has given me a structure for how I should think in different processes. Things that I probably knew, but now had to refine, reflect on and clarify” (T4). The teachers also appreciated the

possibility to choose the literature and the path of learning by themselves, although with support from the leaders of the research circle: “It was positive that we got to set the direction ourselves, and that it took a few meetings before we got there. I think you have been very good ‘companions’ in that” (T5). The same teacher commented on the learning environment as supportive: “I think we have had a good climate in the group, and I think you have contributed a great deal to this with your approach. We have had very rewarding discussions, I think that what we have done is much of what is missing in the profession, there is rarely time for that” (T5).

Theory and Practice

In the third theme, the teachers reflected on *Theory and practice*. Here the teachers saw the research circle as a possibility to combine theory and practice. The research circle provided relevant research in digitalization which could be merged with practice in school: “You have led us through this circle in a very good way and we have alternated theory with practice in the schools in our county” (T1). This was also linked with supporting student learning and equity: “The theory studied provided insights into how to support students’ learning as well as important issues such digitalisation as a tool for equity” (T3). The importance in integrating theory and practice was also seen to be important for student learning:

To a large extent, I can apply and understand the importance of digitalisation for the individual in the school and then I think primarily about the student. The knowledge is also that together we are strongest, a company, a school, a society is not stronger than its weakest link. Equity, which is a very essential part of the state's plan for digitalization, is of great importance, and probably the most important part to develop (I think)." (T2)

Another teacher expressed the work as being concrete, pragmatic and situated in everyday work:

The working method of discussing and making presentations in groups also felt good. It made it a bit tangible and suits me, who is very practical and hands on, very well. It allowed me to imagine myself in a real situation and move on from there. A bit like when I am a process leader in action research, which is also very much rooted in real everyday life." (T4)

The research circle also linked theory and practice by inviting a school leader to describe the work in digitalisation in practice: “I think it has been positive to be able to take part in *mixed* findings, the book of course, but also [the] lecture and the presentation by the principal on practical experiences. Good mix of research from several perspectives and a little more hands on, actual experiences” (T5).

Continued Work

In the theme *Continued work*, several of the teachers also reflected upon future work and the next steps they hope to take in their school practices. One teacher spoke of information and dissemination to others in the school organization: “I will now try to arrange a meeting with school leaders and quality developers to share the journey made within the framework of this research circle” (T1). The work with the final product was also seen as valuable as it was possible to adapt to different contexts: “In the end, it actually became a working material to take with you. Adaptable and with slightly different inputs, depending on the fact that we all think differently, where I can mix and match based on the conditions that exist on specific occasions” (T4). Another teacher expressed this same thought of the final product as a useful product in practice for the continued work: “The final product feels like it can fit in many contexts, even if we all took a slightly different approach to the task, I think it turned out very well overall” (T5). The research circle also inspired reflection on continued work as a teacher: “Thanks to the circle, I have also started to think more actively about what I want to work with in the future” (T3).

Discussion

This paper reports on upper secondary school teachers’ work in a research circle for professional development in digital technologies. In this study, the teachers’ learning reflections showed that teachers’ own learning in the research area of digitalization had increased from an individual perspective and from an organization perspective. Teachers also spoke of increased confidence. The literature and the discussions supported the work and provided a knowledge based in research. The final product, which was the result of the collaborative work during the research circle, was seen as useful, flexible, and possible to adapt to their own context. Thus, the work in the research circle was seen as valuable to combine research in the area of digital technologies and their own teaching in school, i.e. theory and practice. Finally, continued work was seen as dissemination of the knowledge gained in the schools as organization.

In the case of this research circle, upper secondary school teachers’ use of digital was expanded and advanced through professional development in the use of digital technologies to support students’ learning. This work may support teachers’ didactical design (Jahnke & Kumar, 2014; Olofsson & Lindberg, 2014). The study of policy and models could also be seen to support this in line with the intentions of policy (Swedish NAE, 2022). Here, teachers are important to support students’ learning through the use of digital technologies as well as being an active agent of change (Hattie, 2009; Kirkwood & Price, 2013).

For many teachers, time and possibilities to work collaboratively is important (Drayton, 2010). In this study, teachers reported deeper knowledge in the understanding and use of digital technologies as a result of the time to participate and discuss together (Towndrow & Wan, 2012). A research circle provides teachers with the opportunity to meet and discuss an area of joint interest based on research literature together with researchers, i.e. research meets practice (Persson, 2009; Furu & Sandvik, 2019)

The teachers in this research circle reported new knowledge in the area of digital technologies, which involved insights into policy documents, theories, and models related to the use of digital technologies in schools and concrete examples of how to support the use of digital technologies in practice in their schools. For example, in this study, the final product was seen and important as both a documentation of the progress of the work in the research circle as well as a product that could be used in practice to support colleagues understanding of and work with digital technologies. As the teachers are responsible for the choice of literature and reading assignments, the tasks are planned collaboratively by the teachers and researchers. This is in line with Vrasidas' (2015) ideas of the importance of professional development. This professional development can be seen to strengthen teachers' technology-related teaching skills and students' learning activities involving digital technology (Sailer et al., 2021).

Finally, from the perspective of the researchers involved, the work in the research circle appeared to deepen the discussions and knowledge of the teachers as a mutual learning experience (Persson, 2009; Furu & Sandvik, 2019). Continued work in research circles could involve increased support of teachers' responsibility for and ownership of the work in the research circle as an exploration in learning (Pihlgren, 2019). Further development could also be a research circle on digital technologies with an action-based research design.

Limitations and Future Research

This study reports on teachers' professional development in research circle in digital technologies. As the sample of the study is small, future research could involve larger groups of teachers who participate in research circles. In depth interviews would be one method to gain more information on how teachers reflect upon research circles as a form of active professional development which combines theory and practice. Further studies could involve teachers work with digital technologies using an action-based research design.

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ATTENTION UNDER PRESSURE: THE IMPACT OF TECHNOLOGY-ENHANCED LEARNING ENVIRONMENT ON TEACHER PRESENCE

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Abstract

This paper evaluates the use of a blended synchronous learning (BSL) approach in a university setting by specifically focusing on its impact on academics. Through qualitative interviews and reflexive thematic analysis, our findings suggest that the increased number of activities teachers are asked to simultaneously perform in this environment places more pressure on their attention system, which negatively impacts their ability to be present. We suggest that this learning approach alone, even when supported with extensive professional development and pedagogy, may not be the most effective solution for improving teacher presence and student engagement in a classroom.

Background

Federation University is a large regional university with remote campuses across Victoria and Queensland offering blended, on-campus, and online learning to students in Australia as well as international partners. Within its student cohort, about 80% are first in family (i.e., the first member of their family ever to attend university), 75% come from regional or rural areas, and 75% come from one or more of the equity groups (such as Indigenous; low socioeconomic status) (Federation University, 2022 July). The pandemic highlighted the need to keep students connected in real time, and now post-pandemic, flexibility and agility have become the new normal in a hybrid world (Federation University, 2022 April).

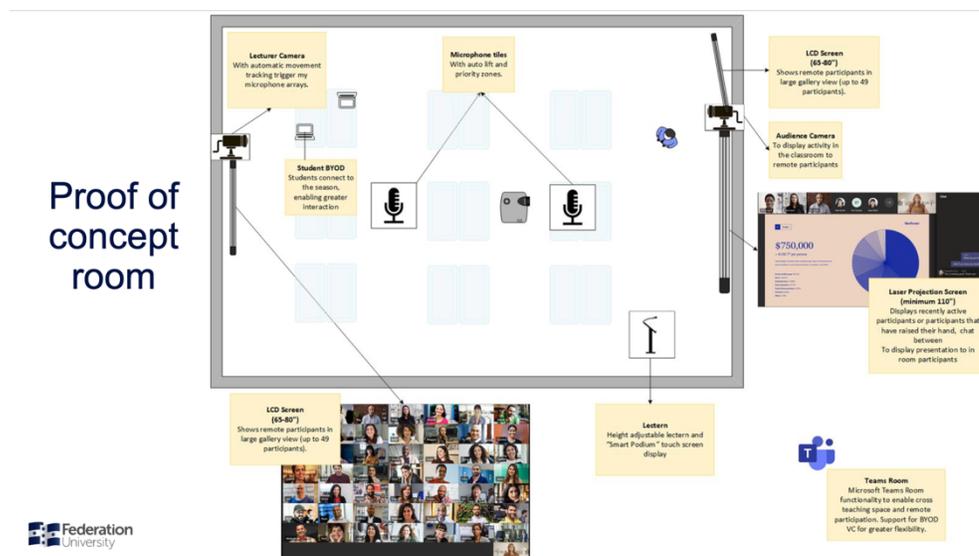
In late 2021, Federation University began trialling blended synchronous environments through what was named the Connected Classroom Initiative (CCI). CCI uses technology-enhanced equipment such as video cameras, microphones, and screens, fitted into physical classrooms for a cross-campus learning experience that provides students with the opportunity to access and interact with academic facilitators in real-time, as shown in Figure 1. Learners, academic staff (present at the lead campus) and facilitators (present at other connected campuses) may join a Connected Classroom from a dedicated space or from their personal devices.

This presented the opportunity for multi-campus synchronous delivery and the potential for increased flexibility and efficiency to gather online and face-to-face students in unified spaces. The need to cater for remote and rural students and

teachers with ongoing uncertainties from the pandemic required solutions to enable ‘presence’ regardless of physical location. Direct instruction modes can still dominate, so to make the CCI successful there needed to be a shift away from this approach towards student centred models such as active learning. It was not expected that teachers would be able to perform this change on their own, in addition to mastering new classroom technology. Therefore, setting up professional learning for changing academic practices was integral to prepare for the CCI. A cross-departmental team was formed to provide various areas of support for the teachers during the pilot phases. This included, but was not limited to, IT support to facilitate learning around how to use the classroom and the technology, and Learning Designers to support pedagogy/andragogy shifts to incorporate frameworks to enhance learning in this new environment.

Figure 1

Connected Classrooms Proof of Concept



Note. Image by Erin Penny – Team Leader ITS (used with permission)

Educational researchers have long purported that educational technology can provide affordances for learning but must be informed by sound educational design and pedagogical planning (Herrington & Oliver, 2000; Garrison & Vaughan, 2011; Raes et al., 2020). Cameron-Standerford et al (2020) state that “readiness to use technology and course management systems is an important factor for continued research and professional development” (p 7), therefore considering the blend of technology, pedagogy, and teaching is an important area of research. Next, we elaborate on the design of pedagogy for the use of these spaces, such as the modes, models and spaces of teaching and learning.

Theoretical Underpinning

Blended Synchronous Learning

Though there are many definitions of what exactly constitutes blended learning, or indeed, just what is being blended, they all tend to vary on a few common themes. These include delivery method, instructional methods, and instruction (Graham, 2005). A working definition of blended learning has been proposed by Graham (2005) who defines it as systems that “combine face-to-face instruction with computer-mediated instruction” (p. 5). Regardless of the definition, blended learning has been an omen of change in higher education as institutions have increasingly adopted it with various configurations and spectrums in education (Dziuban et al., 2018). Some have suggested it is the “new normal” in course delivery (Bozkurt, 2022, p. 2), though others state that trying to define what is normal for education will be in “perpetual flux” (Dziuban et al, 2018, p. 3).

The CCI utilises these ideas as a form of blended synchronous learning (BSL), which can be defined as an instructional method where teaching and learning take place simultaneously for both on-campus and on-line students via computer-mediated communication technologies. Raes et al’s (2020) systematic literature review on BSL states that “flexibility” is the most cited benefit for students and teachers (p. 15). For educational organisations, BSL may reduce attrition by guaranteeing continuity of instruction regardless of students' circumstances (e.g., work, health, family, distance), therefore providing greater flexibility (Vanslambrouck et al., 2018). Pedagogically, it can provide richer learner experiences through collaboration and interaction. Raes et al (2020) note there are challenges surrounding orchestrating an equitable learning environment and need to change pedagogy based on how technology influences teaching in these environments.

Community of Inquiry – Teaching Presence

Bruggerman et al (2021) argue that teachers face many challenges when transitioning to blended learning environments, including changing pedagogy and acquiring new technological skills. They also note that in many cases the teacher may have to adjust their teaching style, strategies, and techniques to suit each group's unique learning environment, which has the potential to be mentally taxing for the teacher. Therefore, one of the focuses of the learning designers and academic support staff during the pilot studies was to introduce pedagogy before the teachers went into the teaching space. While many valuable pedagogical frameworks have been examined in previous BSL research, some are more technology-focused or difficult to parlay to academic staff. The Community of Inquiry (COI), developed

by Garrison et al (2000) was employed to provide a useful model for its visual and conceptual simplicity and common understanding.

The Community of Inquiry (COI) theory proposes that learners' social, cognitive, and teaching presence are three basic factors that influence the overall educational experience of students. COI is aimed at designing, facilitating, and directing social and cognitive processes to achieve expected learning outcomes. Teaching presence is important in determining online learning efficiency, satisfaction, performance, and engagement behaviours (Garrison et al., 2000). Studies on online teaching presence have focused on its relationship with learning engagement, collaborative knowledge construction, and learning satisfaction (Anderson et al., 2001). It is important for teachers to be aware of the many factors involved in teaching presence, as attention to these factors can enhance the learning experience for students. Attention is said to be critically important to the mental processes central to learning (Shapiro et al., 2011) and is one of the fundamental building blocks for social relationships (Jha, 2021). Therefore, the next section of this paper will bring our focus to attention.

Attention

Much of the literature appears to focus on how students do not pay attention in class and lose focus, or on students' resilience, rather than considering attention, focus, and resilience of academics (de los Reyes et al., 2022). The division of attention or trying to pay attention to two or more tasks at the same time can have harmful effects on student performance (Shapiro et al., 2011), and we would suggest that it would also have the potential to be detrimental for teachers. Research that focuses on the impact of this from the teacher perspective is in its early stages (Roeser et al., 2013) with more recent papers focusing on job stress and burnout (Madigan & Kim, 2021), and some considering how to promote stress management (Hepburn et al., 2021). Therefore, investigating how the factors of attention and focus might be present with the Connected Classroom added to the focus of this research.

Shapiro et al (2011) stated that “[a]ttention is increasingly divided in the modern world, as information flow increases and individuals seek to perform multiple activities simultaneously or seek multiple stimulus inputs” (p.497). Introducing BSL increases the number of activities teachers are asked to do in a classroom, and as multi-tasking has been seen to be a myth (May & Elder, 2018), the teachers are engaged in what is referred to as task-switching. When the mind switches between tasks, it can have large decreases in performance and increases the number of errors made (Rogers & Monsell, 1995; Yeung et al., 2006). It has been noted that teaching is among the most stressful of occupations (Roeser et al., 2013; Lee et al., 2022), and teachers' emotions can influence, both positively and negatively, their attention, memory, thinking, and problem solving (Trigwell, 2012). Interaction between teacher and students impacts learning outcomes

(Osman, 2020), therefore managing how teachers balance those interactions could be key. So how do we create teacher presence when we ourselves are not present in the moment and we cannot pay attention to everything everywhere all at once?

Research Questions

As support staff, our role in the CCI was structured to assist teachers in the recognition of their need to transition away from direct instruction, lecturing, or other methods of teaching, and towards the guiding framework of COI. This study sought to explore how the teacher presence element of COI would then manifest itself once the teachers and students were in the Connected Classroom spaces. Experience from the pilot phases, as well as the literature around BSL and task switching, led to the following research questions focused on the discourse facilitation element of teacher presence:

- Were the teachers able to facilitate discourse and be present in class discussions?
- Did the teachers struggle with attention and focus given the multiple spaces they were simultaneously teaching in?

Methodology

A qualitative approach was implemented to reflect the exploratory nature of the research in both data collection and analysis. Qualitative methods are particularly useful in studies where the discovery of new information is sought (Norton, 2009), or studies which allow for the respondent to contribute to the dialogue (Gordon, 2011). This is particularly important in acknowledgment of the variety of perspectives and experiences gathered from the participants and then interpreted by the researchers as reflexive in this research (Flick, 2018).

Data Collection

The data was collected using a phenomenological framework to inform its qualitative approach and to provide deeper insight into Connected Classroom teaching by “investigating experience as we live it rather than as we conceptualize it” (van Manen, 1990, p. 30). In this way, the methodology focuses on gathering and interpreting the “lived experiences” and perceptions of the participants, specifically about the Connected Classroom and their teaching approach and practices. Participants were recruited through purposive sampling, with contact via direct email due to their involvement during the Pilot 2 phase of the CCI. Five academic staff chose to participate in the study and provided informed consent prior to their interviews. Two interviews were proposed for each participant to be conducted via Microsoft Teams by the first author. The first interview (pre-interview) was conducted with participants prior to starting CCI training, and the

second interview (post-interview) took place after the end of their teaching period. Overall, nine interviews of approximately one hour each were completed: five pre-interviews and four post-interviews due to one participant not continuing with the CCI, and who therefore did not participate in the second interview.

A semi-structured interview guide was employed that included prompts for key research areas with flexibility for other questions to be asked as the interview progressed. The interviews reflected the different experiences of each academic in the Connected Classroom and the semi-structured guide allowed enough room to discuss their thoughts on the experience freely, taking their individual contexts into consideration.

Data Analysis

A reflexive thematic analysis (RTA) method was employed to analyse and interpret the interview data. This approach allows for the development of themes from the dataset, while acknowledging the role of the researchers within this process (Braun & Clarke, 2022). For this research, a constructionist and experiential framework influenced the analysis to capture and investigate the realities of our participants' Connected Classroom experiences and their perspectives on teaching. The interview transcripts were reviewed by the researchers to familiarise themselves with the data, and then coded in spreadsheets to generate initial ideas both at a semantic and latent level to explore surface and implicit meanings within the data (Braun & Clarke, 2006). At the same time, the researchers were aware of their reflexive position with the data in order to collate these codes into themes, using the initial research areas of pedagogy shift as an inductive orientation to the data as well as our own deductive lenses to explore specific threads emerging from our interpretation of the data. While the issues in divided attention with the increase in the number of activities was a known factor for the researchers in supporting the CCI, it was not a specific avenue of questioning in the interview guide. Rather, the analysis of the post-interviews reflected this distinct thread within the participants' perspectives on their experiences in the Connected Classroom.

Having conducted RTA, we identified several key themes: (1) the importance of focus and attention in the Connected Classroom space and the challenges that arise from competing demands; (2) the role of technology in facilitating discourse and its potential to hinder communication; (3) perceptions of the students' experience in the Connected Classroom space and how it impacted the teacher; and (4) the competing role of trying to maintain teacher presence while also managing multiple tasks and spaces. In the following section we will explore these themes and discuss the implications of our findings for the CCI, and more broadly, BSL environments.

Findings and Discussion

Theme 1: The Importance of Focus and Attention

Our findings suggest that teaching in the Connected Classrooms could be exhausting for teachers. Specifically, they needed to provide attention and opportunities to different groups of students, and in the Connected Classroom this might be face-to-face, online, as well as students and facilitators in other connected spaces. Consistent with earlier research, that attention is increasingly divided when we seek to perform many activities at once (Shapiro et al., 2011) and that multi-tasking is a myth (May & Elder, 2018), the BSL seemed to make it even more difficult to focus, an important factor that was mentioned by many of the respondents.

- [P222] *“You learn how to jump in the room and have a chat to them. The issue with that is obviously I found that when the groups needed some help. Yeah, you can easily say the ones in the classroom, and you can go to them straight away, but the ones in the breakout rooms they were harder to see if they needed help at all. Yeah, just sort of sharing your time between the online groups and the classroom groups. Umm. It was a bit of a challenge.”*
- [P242] *“And then focus on what particular people are saying, but.... Like I found like it was just like information overload like I got, and I felt the students felt that too. I couldn't shift my focus or attention to multiple platforms at once.”*
- [P252] *“I had, so I had multiple things, so I don't know if that's why, whether is trying to switch between too many things. In a short period of time, if it's in a class, it works because you know I can just open it up. Uh, and also like, you know, the students in the classroom sometimes, you know, I have to like, oh my God, I'm looking at the screen. Talking to them and then?”*

Theme 2: The Role of Technology

Managing technology and equipment for the online groups as well as face-to-face students was also noted to be challenging, especially if technical problems cause disruptions and difficulties for both the teacher and the students, leading to frustration and exhaustion. The factor of technology issues was mentioned by all the respondents, with half of the respondents focusing on this aspect strongly in their interview, suggesting that it was an important attribute to them.

- [P212] *“I mean it's numeracy and digital tech, so it does, we did talk a bit about how technology doesn't always work how you want it to work*

and it's (subject area), so nothing, the students weren't respond the way you think they will at times and so we did use it, the Connected Classroom as teaching focus as well."

- *[P252] "It started off, you know, I was very excited when I started, you know, as I was telling you, like, I love the technology aspect, but I think it was, I would say it was difficult. I had like lots of issues. Especially the technical aspect, so you know from where I started to what I feel about it now. I wish you know; I wish I had like more, I wish I had the technology working a bit foolproof I had. You know, I think I had lost a lot of time in the class. I lost some of my students' interest. I couldn't cover whatever I wanted to teach."*

Theme 3: The Perceptions of Students

When considering the perceptions of students and the ability to facilitate within the Connected Classroom, the results were mixed. Some academics found that having multiple classrooms, while distracting at times, could bring together various viewpoints that a single campus had not considered. Another academic found the team-teaching beneficial in facilitating discourse as they could bounce ideas off the other facilitators as well as the students. Others found that there was a clear difference between the online students' discourse (via the chat) and the face-to-face students.

- *[P222] "I've never had anyone that wanted to put their audio on, they just want to chat... to ask questions. And then yeah, I found that the students in the classroom, you know, they're a bit quiet to start with and then when they become comfortable with the lecturers and the content, then they'll ask more questions."*
- *[P242] "I think in students feeling that they could contribute, and they didn't want to contribute when the cameras are on or when the audio was on by basically froze up the moment we turned it off, that free to open up and then they said well, so what's the point of the connected classroom because... supposed to be connected, but they didn't want to contribute."*

Within the theme around students, a subtheme of perception of safety arose from the scripts. This subtheme is similar to the findings of Mallia (2021) when considering student camera use and non-use during online lectures. Communicating with different groups of students effectively was noted to be challenging, especially when they have different needs, expectations, communication styles, and comfort level in the classrooms. The teacher needed to ensure that everyone was on the same page and that everyone had access to the

same information, which many said was tiring. Halonen (2013) noted that “When students discern unresolved adjustment problems in their professors, they are likely to focus on self-protection rather than learning” (p. 46). The sub-theme that arose from the data was that many respondents found that they were uncomfortable with the Connected Classroom, and then shortly after commented that the students were also uncomfortable, with some participants mentioning issues of “safety” with student concerns.

- [P212] *“I’m usually pretty selective and in my class and I’ll sort of do that eye thing where you catch someone’s eye and just wait until they answer. And that’s tricky because you don’t want to do that if they’ve got to be on the camera and talking to another group because they’re not feeling as safe.”*
- [P222] *“But the students tend to steer away from the cameras anyway, so they I quickly found out where the cameras couldn’t find them and tended to sit there. Yeah, and online student, they didn’t put their cameras on.”*
- [P242] *“And I think it was a case of, well, if you’re uncomfortable, I’m uncomfortable kind of thing. And then it just became well, a case of let’s try and reduce as much of the uncomfortableness of this as possible, so we end up turning off the cameras and the audio, so the students felt comfortable. But then that negates the purpose of that Connected Classrooms.”*

Theme 4: The Competing Roles

Based on our analysis of the data, we found that the teacher presence element of the COI framework manifested itself differently in the Connected Classrooms compared to online classrooms. Specifically, we found that the academics were able to facilitate discourse, but mainly if they reverted to face-to-face teaching and turned the cameras off. They also faced challenges with attention and focus due to teaching in multiple spaces simultaneously.

- [P212] *“No, we definitely shifted how we taught, to a point where we still did the same sort of things, but it was also combining with the other groups. We were very open with the students that this is a trial for us as well and we’re learning in this space. Not everything is going to work how we think it will work and we were open with them about how the timing, which was a really good lesson, I think for them that you know you can have the best plans in the world, but the group of students you have on that day in that moment with those resources, with this happening outside, is not going to be how you planned it.”*

- [P242] *“And I had one student who tried both. So, she was online, and she said it was a horrible experience in the Connected Classrooms online because you felt the teacher wasn't fully present.”*
- [P252] *“Umm, but as I'm telling you know, the way the model that I teach, you know the what the multiple things that we are going through so. If you're just doing like one sort of one sort of activity, probably you know you can have like a more, I don't know it becomes much more simplified. But as if you're doing that, the level of activity that I'm trying to do, like the multiple things, so then it adds a bit more complexity. Because you're switching between different topics, different activities.”*

To address the research questions of the study, two main areas were investigated: the ability of teachers to facilitate discourse and be present in the discussions, and the potential struggle with attention and focus given the Connected Classrooms environment. The findings suggest that academics were generally able to facilitate discourse, despite the challenges with multiple student groups and technology. However, attention and focus seemed to be compromised in this space, creating potential issues for increased mental effort, which could lead to decreased performance and increased errors.

Conclusion

The focus of this exploratory study was to investigate teacher presence in the Connected Classroom with a focus on blended synchronous learning. The researchers (as support staff) already held preconceptions that the move to BSL would be a difficult journey for most teachers. This was due to the multitasking required to navigate: the new classroom technologies; the information and communication technologies; teaching their learning content; establishing students in the teaching spaces; and ensuring their cognitive and social presence could be effectively orchestrated. Furthermore, unpredictable complications such as microphone noise sensitivity, classroom technologies malfunctioning, student complaints, and students' perception of safety due to the cameras, contributed to the negative experiences reported by participants.

While previous research in BSL focuses on the student perspective, this paper serves to highlight that attention and focus is a critical factor in establishing teacher presence and their ability to teach effectively. This also highlights that future implementations of BSL need to attend to deeper consideration of the academic support factors required to assist teachers to troubleshoot, navigate, and thrive in these in this complex classroom environments.

Limitations and Further Research

The limitation of this study was the small number of teachers initially interviewed, compounded by the smaller number of teachers re-interviewed after their time in the Connected Classroom. Recommendations for future study include expansion of teacher perspectives and approaches beyond the pilot phases of the project as the Connected Classroom Initiative shifts into “business as usual” for university teaching and learning.

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FILM MAKING SKILLS FOR PROMOTION OF YOUR PERSONAL BRAND: FMID PROJECT

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Abstract

The following article presents the need to create a personal brand and the acquisition of video creation tools to enter the job market. The new generations see everything through a screen. Nowadays, even the news is no longer read. There is a large percentage of young people who are at risk of dropping out of school because they do not know if they have a place in the labor market. The Erasmus+ Film Making for inclusion and development project provides the opportunity to train in video creation and how to use these tools to promote yourself or project your project in the job market. It has the goal of, through these tools, helping young people at risk of exclusion to generate the motivation and dedication to find their place in the world of work.

Keywords: filmmaking, project, inclusion, development, young people, risk of exclusion, youth workers, personal brand, job market, education.

Creating a Personal Brand as a Tool for Entering the Labor Market

Audiovisual culture is present in personal and professional development as well as in access to the labor market. Developing the skills to create audiovisual products is almost an obligation if we want to make our way in the professional world. We know and can identify a product and its creator without any problem thanks to its "brand". Personal brand is exactly the same, but with us taking it directly to the professional field.

Jez Bezos, the CEO of Amazon, (Quintana, 2021) defined it as "personal brand is what they say about you when you are not in the room" (here and elsewhere, translations from Spanish texts are those of the author). Knowing this definition, we must be clear that the personal brand exists since we are born and that it is something that will remain there whether we work on it or not. It is the mark we leave on others and what others remember about us; it is something like your letter

of introduction. Your personal brand equals your professional and personal demands.

The idea is, then, to work on our personal brand in a way that benefits us. To manage and project our brand so that it is convenient for us when selling our products or ourselves. We could say that the personal brand is the brand of the product that is the person himself. To enhance those talents that make us unique and work on the qualities that we want to highlight in our professional and work environment. We can say that some of the adjectives that define the concept are discipline, constancy, dedication, focus and self-criticism (Quintana, 2021).

Within the concept of personal brand, another related term is “branding”. This term refers to the process of creating our brand, the aspects needed to create a good personal brand and the importance it has in today's world of work. Helping you to know how to sell what you do, not so much what you are, starting from a brand that defines you as a professional and makes you relate to your product (Sáez Hurtado, 2020).

In this way, we can distinguish between personal brand and branding by saying that *personal brand* mixes everything that defines who we are with the actions we use to create the perception of ourselves. *Branding*, on the other hand, is the process by which we seek to develop and promote our brand. Therefore, before carrying out a branding process, it is necessary to define the aspects of our personal brand. Both terms go hand in hand and are necessary for the creation of your personal brand.

With the rise of social media and digital marketing today, we are constantly exposed. If you are not on the networks, you do not exist. Through them we manage to project an image, an attitude, and a reputation that can benefit us when it comes to selling a product. The brands we know are no longer the only ones that have to **generate an impact**. People must get on the same page and give themselves the opportunity to shine with a brand of their own. If you want to stand out and **make a professional difference** or simply create a space and a community that will follow your work, creating a strategic personal brand is essential (Ro, 2022).

Of all the reasons we find it beneficial to create a personal brand, we will highlight three that seem to us to be the most important.

The first is the **increased number of doors** it generates in the working world. Whether you work as a freelancer or in a traditional way, or you are a business entrepreneur, creating a personal brand is important to reinforce and show your capabilities to show that you are someone with presence and value (Trabajar por el Mundo, n.d.).

The second is related to **connecting and generating loyalty with a community**. Personal branding will help you reach a specific and targeted audience. With this you will be able to access, for example, customers interested in your product or investors who want to support your venture. With this you can generate a networking that will help you to move your project forward so that you have support from people and professionals in your same line of work (Pernas, n.d.).

The third and last thing we want to highlight is that your personal brand **reflects your skills and knowledge through different channels**. When building your personal brand, you should create different platforms that give you visibility in which to showcase your skills and knowledge (Quintana, 2021).

For example, a blog will give you the option to communicate interesting content in your professional area. Social networks such as Instagram or X (previously Twitter) will allow you to make visible and disseminate more targeted communications to people in the sector. LinkedIn is the social network that will help you to show yourself as a professional and define your brand as a company. You can show a more professional point of view of your progress, objectives, entrepreneurship... and these are just a few examples of everything you could cover through generating your personal brand (Ro, 2022).

When it comes to generating our personal brand, there are three aspects that we must keep in harmony. These three aspects are: what we say, what we do, and our attitude.

What we say. We must be clear and aware of the discourse we are going to transmit to the public. The personal brand is reflected in everything we publish or transmit, including the image we project. Develop a story that is based on your skills and your points of difference with the rest.

What we do. Actions are more valuable than words and, therefore, what we say must be in harmony with what we do. We must be consistent in what we say and what we do. Demonstrate your added value in the professional world.

Our attitude. Finally, our attitude defines both what we say and what we do. How we say and do things is also part of a good personal brand. Gradually update your personal brand by sharing your goals with an assertive and proactive attitude. We must be aware that all the insecurities and complexes we carry, even if we don't believe it and hide them, are visible (Sáez Hurtado, 2020).

One of the tools you can use to start developing your personal brand, define the adjectives that represent you, analyze your strengths and values to sell, is to create a vision board. A vision board is a mural where you physically visualize who you

are, your objectives, and your professional references. It is important to visualize where we want to get to in order to start the road to get there.

Film Making Skills to Boost Your Personal Brand and Your Project

In recent times, audiovisual content has become an indispensable tool in the performance of different tasks: we study and expand our knowledge, we contact each other and share new experiences, we learn to use new tools. It is clear that the consolidated connection of this tool with our daily lives makes it a resource that we must take into account for more than just its great illustrative value. (de Dios, 2017).

The audiovisual sector is changing at great speed. The Internet and new platforms such as Smart TVs, smartphones, tablets, social networks, etc. allow users to access and interact with audiovisual content in very different ways (Educaweb, 2015).

In this way, all the applications and resources offered by new technologies for audiovisual creation can help us to promote our personal and professional project.

To fit into this idea, experts say that the future of audiovisual production involves the creation and exploitation of content in various media, both online and offline (Educaweb, 2015). That is, it is not enough to create content, but also to value and sell that content. For example, you can generate calendars with weekly ideas for example or think of an audiovisual production strategy that fits your project and yourself.

We already know that with the advent of cinema, television and social networks, audiovisual media have not ceased to be present in our lives. So, what are their real benefits?

According to an article in Indeed (Indeed Equipo Editorial, 2022), there are eight benefits of audiovisual media: accessibility of many resources, increased motivation for learning, information preservation, interactivity, variety of tools for presenting information, videoconferencing, free content, and more information about current events.

We will focus on three of them that will help us in our personal and professional projection:

1. *Interactivity.* Audiovisual media is not just about watching and listening. The good thing about this media is that users can also intervene. You can share content by tagging people you think might be interested. You can write comments on social networks and websites to interact with the publications. You can share posts with others. There is also interactive

audiovisual contents which is prepared for users to perform a certain action and interact with them, instead of passively consuming them (Indeed, 2022), such as, for example, polls, live videos, or Instagram stories with open questions.

2. *Variety of tools to present information.* Audiovisual content can be presented through a computer, a television, a smart phone, or a video projector (Indeed, 2022). The good thing about this is that there are multiple options to share your content and be able to reach more audiences. The more impact your project's publicity has, the more promotion you will get.
3. *Increased motivation of learning.* Until now, the way of learning was mainly based on paper books. However, learning through audiovisual media or videos is more motivating for students because it feels more real and brings them closer to their generation (Indeed, 2022).

Why are we talking about classrooms? Because one of the ways to be able to use audiovisual tools for your professional future starts in the classroom.

Let's now talk about the Erasmus+ project that focuses on the creation of videos for the inclusion and development of young people at risk of dropping out of school or not being able to enter the labor market.

Erasmus+ Project Film Making for Inclusion and Development (FMID)

Film Making for Inclusion and Development is an Erasmus+ project (Erasmus, 2021) that aims to create an environment for the creation of audiovisual resources for those students who are disengaged from the learning process, at risk of dropping out of school, and therefore not having the same opportunities as others to develop a professional career. It is therefore important to encourage young people's commitment to their education and to equip them with skills that will increase their employability potential. This project aims to promote digital literacy among young people and teachers. In short, to encourage the desire to learn and to generate a future project through the creation of videos.

These two conclusions – about risks of early school leaving and marginalization, and the potential of video creation and usage—do not seem related at the first sight. However, the connection is significant – video creation skills have become a great advantage of any person entering the labour market or planning their own business. These skills can be used to support endangered youth communities in self-expression, but also professional networking, job searching, branding, life-long learning, sales etc. Online video creators seem to be more likely to recover from crisis than solely-traditional job professionals

All the partners forming the consortium have prior experience in implementing Erasmus+ projects. The coordinating organization of the project is Jugendförderverein Parchim/Lübz e.V (JFV), which has extensive previous experience in coordinating Erasmus+ projects and projects of inclusion of people at risk of exclusion as refugees.

This 24-month project consists of three project results: the first one dedicated to resources development for youth; a second result focused on resources development for youth educators; the third result is the development of a platform for upload all the resources.

In essence, the project has consisted of developing resources for the two main target groups: youth students in risk of exclusion and youth workers or educators.

Development of Resources for Young People (PR1)

This outcome consists of four steps: the creation of a value proposition, the development of resources, the translation of the resources and the implementation of those resources. The leading partner of this result was Siglo22.

The bespoke resources in video-making for young people have used an embedded-learning and enquiry-based learning approaches mixed together in proportions to better target the youth that would benefit the most from the acquisition of the new skills.

The resources have been created for participants to help them express themselves and create high-quality videos, with a special emphasis on the usefulness of these skills in contexts of employability, self- development, and entrepreneurship. Harnessing the natural creativity of young people and using their interest in social media with teaching the entrepreneurial skills will help them channel their hobbies and strengths into more effective job seeking and business development in the future.

The learning resources for young people have been divided into four main areas, covering video creation, production, and usage in the four contexts. These main topics describe the areas you need to consider when creating a video or audiovisual production:

- 1) Storytelling: what I want to tell, the narrative, the basic story of my project.
- 2) Personal brand: who I am and who my project is in relation to myself. The personality of my project, how I make myself known, and what I want to show my audience with my proposal.

- 3) Business development: who my audience is, whom I want to address, who might be interested in what I want to tell. Plan the strategy to contact the audience and the way to approach them.
- 4) Advertisement: how I want to do my project, the way to produce it, who to count on for it, the general shape of the shooting.

The total resources that have been developed are: four podcasts, four animations, four breakouts, twenty PDFs, twenty videos and twenty infographics. All resources will be accessible in all the languages of the partners to ensure the accessibility of content for all individuals participating in the pilot phases and the future autonomy of the project.

The Implementation

The implementation of the project consisted of a local film festival as a multiplayer event and a masterclass as a C2.

Each country held its local film festival, which consisted of a previous training of resources for both young people and youth educators. This was followed by a series of videos with 20 young people in pairs. A total of ten videos were presented at the festival. Of these, one pair per country won. The prize of the local film festival was the masterclass that took place in Madrid.

The partner leading the masterclass was Siglo22. The masterclass lasted five days during which different activities took place. The general idea of the project was presented, the winning videos were screened, and two masterclasses were held.

The first masterclass was given by Spanish director and screenwriter Sergio Milán and Spanish actress Beatriz Melgares. They talked about the different professional opportunities related to the audiovisual world and the young people were also able to see live how the different shots affect the camera.

The second masterclass was given by actress and teacher Alicia de Pablo and consisted of promoting these videos or projects through social networks. Each pair was able to make a promotion strategy that was shared on the project's Instagram.

The idea of the implementation in this project was to make it as dynamic and interactive as possible, with the objective that young people could have a direct contact with the creation of videos and see their possibilities in the working world. Thus, they could use these tools as a projection of their ideas both in the audiovisual world and in the rest of professions.

Conclusions

As we have seen, creating a personal brand, and acquiring tools for film making, is a closer way to enter the working world not only in general but also and especially for young people at risk of exclusion.

So why not promote the creation of videos as a tool to get closer to the working world? As we have seen, audiovisual platforms are already part of our daily lives and even more so for young people. Everything is done through a screen, and news is no longer read, it is seen and heard. So, it seems quite logical to include film making tools when proposing a project, an idea or simply a brand.

Thanks to initiatives like the Erasmus+ *Film Making* project, the integration of video creation skills in young people at risk of exclusion is necessary to generate motivation and dedication in them.

The project is in the final stages of development. Starting in September 2023, the resources will be available to everyone. It is in our hands to help our young people get started in the world of work and show them that there is a place for them.

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POST-COVID-19 TEACHING: REFLECTIONS ON EXPERIENCES AND LESSONS LEARNT

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Abstract

On December 31, 2019, the first case of Covid-19 was reported in Wuhan, China. Covid-19 and quickly spread worldwide. For many countries, this involved a shift to online learning for educational institutions on many levels. As things more or less move back to a new-normal state, it is of interest to reflect upon the changes which have been experienced and the lessons learnt as teachers within the ICICTE community. This poster reports on the results of a collaborative workshop based on written reflections as a way to capture and explore post-Covid-19 innovative digital trends in teaching during the ICICTE22 conference. The contributions showed challenges in being locked into Zoom, more distance to students and difficulties for students who worked and studied at the same time. Possibilities involved more efficient use of time, redesign of teaching and increased knowledge of technology. Here, hopes were expressed that post-Covid-19 teaching would shift the focus from technology toward technology to support quality in higher education. As this poster reports on a very small sample, future work should involve a larger sample of teachers' deeper reflections through interviews. Further, this work should more clearly identifying challenges and possibilities. This work is of importance for not missing opportunities for educational change in post-Covid-19 work in higher education.

Editors' note: this abstract is included in the proceedings because the poster presentation was delivered as a regular presentation during Session 3 of the conference.

TEACHING KIDS THE BASIS OF CODING. MAKE IT FUN!

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Abstract

The following article presents the need for the integration of coding in classrooms to develop 21st-century skills such as critical thinking, problem-solving, and creativity. In a computer-driven world, younger generations increasingly demand to learn the foundations of coding, such as computational language. There is an observed lack of training in the field of programming, both among students and, more concerning, among teachers. The need for tools that address how to integrate programming in the classroom is imminent.

The Erasmus+ Coding4Kids project provides the opportunity for primary and secondary education students to learn the foundations of coding and offers tools for primary and secondary education teachers to integrate it into their subjects.

Keywords: coding, project, coding in education, STEAM methodology, primary education, secondary education, teacher training, creativity, critical thinking, problem-solving,

Coding as Digital Competence in Education

Digital skills are assuming a growing significance within contemporary society. As asserted by UNESCO, these proficiencies facilitate the creation and dissemination of digital content, foster effective communication and collaboration, and offer problem-solving capabilities (Cuesta, 2022).

Concurrently, within the realm of professional environments, the demand for digital skills by enterprises and employers is progressively escalating. Such skills empower organizations to enhance their competitiveness and adapt to modern practices, thereby contributing to heightened productivity (Cuesta, 2022).

Programming and coding languages are integral components of the aforementioned digital skills. To adequately equip young individuals for their forthcoming endeavors, it is imperative that educational institutions incorporate the teaching of such languages into their curriculum. Particular emphasis should be placed on

cultivating the aptitude to write in programming languages, enabling students to create websites and programs.

The prevalent challenge lies in the inherent difficulty that adults often encounter when attempting to grasp this novel language. In contrast, digital natives perceive programming as a familiar dialect, effortlessly harnessing it to stimulate their imagination and acquire knowledge through interactive engagement (Fundación Telefónica, 2020).

In an era dominated by computer-centric societies, it is imperative for students to acquire proficiency in computer programming languages. In the future, the ability to program may prove to be as essential as possessing proficiency in spoken English. While subjects such as mathematics, geography, chemistry, physics, and biology have long held significance in the realm of scientific education, computer science, despite its distinct domain, has yet to establish its rightful place within the school curriculum.

The question arises: should programming and coding be compulsory subjects? Addressing this query necessitates an examination of the future demand for skills within the professional sphere that these young individuals will encounter. Research conducted by Carl Benedikt Frey and Michael A. Osborne indicates that as many as 54% of jobs in Europe could be automated within the next decade (Benedikt & Osborne, 2013).

In the digital realm, it is imperative for young individuals to comprehend the internal workings of computers and software. Emphasizing computational thinking is of utmost importance, as this language underpins and propels numerous technologies that pervade contemporary society (Yadav, 2014). This surpasses the confines of current computer science education, which primarily revolves around the acquisition of computer operation and utilization skills. The underlying perspective asserts that acquiring proficiency in present-day computer programs may yield limited utility, as they swiftly become outdated. Instead, it is crucial to develop proficiency in navigating various forms of digital media. While technology undergoes rapid transformations, the fundamental principles of programming have endured unchanged throughout this period.

Is it necessary for all children to be trained as programmers? No, but it is essential and realistic to provide all children with a foundation in programming basics. This would enhance their understanding and comprehension of how technology functions. Is such an endeavor feasible? In terms of teaching materials, there is an abundance of resources available for imparting programming skills to children and young individuals.

However, the challenge lies in integrating programming education into the curriculum and adequately preparing teachers to deliver this instruction. A study conducted by the Organisation for Economic Co-operation and Development [OECD] in 2018 revealed that less than 40% of European educators felt adequately equipped to utilize digital technologies in their teaching practices (OECD, 2019a). Furthermore, a study conducted by the International Association for the Evaluation of Educational Achievement [IEA] in 2018 indicated that no more than one-third of students aged 13-14 possessed even the most rudimentary level of digital skills (IEA, 2018).

As per data provided by the European Commission [EC] (EC, 2019), a substantial proportion of students in both lower-secondary and upper-secondary education levels, specifically 79% and 76% respectively, have rarely or never participated in coding or programming activities within their educational institutions. This survey encompassed 31 countries and involved interviews with school management, teachers, students, and families.

In response to these findings, the European Union has implemented initiatives aimed at digitalizing education. Examples of such endeavors include the Digital Education Action Plan 2021-2027 (EC, 2020) and the EU Code Week, which commenced in 2020 (EC, 2023).

The Skills that are Fostered through the Learning of Coding

The knowledge required for coding skills will help understand the "background" of the devices we use on a daily basis. Programming teaches children to create rather than consume. Through programming, they acquire skills such as creative and logical thinking, spatial awareness, problem-solving abilities, structuring things/situations, collaboration, and more (Bers, González-González & Armas-Torres, 2019).

The purpose of learning programming is not necessarily to train children to become computer programmers, but rather to impart them with skills that will be highly valuable for any future educational or professional pursuits. Creative and critical thinking are among the essential skills for students. These skills can be enhanced through programming by utilizing playful, gamified, dynamic tools that foster creativity, critical thinking, and logical reasoning.

Creativity is a vital skill that empowers individuals to think innovatively, generate fresh ideas, and approach problems from new perspectives. These skills are included in the well-known 21st-century skills (OECD, 2019b). Integrating coding education, as an innovative pedagogical approach in the field of education

(Sánchez-López, Pérez-Rodríguez, & Fandos-Igado, 2019), in schools can provide students with a unique platform to nurture their creativity.

The integration of coding with other disciplines offers a seamless blend that enables students to explore the synergies between computer science and various domains. By incorporating coding into subjects like art, music, literature, science, or social sciences, students are empowered to unleash their creativity through interdisciplinary projects. For example, they can create interactive visualizations to represent scientific data, compose digital music using coding principles, design digital storytelling experiences, or develop virtual reality applications that simulate historical events. The amalgamation of coding with other disciplines fosters a comprehensive comprehension of how computational thinking can amplify creativity and innovation in diverse fields (Williams, 2021).

According to Yadav and Cooper (2017), fostering creativity through coding education provides schools with an opportunity to cultivate essential skills for the digital era. This approach not only prepares students for future careers in technology but also equips them with transferable skills applicable in diverse domains. The cultivation of creative problem-solving, innovative thinking, and interdisciplinary exploration through coding empowers students to become lifelong learners and active contributors in a constantly evolving society.

Moreover, coding as a creative outlet enhances student engagement and motivation, enabling them to develop a profound passion for exploring and creating with technology. They transition from being mere consumers of content to becoming creators or, at the very least, gain the motivation to create.

Erasmus+ Project Coding4Kids

The Erasmus+ Coding4Kids project [2022-1-ES01-KA220-SCH-000086530] stems from the European need to incorporate coding into primary and secondary education. It embarked on its journey on December 1, 2022, and will continue to develop its outcomes until December 31, 2024. Over the course of two years, the project consortium, comprising Spain, Greece, Cyprus, the Netherlands, and Ireland, will collaborate to create educational resources for students and teachers pertaining to the fundamentals of coding.

All the partners forming the consortium have prior experience in implementing Erasmus+ projects, as well as projects related to new technologies, STEAM methodology, and coding. The coordinating organization of the project is the Autonomous University of Madrid, which has extensive previous experience in coordinating Erasmus+ projects and specializes in bachelor's and master's degrees in teacher training.

This 24-month project consists of four work packages: the first one dedicated to project management; a second work package focuses on creating learning modules for primary and secondary students; the third work package involves teacher training materials; and the final work package is responsible for promotion, dissemination, and activities to engage stakeholders.

In essence, the project will develop resources for the two main target groups: primary and secondary education students, as well as teachers.

Development of Learning Modules

The learning modules are developed within the second work package of the project, targeting primary and secondary education students. Among its objectives, we can highlight the creation of a set of learning modules on programming, the development of activities to promote the learning of programming fundamentals, the acquisition of new digital tools and methodologies, and the exchange of knowledge, contexts, and ideas among partners.

All modules will be accessible in all the languages of the partners to ensure the accessibility of content for all individuals participating in the pilot phases and the future autonomy of the project.

Twelve learning modules are being developed, divided into three phases: computational language; introduction of new concepts such as variables, methods, and procedures; and learning to automate.

The structure of the modules consists of a brief introduction, description of the objectives, a concise theoretical content related to the module's topic, and three lesson plans for each module. The lesson plans are documents designed for teachers to use directly in the classroom with their target audience, the students. For example, an example of a lesson plan for Module 1 of the first phase is "What is computational language? Definition and introduction".

To develop these modules in a digital format, a training session was scheduled for the consortium in Cyprus, where the Cypriot partner provided training to the other partners on the development of SCORM packages and adapting the modules to an e-Learning platform.

To ensure the quality of the outcomes, once all the lesson plans are created and the modules are finalized, a pilot phase will be conducted. Each partner country will test the learning modules with four primary and/or secondary school teachers and 100 students. This will involve a total of 24 teachers and 600 students who will

provide feedback and suggestions to ensure the final result meets the necessary quality standards.

Train the Trainer Package

The third work package of the project focuses on the development of an e-learning platform where teachers will have access to all the resources developed in the project, including the lesson plans, theoretical content, and other tools to incorporate programming into their teaching practice.

This platform will be user-friendly and developed in Moodle, hosting various content for teachers. First, the theoretical content will be generated based on the creation of the lesson plans in the previous work package. Furthermore, all the content created in the project outcomes will be adapted to the Moodle format, providing a more visual, engaging, dynamic, gamified, and playful learning experience. Moodle offers different tools that will facilitate the adaptation of such content.

Jaitek Tecnología y Formación (Jaitek) is the partner responsible for the development of the platform. They are one of the Spanish partners in the project, with over 20 years of experience in developing LMS platforms, e-learning solutions, training in new technologies, and teacher training.

Conclusions

As we have seen, the inclusion of programming in classrooms promotes the acquisition of multiple 21st-century skills, such as critical thinking, problem-solving, and, above all, creativity.

So why don't we include this discipline in all classrooms? The main problem lies in the lack of teacher training in the field of programming. This does not necessarily mean that all teachers need to be programmers, but rather that they should acquire basic programming concepts and, most importantly, tools, resources, and materials to integrate it directly into their teaching practice, regardless of the subject.

Thanks to initiatives like the Erasmus+ *Coding4Kids* project, the integration of programming in classrooms is increasingly in demand and sought after. With this project, we not only obtain a package of resources for the classroom, but also theoretical content specifically aimed at teachers, enabling them to acquire the basic yet necessary knowledge about programming and how to integrate it into their subjects.

The project is still in the development process, but it is expected that the pilot phase will yield results that help demonstrate the need for the topic and the desired quality of the resources.

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ROBOAQUARIA: ROBOTS IN AQUATIC ENVIRONMENTS TO PROMOTE STEM AND ENVIRONMENTAL AWARENESS

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Abstract

This paper examines the effectiveness of a funded program, called ROBOAQUARIA, running in five different countries. It focuses on using Robotics in the marine environment. Its main aim is to promote STEAM education, integrated with environmental topics, in elementary schools. This is attempted through both theoretical and practical activities. The effectiveness of the program is approached by examining how participants respond in what concerns the impact of the program in teaching practices, content knowledge, and professional development. The data for the research came from reports submitted by each country. The findings are generally positive.

STEAM Education

STEAM Education has gathered attention of researchers, teachers, policy makers over the last decades. Initially, it is perceived as a new field of study, which encompasses topics from different areas: Science, Technology, Engineering, Arts and Mathematics. However, STEAM education, and the research interest around it, is not restricted only to the new cross curricular content. It is considered as an innovation, which reflects general changing trends in schools, teaching practices, and perceptions. Due to its interdisciplinary nature, researchers and educators treat it as opportunity for greater change in school functions (Quigley et al, 2020).

STEAM Education Implementation

STEAM is linked to implementation of problem-solving activities oriented towards inquiry-based approach. Certainly, this type of approach is not new. In STEAM, it is considered the most appropriate approach, since through this, learners will deal with actual circumstances and challenges. They will be encouraged to construct knowledge, develop skills, and adopt attitudes on how to deal with issues relating to the component subject areas of STEAM, in a creative, cumulative and substantial way. The session should not be limited to asking the learners to memorize concepts or describe phenomena. They should be asked to design, plan, and create too. The problem-based approach facilitates a shift from traditional dominating, direct instructional teaching (Perignat & Katz-Buonincontro, 2019).

Moreover, STEAM is linked to a higher level of technology integration in teaching and learning. While dealing with everyday life issues and challenges, which can derive from fields such as Science, Engineering, Mathematics, learners will become familiar with how to use technology to deal with them, come up with solutions, and justify their work. Skills of digital literacy are crucial. STEAM should not be seen as a common usual Information Communication Technology (ICT) class. It should go beyond that. In combination with the problem-solving approach, thanks to technology integration, learners are expected to gain qualities and competencies that will help them become more creative, active, and competitive in their future lives (Cohen, 2017).

Simultaneously, STEAM is linked to Arts integration. The addition of the Arts factor can enhance even further the synthetic creativity of the new knowledge. This integration has different aspects. Initially, it is important for learners to understand basic points such as the fact that engineers and designers might focus on visual arts to improve their products or output. They would not only focus on function and productivity. Aside from that, they will understand how creativity integrates with problem solving situations, with the help of imagination, in planning and programming. In this context, the term “Arts” may describe not only visual and fine arts, but generally humanities and social sciences (Guyotte et al., 2015; Henriksen et al., 2016).

All these factors—problem-solving, technology integration, and art integration—prove that STEAM is not just a new subject but an opportunity for greater changes in the education context (Quigley et al., 2020).

STEAM and Environmental Education

STEAM is, therefore, associated with educating learners about crucial problems, including challenges of environmental nature.

Hsiao and Su (2021) carried out research on students who engaged in STEAM activities within classes that emphasized sustainable development. A total of 303 elementary school students took part in tasks that aimed to help learners develop self-efficacy skills and self-motivation towards acting to help the environment. These activities were based on Virtual Reality applications. With pre-tests and post-test questionnaires and a thorough application of inferential statistics, the researchers found a statistically significant correlation between an increase in self-efficacy and experiential learning and their impact on learning motivation, satisfaction, and learning effectiveness. They conclude “A good learning environment is all about undergoing an experience, and the improvement of students’ self-efficacy greatly affects their learning satisfaction and learning outcomes” (p. 19), further suggesting that STEAM education can indeed help learners develop qualities that might help them become more environmentally concerned and conscious. They stress the importance of teaching through gamification, as a form of problem-based learning.

Chen and Lu (2018) carried out research focused on using STEAM for environmental matters around nutrition and agriculture. This research included designing six activities around relevant themes: environmental ethics; sustainable development; climate change; disaster prevention and response; sustainable energy resources usage; and quantity meter. These activities existed in the distributed Food and Agriculture Curriculum of Taiwan and used various applications of ICT, as part of STEAM Education. They implemented these activities in 106 elementary school students who completed questionnaires, as pre-tests and post-tests. Their analysis was both qualitative and quantitative. The results were encouraging as learners developed deep understanding expressed motivation to work towards working out relevant challenges in future.

Santi et al (2021) published a bibliometric study around the connection between environmental education and STEAM. By searching with the help of VOSViewer, the authors collected 30 articles from 25 journals, published between 2013 and 2020. The journals were focused on various research areas, such as physics, mathematics, environmental studies, computer studies, social sciences, education or humanities. The articles were written by a total of 91 authors, from 13 different countries, with the United States of America having greater number of contributions. This shows that there is a rising trend in researching how STEAM can indeed assist in environmental matters, at an international level. The main keywords identified were: Research and development; Educational technology; Flipped Classroom; Electronic platform for education; Critical Thinking; Teacher Effectiveness Steam oriented educational environment; Comparative effectiveness; Electronic assessment; Learning STEAM oriented approach; Technological science; Educational resources; Educational environments; and Integrated steam

education. This proves that the themes investigated have to do with learning approaches, contexts, themes and goals.

In conclusion, the relationship between STEAM and Environmental Education is complex. That is why researchers, from various fields, over the last years tend to examine it thoroughly (Santi et al., 2021). Teaching environmental education with the help of STEAM, according to researchers, should be well-planned and should be focusing on setting the conditions for conscious adults. This way, it will set the foundations for long-term solutions (Chen & Lu, 2018; Hsiao & Su, 2021).

Dimensions of Educational Innovation through STEAM

The implementation of STEAM in schools is approached as an attempt for educational innovation. This innovation is observed in different levels of the school functions. Starting from the main elements of problem-based learning, technology integration and art integration, STEAM affects different dimensions, regarding the work of teachers and members of the educational community (Quigley et al, 2020).

Certainly, the first dimension is about *teaching practices*. To achieve the appropriate methods, such as problem-based learning and integration activities, teachers need to become familiar with new practices, which will help learners understand the necessity of STEAM and their potential to deal with various problems. Teachers—who are the moral agents of reform (Fullan, 2020), as they will have to implement any attempt to reform and innovate in education—should understand what the better ways are to deliver the new learning outcomes. It is important to estimate teaching practices, actual or new, so that they can see which fits better to their work and goals. In doing so, they should see which practices are more appropriate for the learners they have and the place where they work (Cohen, 2017; Fullan, 2020).

The second dimension is about the *content*. STEAM has to do with Robotics, which includes understanding what robotics is, how it works and how it can be used to analyse and learn around issues. In the case of this study, it is important to stress how Robotics relates to environmental subjects, how it can promote environmental awareness and lead to environmentally literate and concerned citizens. Within this, teachers should help learners understand how integration works, so that learners will also be generally able to combine knowledge, skills and attitudes of different subjects (Guyotte et al, 2015; Cohen, 2017).

The third dimension is about *professional development*. Teachers need continuous training about STEAM and innovation. This will help them deepen their knowledge and expertise in teaching STEAM, in theory and practice. The topics that this professional development should focus on will have to do with content and practices, but other issues too regarding innovation. Challenges always arise

whenever innovation is implemented. Moreover, there should be continuous evaluation and assessment. Professional development should therefore pay attention to challenges and assessment. It is especially important to establish cooperation and collaboration. Teachers should interact among themselves and with members of education community. This will increase discourse, exchange of experiences, and information, and can lead to more effective professional development (European Union [EU], 2023; Fullan, 2020; OECD, 2019).

In short, three basic dimensions of innovation through STEAM, particularly in environmental education, are: the practices that teachers should adopt and apply; the content knowledge they should deliver; and the professional development they receive generally and specifically about the innovation. These dimensions are interrelated. By examining them, it is possible to gain insight into the effectiveness of STEAM innovation (Cohen, 2017; European Commission [EC], 2023; Fullan, 2020; OECD, 2019).

The Study

This research project was planned bearing in mind the potential of STEAM to assist in promoting important skills to learners. The project named “ROBOAQUARIA: Robots in Aquatic Environments to Promote STEAM and Environmental Awareness” is program funded by the EU. It is planned to run from 2022 until 2025 as a consortium of ten partners from five European countries, Italy, Greece, Cyprus, Croatia and Italy (Scaradozzi, 2022).

Rationale and Design of ROBOAQUARIA

The idea of this project was based on the finding that STEAM can assist in developing active citizens, who are critical thinkers and can implement combined knowledge from different fields, to overcome challenges or real life (OECD, 2019), along with the general policies which call for promotion of green skills, teacher training, behaviour shift, and awareness of environmental challenges (EC, 2023).

The project therefore aims to design marine robotics equipment in the shape of fish and deliver learning activities in schools. This aims to introduce an innovative approach to environmental education, through STEAM.

A curriculum on marine robotics is planned to include guidelines on how to construct marine robots, with emphasis on teaching, through a wholistic, interdisciplinary approach. Educators and members of school communities will engage on hands on activities, which will aim at the development of green skills, and environmental and sustainability awareness as well as coding. There will also be an electronic platform for information and further assistance (Scaradozzi, 2022).

Additionally, through these classes, learners are expected to boost further knowledge, skills, and attitudes around science and mathematics (OECD, 2019).

The main target groups of this project are the teachers, who will receive training not restricted to only assembling kits and superficial coding. Instead, it will go deeper into issues around the need for STEAM Education, its potential and challenges. In fact, by the end of the program teachers will expand their expertise in carrying out interdisciplinary training programs related to the promotion of sustainability and green skills through coding and robotics. They will also improve their capacity to influence policies around using digital technologies in education at local, regional, or national levels. Through the distribution of material with the websites and through actions such as conferences, activities, and participation in education events, the project, its rationale and progress, will be presented in the academic community and the wider public too, including policymakers and stakeholders (Scaradozzi, 2022). This way, the project will set the foundations for further and greater reforms within the schools. The support provided to teachers, school leaders, and school communities will go beyond a temporary pilot application of an individual teaching approach. Instead, it will be an initiative for further reform in functions and ideas of the school system (Fullan, 2020).

The innovation of this program lies in several points. First, it includes implementation in several countries. Moreover, it focuses on elementary school students, who are expected to learn about Robotics and carry out activities to deepen their knowledge, skills and attitudes towards environmental issues and make decisions (Scaradozzi, 2022). The previous research linking STEAM with environmental education seems to emphasize other parts (Chen & Lu, 2018; Hsiao & Su, 2021; Santi et al, 2021). Here, the combination of theoretical and practical teaching of STEAM can make more precise the potential of the elementary school context to embed STEAM activities regularly. In other words, it can give insights into the level at which the school culture changes, to lead to more STEAM-friendly schools (Fullan, 2020; EU, 2023).

Methodology

The scope of the study therefore is to examine whether the schools that participate in this program adapt so that they can accommodate STEAM activities effectively, specifically for the program ROBOAQUARIA and more generally as well. Any innovation implemented in schools should have such focus (Fulan, 2020). This scope can be achieved through three basic research questions, which reflect the dimensions of innovation through STEAM (Cohen, 2017; EC, 2023; Fullan, 2020; OECD, 2019). The questions are formed as follows:

- 1) Do the teachers adopt new practices to apply STEAM activities?
- 2) Can the content knowledge be delivered appropriately?

- 3) Is there sufficient professional development provided generally and specifically about the innovation?

The data for the research were collected through reports that each country must submit, as part of the program. These detailed reports present the progress of the programs' implementation in the schools. They include questions regarding the three dimensions, the practices, the content knowledge, and professional development. They are completed by a group of participants and researchers who are in direct communication and cooperation with the schoolteachers and include data from the implementations in schools. Since they are formally part of the funded program, it is strictly evaluated that they are substantial, cumulative, factual, meticulous, and correct. Therefore, they are considered accurate data sources.

These reports were submitted by June 2023 and collected to be analysed. Analysis was based on qualitative methodology through coding with themes and codes (Yin, 2015). Three basic themes or categories were used. There were “practices”, “content knowledge”, and “professional development”. Each corresponded with the relevant research question.

Each theme included several codes. The theme of *practices* included the codes: problem-solving, technology integration, arts integration, planning, learning outcomes. These reflect the basic points of practices related to STEAM (Perignat & Katz-Buonincontro, 2019). The theme of *content knowledge* included the codes: environment, technology, digital literacy competencies. These reflect the basic points of content knowledge teaching through STEAM (Cohen, 2017). Lastly, the theme of *professional development* included the codes: training, challenges, evaluation, school culture. These reflect the basic points of professional development in innovation (Fullan, 2020). The relevant themes and nodes in the reports were gathered and analysed, so that basic findings and conclusions can be drawn (Yin, 2015).

Discussion and Findings

The results of coding show that the report of each country mentioned the codes. This probably indicates that all countries justified the importance of the basic dimensions or themes of STEAM teaching (Cohen, 2017; EC, 2023; Fullan, 2020; OECD, 2019).

Teaching Practices

With regards to teaching practices, there was mention of all the codes. It was particularly interesting to come across mention of specific practices in the reports, which were coded under “problem-solving”, such as “*Active engagement of the*

classroom using the strategies of working in group, cooperative learning, laboratory activities, learning by doing and peer tutoring. Also, involving students in problem solving activities and problem based learning. Storytelling and debate could help integrate the 'A' of STEAM, but also tinkering and 3D printing activities". Such responses show that teachers appreciate the necessity of problem solving through inquiry-based teaching in STEAM, which are mutually related (Perignat & Katz-Buonincontro, 2019).

Integration with technology and arts was also frequently pointed out, in responses such as *"Interdisciplinary integration plays a key role in STEAM education, as it combines science, technology, engineering, arts and mathematics to provide a holistic and integrated learning experience for students. Teachers can promote a range of core competencies and prepare students for the complexities of the modern world by integrating multiple subjects and skills into their lessons"*. These quotes show that teachers appreciate integration; they believe that STEAM assists and they intend to implement it, in their practices, as is indicated by literature (Cohen, 2017).

With regards to arts integration, there were schools that mentioned that STEAM activities can be combined with activities such as storytelling, or activities that can address to learners of different backgrounds, which they stressed as issues that concern generally the teachers' work and context, which perhaps means that STEAM innovation can assist in this aspect too, by improving school culture (Fullan, 2020).

Lastly, there were codes that showed that teachers put emphasis on learning outcomes. A response that encompasses these codes was *"Many careers today require a combination of skills from multiple disciplines. By incorporating cross-disciplinary integration, educators can better prepare students for diverse career paths. STEAM education nurtures a well-rounded skill set that is highly valued in fields such as engineering, technology, design, scientific research, and entrepreneurship."*

All these responses show that teachers are familiar with practices that promote STEAM implementation efficiently and they are eager to implement them. This can enhance the school potential to embed STEAM regularly (Quigley et al., 2020).

Content Knowledge

With regards to content knowledge, all codes were marked in the reports. The partners emphasized the issue of environment, as it can *"help students understand basic principles in a tangible way (proposing tangible activities) and making them aware that issues about the environment are felt by all the local community and not only. We are all humans sharing this one Earth."* Another report mentioned *"Environmental education was emphasized for ecological awareness and*

sustainable practices". Such responses show that teachers can connect environmental issues within the STEAM project, as part of the content knowledge transferred, which is a desired goal (Guyotte et al, 2015; Cohen, 2017).

Technology was also frequently mentioned. Indeed, all partners mentioned that learners enhanced their knowledge, regarding ICT, Robotics, and coding. They added that they had the opportunity to teach topics that are not involved in their national curriculum, which they considered a significant advantage of the project. So, knowledge about technology is included in the content knowledge which has the potential to be delivered in the project (Cohen, 2017; Quigley et al, 2020).

Similarly, the digital skills competencies code was noted, as participants mentioned that learners managed to understand the necessity of teamwork and collaboration. One teacher reported "*Participants also recognize the potential of Educational Robotics in cultivating 21st-century skills including problem-solving, creativity, communication, and critical and analytical thinking. They discussed successful strategies such as using programmable robots, coding platforms, and national and international initiatives (e.g. competitions, involvement in European projects, etc.) to motivate students and make learning more interactive.*" Responses such as this one show that teachers believe that this project can help students develop qualities of active citizens, which is essential in innovation through STEAM (Guyotte et al, 2015).

Professional Development

The nodes concerning professional development were all coded too. Training was mentioned as necessary for the effectiveness of the program. In fact, a report mentioned that teachers should propose "*More professional development opportunities, so that teachers can: a) realise the importance of STEAM education and educational robotics and their great pedagogical potential in teaching about the environment, b) gain the relevant knowledge and skills to be able to use tools and platforms available, c) develop the relevant confidence to implement innovative activities in class*". At the same time, another report mentioned that it would be useful to seek ideas such as "*Establishing clear development strategies and priorities: Schools can benefit from developing clear strategies and setting priorities to guide the implementation of STEAM education, educational robotics, and environmental education. This includes seeking support based on specific needs and actively addressing resource and space challenges*". These responses, although they reveal that teachers might lack adequate training, also suggest they are willing to take advantage of opportunities, so that they will be able to implement innovation in STEAM, which is crucial (Fullan, 2020).

Challenges were also mentioned. Participants commented that they are concerned about having the necessary equipment, infrastructure, resources, and tools, and finding time. These are common challenges that emerge whenever innovation is attempted within a school context (Fullan, 2020; OECD, 2019). Despite these challenges, teachers emphasized that they are willing to carry on with the program, which raises the possibility for the innovation to be successful (EU, 2023; Fullan, 2020).

The method of evaluation was also discussed in the teacher reports. Participants suggested that it would be beneficial to have peer assessment and collaboration that can give significant feedback. According to a report, *“Participants highlighted the fact that there is not a structured assessment procedure to evaluate students’ learning in the field of STEAM education, educational robotics, and environmental education. Different assessment methods and strategies were proposed to evaluate students’ acquired knowledge”*.

The parameter of school culture was brought up as well. While making a summary of the implementation report, a participant commented that *“Throughout the discussion, participants shared valuable tips and recommendations based on their teaching experiences. They highlighted the significance of providing professional development opportunities for educators to enhance their knowledge and skills in STEAM education, Educational Robotics, and Environmental Education. They also stressed the importance of structure support from the Ministry of Education as well as the collaboration among teachers, schools, and stakeholders to share best practices, resources, and overcome common challenges”*. Such comments show that participants appreciate the need and the potential of STEAM to improve school culture, which is essential if the reform is to have a long-lasting impact on school functions (Cohen, 2017; EC, 2023; Fullan, 2020; OECD, 2019).

Conclusions

This study examined the implementation of a program called ROBOAQUARIA, a funded program that includes Robotics in a marine environment. STEAM and Robotics education combine teaching of different subjects: Science, Technology, Engineering, Arts, and Mathematics. STEAM activities can help schools shift from traditional subjects to new patterns of teaching and function, with problem-based, technology-supported activities of integration that enhance qualities important to citizenship (Quigley et al, 2020). ROBOAQUARIA is a consortium of five European countries, Italy, Croatia, Cyprus, Greece and Ireland. It focuses on using STEAM to promote environmental awareness. Compared to other similar projects, it is innovative as it includes practical robotics activities in elementary schools (Scaradozzi, 2022).

To examine the effectiveness of this program, an implementation report was collected from each participant. The data from these reports were analysed through a qualitative analysis, against three basic dimensions of STEAM implementation: teaching practices (Perignat & Katz-Buonincontro, 2019), content knowledge (Cohen, 2017) and professional development (Fullan, 2020). The results show that teachers are willing to adopt new practices, which they consider as more appropriate for STEAM teaching. In addition, significant content knowledge about environment, robotics and digital technologies can be taught. Moreover, there is appropriate concern around professional development, which can lead to improved school culture and function thanks to the program. All these findings signify that this project is implemented successfully and can have significant impact in schools (Fullan, 2020; OECD, 2019).

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APPLYING THE QUALITY MATTERS RUBRIC TO ASSESS ACCESSIBILITY

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Abstract

The exponential growth of online learning in recent years highlights the importance of making e-learning material accessible to all students. Therefore, accessibility is a critical component of online learning, and ensuring that courses stay accessible to all students is essential. The Quality Matters (QM) rubric is a widely recognised tool for evaluating the quality of online courses. The study used a qualitative approach to assess the accessibility of a short course using the QM rubric. Although the QM rubric is designed to evaluate course design and content, we only used it to assess the overall accessibility of the course. The study found that the QM rubric was an effective tool for evaluating the accessibility of the course, highlighting both the strengths and the weaknesses of course design. Although a high score on the QM rubric indicated that it was accessible to a wide range of students, the fact that one of the essential standards (8.3) was not met resulted in the course being seen as not accessible to students with disabilities. The study identified areas where the course could be improved to make it even more accessible, such as providing heading styles in tables and documents and ensuring that all images had appropriate alt text. Overall, the study highlights the importance of instructors and learning designers using tools to ensure that their courses are accessible to all students, regardless of their abilities.

Introduction

According to the Statista research department, the global e-learning market could potentially reach 400 billion U.S. dollars by 2026 (Statista, 2022). Not only is the e-learning market growing, but also the use of learning management systems for e-learning, with a standing of 18 billion U.S. dollars in 2019 (Statista, 2022). Astonishingly, investing in educational technology in the UK grew to 583 million U.S. dollars in 2022, which was slightly less than the previous year (Statista, 2022). Taking in consideration the overwhelming popularity of e-learning, learning management systems, and educational technology, it goes without saying that the role of the learning designer as creator of online learning experiences (Kumar & Ritshaupt, 2017) is growing in importance and with that the evaluation of e-learning programmes, specifically towards accessibility (Timbi-Sisalima et al., 2022). Even if the world portrays a picture of billions of US dollars invested in e-learning and

technology, and the fact that the use of technology enhances access and digital inclusion to education (Adam & Dzang, 2021), the digital divide is still evident in many countries (Okunola et al., 2017). The lack of devices, internet, and electricity prevents students from reaching their full potential. Other physical disabilities could also be preventing students from accessing quality content (Newman et al., 2017). It is against this background that the researchers are interested in how an existing QM rubric (6th Edition) can be used to show possible accessibility gaps in online programmes (Quality Matters, 2023a). (Note that after our study was conducted, QM published the 7th edition of the rubric).

Literature

As institutions of higher education undergo a technological paradigm shift, the topic of quality assurance (QA) has become a top concern for university leadership worldwide (Newton, 2007; Van Damme, 2002). The renewed interest in this age-old debate is fueled by a combination of contextual factors, including global competition, external demands for increased accountability and responsiveness, financial limitations, and the impact of massification (Abdous, 2009). These factors are compelling higher education institutions to implement QA procedures, especially for e-learning, which has been subject to criticisms of poor quality and inadequate standards (Chua & Lam, 2007).

Studies done on open online education (Stracke, 2017) and a few universities in Africa blame the challenges that e-learning faces on the lack of quality assurance (Chawinga, 2016; Makokha & Mutisya, 2016). Open online course quality is currently questioned because of high drop-out rates (Stracke, 2017). Therefore, it is implied that well-designed courses, learning activities, and assessment opportunities contribute to better quality of e-learning and higher motivation of students to participate in the learning process (Stracke, 2017), stressing the importance of quality assurance standards.

Quality Matters (QM) is a non-profit organisation that focuses on promoting and improving the quality of online education (Quality Matters, 2023b). QM provides a set of standards, guidelines, and a review process to evaluate the quality of online courses and programmes. The organisation helps institutions and teachers to create and maintain high-quality online courses and programmes by providing guidance and training on online course design, evaluation, and continuous improvement of existing online short courses and programmes.

To achieve quality online programmes and short courses, a set of organised and structured management and assessment procedures need to be in place, which are consistently implemented and followed. These procedures are designed to ensure

that quality is systematically managed and evaluated throughout the process, with the aim of achieving quality online short courses and programmes (Harman & Meek, 2000). Quality assurance in online courses refers to the process of ensuring that the design, delivery, and outcomes of online courses meet a set of predefined standards and expectations. QM's quality assurance process is based on a peer-review model that involves a team of trained reviewers who evaluate courses based on the QM Standards for course design (Quality Matters, 2023b). These standards cover various aspects of online course design such as course overview and introduction, learning objectives, assessment and measurement, instructional materials, student engagement, and accessibility.

The QM review process includes a comprehensive review of the course design, including the alignment of course syllabus, learning materials, course structure, and assessment methods (Loafman & Altman, 2014; Varonis, 2013). The review team provides detailed feedback and recommendations to improve the course design and meet the QM standards. The review process aims to ensure that online courses and programmes are designed to meet the needs of students and provide them with a high-quality learning experience.

Quality assurance is essential in online courses because it helps ensure that students receive high-quality learning experiences (Loafman & Altman, 2014; McNaught, 2001). Online courses have become increasingly popular due to their convenience and accessibility, but they also come with unique challenges (Castro & Tumibay, 2021). These challenges can include technological issues, lack of face-to-face interaction, and the need for self-discipline and motivation (Gillet-Swan, 2017). QA helps to address these challenges by ensuring that online courses are designed in a way that promotes effective delivery and learning.

The QM rubric is a set of standards that provides a framework for evaluating the quality of online course design (Elaasir & Bouziane, 2019). The rubric is based on research-supported best practices and covers eight general standards: course overview and introduction, learning objectives (competencies), assessment and measurement, instructional materials, learner activities and learner interaction, course technology, learner support, and accessibility and usability (Quality Matters, 2023a). The rubric is intended to be used as a guide for course design and evaluation, with the goal of improving the quality and effectiveness of online courses (Loafman & Altman, 2014). The QM rubric is designed to be flexible, allowing institutions and teachers to adapt it to their specific needs and goals. It is also scalable, allowing it to be used for both small and large courses. The 6th edition of the higher education rubric provides specific standards and criteria for each of the eight general standards, with a total of 42 specific standards. The rubric has three categories of standards: Essential (3 points), Very Important (2 points), and Important (1 point) (Kreie and Bussmann, 2015). Online courses need to meet

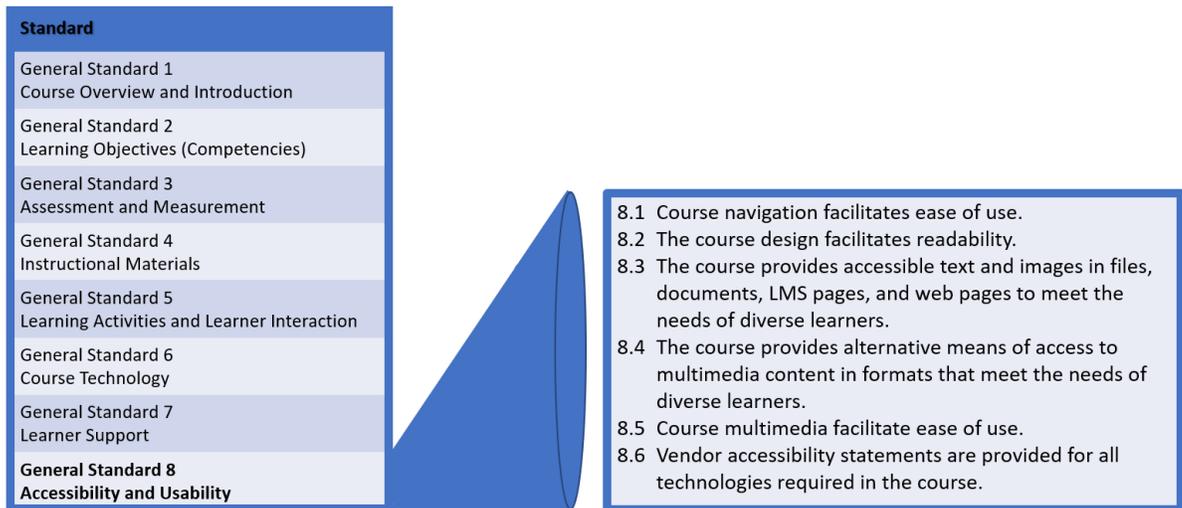
all the essential standards in order to be QM certified. An official review team consists of three reviewers; however it is possible for two reviewers to agree that an essential standard is MET and the points will automatically be assigned.

The QM rubric can be used in several ways. It can be used by course designers and teachers as a guide to design and develop effective online courses that meet the needs of learners (Loafman & Altman, 2014). It can also be used by institutions to evaluate the quality of online courses and ensure that they meet specific standards and expectations, either through an official QM review that can result in certification or an informal internal review. Additionally, the QM rubric can be used as a tool for continuous improvement, providing a framework for educators to evaluate and revise their courses to ensure that they are effective and engaging (Legon, 2015).

Accessibility is part of General Standard 8 (GS 8) on the QM rubric (Quality Matters, 2023a). The accessibility standard in the QM Rubric is focused on ensuring that online courses are designed to be accessible to all students, including those with disabilities or other special needs. The accessibility standard in the QM rubric includes several specific standards and criteria that course designers and educators should consider when designing online courses (Figure 1).

Figure 1

General Standard 8 with its Specific Review Standards



Authors such as Bailey and Gkatzidou (2017) and Permvattana et al. (2013) highlighted the importance of looking at accessibility from a holistic approach. In the past many e-learning designers saw accessibility as only an accessible website and platform (Timbi-Sisalima et al., 2022). Bailey and Gkatzidou (2017) suggest

universities take the accessibility of the technology, the operational use and the psychological accessibility in consideration when designing e-learning material. The accessibility of the technology relates to whether the student can access the e-learning, whether it is compatible with assistive technology, and how does it address the user needs. The operational use of technology is related to whether the student can use the e-learning material and how well can they use it and whether it meets the students' expectations. The psychological accessibility of technology refers to how useful and appropriate the e-learning material is.

Timbi-Sisalima et al. (2022) emphasise the importance of accessibility in e-learning and in doing so, promoting lifelong learning opportunities for all. Through the use of educational technology, students can have access to learning opportunities at any time, from anywhere (González-Zamar et al., 2020). This increased access is aligned with the Sustainable Development Goal 4 (SDG4) of Quality Inclusive Education for everyone (United Nations, n.d.). Adhering to SDG4 fosters opportunities for previously marginalised populations to have access to education through well designed e-learning programmes. Therefore, a rubric is needed to evaluate the accessibility of e-learning in a consistent manner and also determine the lack of accessibility in e-learning modules (Elaasri & Bouziane, 2019).

There are many standards available to evaluate e-learning, such as the adapted ISO 9126 that has a strong focus on technology, learning content, and the business aspects (Djouab & Bari, 2016), and the Rubric for e-Learning tool evaluation that focus on functionality, accessibility, technical, mobile design, privacy and the three presences of the Community of Inquiry framework (Anstey & Watson, 2018). Other studies stress the importance of universal learning design specifically to address the accessibility of students with disabilities. According to the CAST (n.d.) website and confirmed by Ralabate (2011), each part of a curriculum has multiple and flexible ways for representation, expression, and engagement that needs to be part of the design.

Derived from the building industry, universal design for learning attempts to give students equal opportunities to learn. Similar to people having a choice between using a staircase, escalator, or lift to move from one floor in a building to another, universal design for learning offers various pathways to learning. These pathways can refer to different ways students access information, demonstrate their skills, and engage with others in an online module, and still maintain quality (Robinson & Wizer, 2016). Not only does universal design for learning relate to access but also guide the creation of learning outcomes, activities, and assessment. Therefore, multiple representations of concepts, multiple ways of demonstrating knowledge, and a variety of activities to keep students interested and engaged, forming the basic principles of universal design for learning, need to be included in the module (Stringam, 2014).

Robinson and Wizer (2016) recommend that a combination of QM and Universal Design Learning (UDL) principles provide a guide to creating accessible online learning. Amongst others, they suggest that students as partners need to be included. The basic principles of UDL are incorporated in the QM rubric in General Standards 1 and 3-7 (Stringam, 2014) and will not be explicitly addressed in this discussion. The QM rubric provides a well-established framework for course designers to improve the design of online courses (Loafman & Altman, 2014); therefore, for this study the QM rubric, specifically GS8 (Figure 1) was used to review a course.

Theoretical framework

QM originated from an opportunity where universities shared their online courses. In an attempt to evaluate course quality, a group of lecturers were curious about “how do we measure and guarantee the quality of a course” (Quality Matters, 2023a; Shattuck, 2015). Obtaining a research grant, Maryland Online developed a list of standards, referred to as the QM rubric, which include a peer-review process. This process made provision opportunities for lecturers to be trained, guided and certified to evaluate the quality of online and blended learning courses (Quality Matters, 2023a; Shattuck, 2015).

The QM 6th edition Higher Education rubric consists of eight high level General Standards, broken down into 42 Specific Review standards. When participating in a peer-review process, strong emphasis is placed on the matter of alignment. Like a golden thread, the learning outcomes (2.1, 2.2), the assessment activities (3.1), the learning material (4.1), the learning activities and interactions (5.1), and the technology use (6.1) need to align so that students can master their learning goals (Legon, 2015; Quality Matters, 2023a). For this study the emphasis will be on Specific Review Standards (SRS) 8.1 - 8.6 under General Standard 8, investigating the accessibility and usability of online courses (Figure 1).

Methodology

An eight week fully online short course on “Instructional Design Tools for e-Learning” is evaluated against the Quality Matters rubric for accessibility. The purpose of the short course was to enable students to master design and development techniques using a variety of online tools for education and training. Topics such as social media tools, animated and interactive videos and presentations, storyboarding and mobile device apps were covered and presented through a hands-on, constructionist approach. Evidence of learning throughout the eight weeks presented through an online website.

For the purposes of this paper, GS8 and its SRS's (see Figure 1) will be assessed to explore the accessibility and usability of the course and highlight areas of improvement (Elaasri & Bouziane, 2019).

A qualitative grounded theory approach within the interpretivist paradigm is followed to inductively explore patterns of accessibility and provide areas of strengths and weaknesses for further deliberation (Khan, 2014). A rigorous content analysis into the accessibility within the course provided a SWOT matrix of analysis including Strengths, Weaknesses, Opportunities, and Threats.

Findings

The findings for this study will be presented using the QM Higher Education 6th Edition Rubric GS8 as a structuring principle. It is also important to note that the course under review was not designed to meet Quality Matters standards; however, the review will provide the researchers insight into what improvements need to be made in order to get the course QM certified. Furthermore, when QM reviews are done, the reviewer is required to provide feedback in a manner that is constructive, specific, measurable, sensitive and balanced. For the purpose of this article, each SRS will be provided in a factual manner, highlighting the evidence found in the course and not in the manner or tone that would be sent by a reviewer to the course developer. The data is synthesised and discussed. Decisions are still based on the 85% rule set by QM, meaning that a standard is considered met if the course meets expectations for that standard at the 85% level or higher. Recommendations are presented using a SWOT matrix to identify areas of strength, weaknesses, opportunity and threats.

It is understood that General Standard 8 - Accessibility and Usability is meant to review the course design to identify commitment to accessibility and usability to all learners. In doing so the course:

...utilizes the principles of Universal Design for Learning (UDL) and reflects a commitment to accessibility, ensuring all learners can access all course content and activities, and to usability, ensuring all learners can easily navigate and interact with course components. (Quality Matters, 2023a, p. 39)

GS 8 Specific Review Standards Applied to the Course

The application of the SRSs for GS8 are discussed with examples from the short course that was evaluated. The audience for the review of each standard is the course instructor and/or designer, who is addressed in the first person.

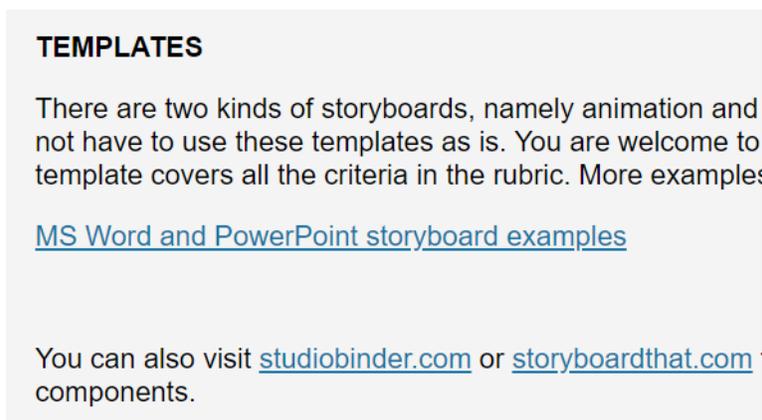
Specific Review Standard 8.1 - Course navigation facilitates ease of use.

The course landing page is “Welcome page”. The course demonstrates easy navigation by providing a menu structure at the left-hand side that gives the student a clear indication of how the course is structured, what to find at each link, and options for further support. The menu is logically arranged to illustrate course material, assessment, collaborative opportunities, and additional resources. Since the menu is available at all times, the user can access any page at any time. The welcome page requires students to scroll down rather than across for efficient movement through activities. When selecting an option at the left menu, each page opens and concludes with a link to navigate to the next page with the name of the next page indicated. There is a consistent layout and design for each one of the weeks. In doing so the lesson follows a logical flow, where students know what to expect next. Each lesson follows the structure from the welcome video, assessment summary table, join a group (where applicable), content and activities, reflection, and bragging rights to the list of tools at the end. At the bottom of the page is a link to continue to the next page. All activities have clickable submission links with instructions.

Almost all hyperlinks have meaningful names; however, at Week 6 Activity 1 Storyboard instructions, meaningful names were not used for “studiobinder.com” and “storyboardthat.com” (Figure 2). Providing text description such as “Studiobinder website” is always valuable for course navigation. While text description was provided for the first link on the Study guide page, you did not provide it at the second link “*click here to download the assessment summary*”. In week 7, I could not locate the HTML tags or an accompanying text link for the icons in the Design Principles Revision section. Although tables in the beginning of Week 1-8 are used to organise data, table headers were not used.

Figure 2

Example of meaningful names for hyperlinks not used.

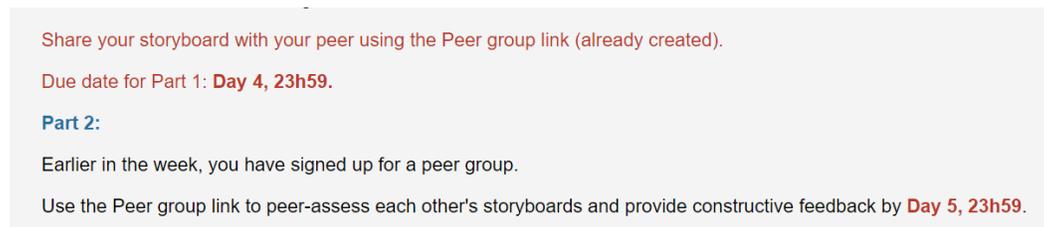


Specific Review Standard 8.2 - *Course design facilitates readability*

The layout of each item is consistent. Bold is used to group topics with more than enough white space to reduce eye fatigue. Headings are used to indicate change in topic. Headings and font sizes are consistently used throughout making it legible for on screen reading. Simple fonts, contrasting text and background colours are used. Bold font is used for instructional purposes only. Minimal colour is used, minimising distraction. However, the use of colour in Week 6 Activity 1 Storyboard Instructions and Week 6 Activity 2 LMS instructions “storyboard” and “create” (Figure 3), has no meaning and could possibly be removed.

Figure 3

Example of colour not used meaningfully

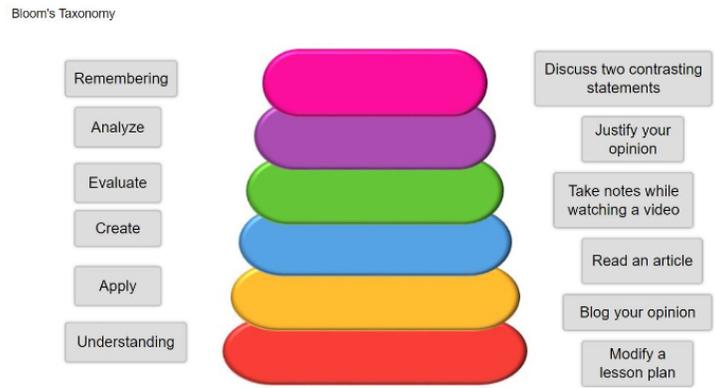


Specific Review Standard 8.3 - *The course provides accessible text and images in files, documents, LMS pages, and web pages to meet the needs of diverse learners.*

The LMS caters for accessibility; however, images and graphs are not described via an alt-tag, long description, or audio description. Document or HTML titles, headings, etc., are not formatted using styles (Heading 1, Heading 2, etc.) found in the word processing software (such as Word) style gallery. PDF documents, MS Word attachments and table-text are accessible, but again the headings are not formatted as Heading styles. For example the Week 8 declaration attachment is seen as accessible, but no headings were used for the table. All tables are set up as text and not embedded as images. They are not presented as screen captures. Tables are set up with headings for columns and rows and are used only for summarising data, not for formatting. Tables do not have captions, alt-text or alt-tags, but are formatted so that headings repeat. Any text contained in PDFs is selectable and searchable. Text colours are relied on to convey meaning. The meaning is not conveyed in another way that does not require perceiving different colours. Underlined text is avoided unless used for navigation. Week 3 Bloom's Taxonomy activity (see Figure 4) is not accessible to diverse learners.

Figure 4

Drag and drop activity on Blooms Taxonomy



Specific Review Standard 8.4 - *The course provides alternative means of access to multimedia content in formats that meet the needs of diverse learners.*

Transcripts are provided for almost all videos and audio content (Figure 5). Nearly all the videos have closed captions, making it possible for hearing impaired and students using screen readers to access them. When adding text to animations, it increases the accessibility for students. However, special care needs to be taken to make sure that the message of each scene is translated into either audio or text. For example, the Welcome video and week 7 do not have a transcript or close-captions. Although padlets are compatible with screen readers, instructions need to be provided so that videos are still captioned and descriptive text is used by the person that posts.

Figure 5

Example of video length and transcripts added



Specific Review Standard 8.5 - Course multimedia facilitate ease of use.

Graphics and animations are used to enhance instructional materials and illustrate ideas without causing distractions. Images are appropriately sized and can be viewed in their entirety without scrolling in most cases. Audio quality is clear. As all the videos are uploaded on YouTube, they can be resized and controlled through the YouTube application and resolution is sufficient for comprehension. There are no videos more than 8 minutes long (Figure 5). Movement through presentations can be controlled. Video streams smoothly without frequent interruptions. Guidance is provided about the best browser to use.

Specific Review Standard 8.6 - Vendor accessibility statements are provided for all technologies required in the course.

There is no evidence of any vendor accessibility statements about technology used.

Decisions

Since this was an in-house evaluation of the short course, only two reviewers evaluated the short course against the QM rubric for GS8. The decisions based on the review were agreed upon for each specific review standard and are presented in Table 1. Awarding points is on an all-or-nothing basis. In a QM review, if reviewers do not agree then the majority out of 3 rules.

Table 1

Decision and score for Specific Review Standard 8

Specific Review Standard	Decision	Score
8.1*	MET	3/3
8.2*	MET	3/3
8.3*	NOT MET	0/3
8.4	MET	2/2
8.5	MET	2/2
8.6	NOT MET	0/2

* Essential standards

Discussion and Conclusion

To determine if the existing 6th Edition QM Higher Education Rubric can be used to show possible accessibility gaps in online programmes, a short course was evaluated based on SRS 8.1-8.6. We found that the QM rubric was a suitable tool to review the accessibility of the course. It highlighted that even though the course would be accessible to most students, there are areas where students with disabilities would not be able to access information or assessment activities. Therefore, it is important for lecturers and learning designers to pay attention to the aspects mentioned on a rubric such as the QM rubric to ensure that their carefully crafted courses are equally accessible to all participants. The course would not have passed the accessibility criteria at an 85% level, because it failed to meet essential standard 8.3. There are several areas for improvement that need to be addressed to truly accommodate all learners. However, based on the analysis of the QM review done, Table 2 provides a summary of the key findings in terms of the Strengths and Weaknesses of the course. The researchers chose to present the evidence and areas for improvement using a SWOT analysis split over two tables, as it is a useful method to analyse a situation and identify possible opportunities for improvement and why it would be useful to implement.

Table 2

SWOT Analysis of the Short Course in Terms of Accessibility: Strengths and Weaknesses

Strengths	Weaknesses
<ul style="list-style-type: none"> ● Easy navigation; always visible menu structure ● Consistent layout of weeks ● Meaningful names for links ● Clickable working links ● Clear use of English, no grammatical errors ● Tables presented as text ● PDFs are searchable and selectable ● Transcripts, close captions for videos ● Videos published through YouTube (transcripts, close caption, good resolution, control keys, compress capabilities) ● Videos shorter than 15 minutes 	<ul style="list-style-type: none"> ● Text formatting (heading styles and colour use) ● No tags for tables ● No alt-tags or long descriptions use for images ● Interactive activities not accessible ● Decorative images have no alt-text or descriptions ● No vendor information

For the second part of the SWOT analysis of the short Course, Table 3 provides Opportunities and Threats. These Opportunities and Threats can be translated into recommendations for improvement to the course.

Table 3

SWOT Analysis of the Short Course in Terms of Accessibility: Opportunities and Threats

Opportunities	Threats
<ul style="list-style-type: none">● Using text colour for instructional purposes and consistent heading styles of easy reading● Add tags for tables to improve accessibility● Explore possibilities for making interactive activities accessible● Add vendor information for recognition and to display the accessibility and privacy statements.● Add alt-text and descriptions to images for screen readers	<ul style="list-style-type: none">● Emphasis on topics presented in tables might be lost to students using screen readers● The meaning of images is lost when students use screen readers● Some videos might not have transcripts, closed captions, audio, or explanations

The course design and navigation does exemplify accessibility (GS 8) for all learners as mentioned by Robinson and Wizer (2016). The course design uses various methods of responses and navigation as a mode for providing options for physical participation (SRS 8.1). Accessible technologies are used with guidance for accommodating accessibility and usability (SRS 8.1). There is an effort to provide instruction for all learning modalities as alternatives are provided for the perception of auditory and visual content (SRS 8.4). The course design focuses on minimising distractions by the way the text is presented (SRS 8.2) and facilitating ease of use when utilising multimedia (SRS 8.5). Content is presented in a customised manner to best meet the learning needs of diverse course populations (SRS 8.2). The course accommodates and optimises the use of assistive tools and technologies (SRS 8.4). However, the course does not make provision for accessible text and images in files, documents and webpages, withholding students from the true meaning of the content (SRS 8.3). Also, the accessibility statements of all the vendors are absent, causing end-users (with or without disability), to not have access to information about the possible barriers of the technology used (SRS 8.6).

In conclusion, our findings and sentiments are the same as those of Loafman and Altman, (2014), that the QM review experience has been incredibly beneficial for the review of the course we teach and we believe other online instructors might also benefit from applying the QM rubric to their online courses or programmes. Accessibility is often overlooked but a review such as this focusing specifically at accessibility gives a true sense of how students with disabilities are “left out” from receiving quality education.

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PLAYING AN INDIGENOUS SOUTH AFRICAN GAME AS AN INDICATOR OF SUCCESS FOR LEARNING PROGRAMMING IN HIGHER EDUCATION INSTITUTIONS

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Abstract

This paper explores Morabaraba, a strategy-based African indigenous game, to develop problem-solving skills in computer programming students enrolled in higher education institutions in South Africa. This paper will not test any hypothesis or analyse any data collected, but rather explore the Morabaraba game play required to successfully solve programming problems. Morabaraba is a traditional South African game that has been passed down through generations of Africans which requires strategic and analytical thinking to win the game.

The result of the research identifies the critical thinking skills and abstract thoughts required for successful problem solving and correlates these to the skills that Morabaraba develops.

Introduction

Under South Africa's history of Apartheid, there were substantial disparities in the provision of schooling among the segregated population, with a disproportionate allocation of resources allocated to the minority white population (Sayed & Kanjee, 2013, p. 5). This resulted in many students who are enrolled to learn programming in higher education institutions in South Africa being non-English first language speakers, even though they have been taught and assessed in English at school (Barlow-Jones, 2019).

Many learners within the South African context experience difficult learning conditions and the problem being investigated is whether indigenous games could positively influence learning for programming, especially for learners from disadvantaged communities (Foko & Amory, 2008).

Barlow-Jones (2019) further explains that early foundational programming concepts which scaffold one on another are not easily grasped by students in the beginning stages of learning problem solving. Strategic indigenous games like Morabaraba could bridge the gap between language requirements and cognitive and social constructivism.

Problem Statement

The aim of this paper is to: (1) explore the potential of Morabaraba in programming courses in higher education to develop problem solving skills in students enrolled in Information and Communications Technology (ICT) courses; and (2) align the benefits of playing an indigenous African game to improve programming abilities.

Methodology

In this study, a qualitative approach was adopted using content analysis and comparisons. This was considered appropriate since the researchers required an in-depth exploration of Morabaraba games. The researchers relied on secondary data gathered from published journals, books, articles and websites. Various authors within South Africa have leveraged the role and learning affordance of different indigenous games, including Morabaraba. The following research questions will be answered:

- What cognitive capabilities are required for programming?
- Does Morabaraba contribute positively to the requirements for programming?

Theoretical Framework

Before drawing any conclusions about using an indigenous game to facilitate and improve learning for problem solving in computer programming, it is important to explore social constructivism as a learning theory .

Social Constructivism

Although there are many different learning theories and approaches to learning, the constructivist learning theories pursue to understand how learners create knowledge concepts and what these mean for understanding influences on thought processes.

Social constructivism was developed by a Russian psychologist Lev Vygotsky. According to Vygotsky (1978), cultural development is influenced by two factors: the social level and the personal level. Learning is viewed as a process of active knowledge construction with contributions from and within social forms and processes. Social constructivism emphasizes communication and social life in the forming of meaning and cognition (Boudourides, 2003), and the learner is considered a co-creator of the knowledge (Taylor et al., 1997). Social constructivism has the most bearing in this paper because Morabaraba requires two players, which reinforces the active learning construction using social constructivism.

This paper frames its discussion based on the social constructivist theory that: 1) learners will develop problem-solving skills based on already existing social constructs to which they add new meaning; and 2) others have a role to play in the construction of an individual's knowledge.

Learning for Problem Solving and Computer Programming

Ben-Ari (1998) found that from his research that cognitive constructivism is the preferred learning theory for success in computer programming rather than passive learning where the learner sits back and learns theoretical content. Ben-Ari (1998) argues that learning problem solving and programming will be more successful using active learning. He concludes that computer programming students must create their own understanding of programming and problem solving from external factors and the guidance and feedback provided by their facilitators, lecturers, and peers.

Using games as a pedagogical tool for teaching and learning computer programming is not new (Lawhead et al., 2002). Pitiera & Haddad (2011) state that using games as a learning tool is advocated as games have the potential to positively contribute to successful learning.

Problem solving for computer programming has always been a challenging discipline for entry-level South African students in higher education. Students who struggle to understand key concepts and content can be left behind in the classroom, especially in subjects like problem solving and computer programming, where concepts build on each other (Barlow-Jones, 2019). Programmers need to have the ability to create the structure for programming logic using algorithms or pseudocode. Algorithms are defined as a set of precise rules determining how to provide a solution to a problem or to perform a task (Garner, 2006).

Background of Games

Juul (2003) proposed that games are formal systems based on rules with variable and quantifiable outcomes. Different outcomes are assigned values and players labour to influence the outcome, and in the process the player feels attached to the outcome. Ultimately, the consequences of the activity are optional and negotiable. Society views games as being recreational in many instances (Kovačević & Opić, 2013). It is understandable that play is defined as a form of human activity that is associated with early childhood and continues to follow them throughout their life (Kovačević & Opić, 2014).

Games, including indigenous games, stimulate psycho-motor, cognitive, emotional, and social development in children (Kovačević & Opić, 2013). Nxumalo and Mncube (2018) argue that indigenous games can be modified to fit contemporary needs. Teaching of programming concepts is such a need.

Strategic Board Games for Problem Solving

A strategy game or strategic game is where the players autonomously use their decision-making skills in determining the outcome. Almost all strategy games require internal decision tree-style thinking, and typically very high situational awareness (Karasimos & Zorbas, 2020). Chess has long been recognised as a game that develops critical thinking and analysis in the players, but there is very little research into indigenous South African (or African) games like Morabaraba.

What is Morabaraba?

The Morabaraba game is a two-player strategy board game based on tactically manoeuvring tokens, referred to as cows, around the board. The game is based on cows, which have historically represented the traditional African supreme symbol of wealth. Morabaraba was used to share cattle herding strategies in parts of Southern Africa including South Africa, Botswana, and Lesotho. Historically men and boys were responsible for hunting, protecting the tribe members and tending to the animals. Women and girls maintained the crops, cooked, cleaned and collected water (South African History Online, 2019). These traditional roles persist in the rural areas in South Africa, where many of the disadvantaged South Africans live.

Through Morabaraba, young boys were taught strategic and tactical skills when dealing with cattle (Russouw, 2002), and, even today, the playing pieces are known as “cows”. The game does not require special equipment as tokens can take any form, including stones or bottle tops, while the board can be drawn in the sand (Nkopodi & Mosimege, 2009).

The board (see Figure 1 below) is composed of three squares or levels with lines connecting the corners and the middle of the squares. Each square has eight junctions at which cows may be placed. Specific strategies and rules need to be employed at each level. The cows can be moved along the lines, including lines forming the squares. Each game starts with an empty game board and each player has twelve cows, a different colour from the opponent's cows, and may lose or gain these at different game stages (Mkhonto & Cloete, 2010).

The game involves three stages (Jama, 2000; Mosimege & Ismael, 2007; Nkopodi & Mosimege, 2009). The first stage involves each player, in turn, placing a cow on one of the empty intersections of the board, with the aim to get three cows of the same colour lined up to create a "mill". These mills can go in any direction, i.e., vertical, diagonal, or horizontal (Mosimege & Ismael, 2007).

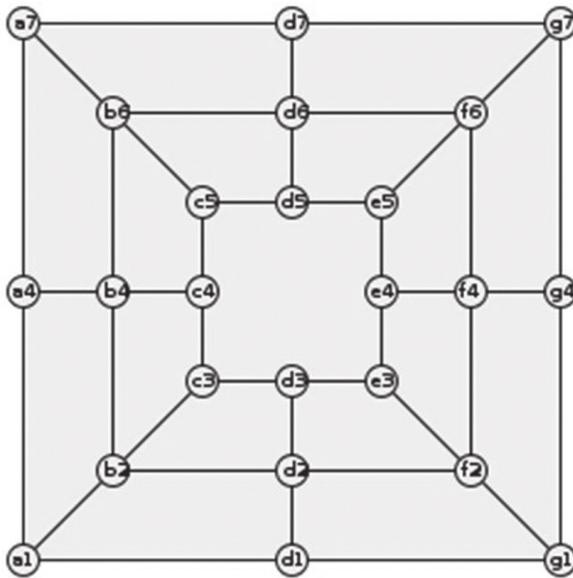
The second stage involves moving the cows in an adjacent empty space with the aim to create a mill. The opponent can try to block these moves by employing a countermove of repositioning their cows or creating a new mill (Mkhonto & Cloete, 2010). The player who successfully creates a mill can "shoot" one of his or her opponent's cows, which is then out of the game and removed from the Morabaraba board (Mkhonto & Cloete, 2010; Mosimege & Ismael, 2007). An exception to the rule is that a cow cannot be shot if it is in a mill itself unless all the player's cows are in mills, in which case they are all targets. When a cow has been shot, it is the end of the turn and the opponent's turn to move a cow to a free location to create a mill and thereby shoot an opponent's cow. Similar moves may be repeated in some cases.

When a player is left with only three cows, any one of the cows can be moved to any empty space on the board, regardless of "jumping" the lines (Mkhonto & Cloete, 2010; Mosimege & Ismael, 2007). Application of this rule signifies the final stages of the game.

There are two ways to win the game: firstly, if the opponent can't make a move, and secondly, if the opponent has only two cows left (Mkhonto & Cloete, 2010; Mosimege & Ismael, 2007). The rules also state that if each player only has three cows left and neither can shoot one of their opponent's cows in ten turns, then it is a draw.

Figure 1

Morabaraba Game Board



Note. Source of figure: https://www.researchgate.net/figure/Morabaraba-game-board-diagram_fig7_346308505

Cognitive Abilities Associated with Morabaraba and Problem Solving

The cognitive requirements for playing Morabaraba and Problem solving align closely as both require logical and abstract thinking to develop a strategy to provide a programming solution or to win the game.

Cognitive Abilities Associated with Morabaraba

Several researchers have concluded on the benefits of utilising Morabaraba in teaching and learning, specifically in enhancing mathematical skills (Mosimege, 2020; Tachie & Galawe, 2021). Various important skills are developed and learning principles imparted through the process and rules of the game (Bayeck, 2017). For instance, the rule that a player cannot capture more than one cow encourages empathy and compassion toward the opponent.

In addition, language acquisition and computational thinking skills are stimulated through utilising metaphors during the game in defining the action plans and movement of cows (Bayeck, 2017). Computational thinking can be defined as an abstract thinking process, based on an algorithm, for effectively and efficiently

defining and solving a problem such that the solution is reusable in different contexts (Shute et al., 2017). The fact that the game was a key strategic game brings attention to its relevance in problem-solving skills development.

Cognitive Attributes Associated with Problem Solving for Computer Programming

Papadopoulos & Tegos (2012) concluded that programming requires higher level thinking skills such as problem solving, critical, and computational thinking skills. All of these require abstract thinking. Likewise, Gomes & Mendes (2008) posit that problem solving, computational thinking, abstraction, critical thinking, and analytical thinking are all important attributes required for problem solving in computer programming. To problem solve for programming, the problem must be analysed and then the logic (program design) created. Critical thinking and strategy are a large component of this process, which will include higher order thinking skills and pattern recognition.

Aligning Cognitive Properties of Morabaraba and Problem Solving

Similarities can be drawn based on the mechanics and rules of Morabaraba and the cognitive requirements for problem solving and therefore programming. Strategic thinking and problem-solving are entrenched in the winning rules of the game (see Table 1 below) and social constructivism with the two players.

Table 1*Aligning the Cognitive Properties of Morabaraba and Problem Solving*

	Morabaraba	Problem Solving
1. Tools required	<ul style="list-style-type: none"> • Board with 3 nested squares /levels. Each square has 8 junctions. • 2 players • 12 tokens per player 	<ul style="list-style-type: none"> • Pseudocode and flowcharts are used in the planning of the logic for computer programming
2. Cognitive abilities required	<ul style="list-style-type: none"> • Strategic thinking. • Analysis of moves. • Problem-solving skills. • Abstract decision making. • Computational thinking. • Logical thinking. • Pattern recognition. 	<ul style="list-style-type: none"> • Strategic thinking. • Analysis of the problem to solve. • Abstract thinking • Computational thinking. • Logical thinking • Pattern recognition.

Recommendations and Conclusion

The alignment of the cognitive abilities associated with Morabaraba and problem solving is noticeable. Previous research into the benefits of chess for problem solving suggests that Morabaraba will have similar benefits. While Morabaraba has traditionally been played using a physical board or by drawing a board in the sand, the game can also be played online and can be downloaded as a mobile app. This study argues that playing the game in any form or version affords an opportunity to enhance a learner's programming skills. We argue that the skills gained by playing Morabaraba are transferrable to learners studying programming in higher education. Future studies will be carried out which will evaluate player experience and learning outcomes in the primary target population of students undertaking programming in their undergraduate studies.

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VRTEACHER PROJECT: A REVOLUTIONARY APPROACH TO TEACHER EDUCATION USING VIRTUAL REALITY

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Abstract

This paper presents the rationale behind the VRTEACHER project and the integration of Virtual Reality (VR) technology in teacher education. The paper explores how VR and perspective-taking can promote the development of teacher's competences such as empathy. Furthermore, the paper provides an overview of the project's methodology, the VR application developed, and some preliminary results related to the impact of VR-based training, emphasizing the potential benefits in terms of enhancing teaching practices, promoting inclusivity, and fostering a deeper understanding of students' experiences. The paper aims to contribute to the existing body of knowledge on the integration of VR technology in teacher education.

Keywords: Virtual reality, teacher training, empathy, perspective-taking

Introduction

Teachers play a crucial role in driving educational excellence and sustainable development, making them a pivotal force in the realm of education. The "Education and Training 2020" strategy in Europe has underscored the importance of teachers, highlighting the importance of their initial education and continuous professional development (Organisation for Economic Co-operation and Development [OECD], 2020). In today's dynamic educational landscape, teachers face unprecedented challenges as classrooms become more complex, diverse, and digitalized. Moreover, the outbreak of the COVID-19 pandemic has exacerbated the challenges in education, making an imperative need for the implementation of innovative training approaches to equip educators with lifelong skills.

In this context, the VRTEACHER project aimed to empower teachers by introducing a novel Virtual Reality (VR) based approach designed to respond to in-class crisis situations, such as a pandemic. The integration of VR in teacher training holds significant potential as it provides a safe and controlled virtual space for experiential learning and practical training (Stavroulia et al., 2019; Stavroulia and Lanitis, 2023). Through engaging and immersive experiences, VR can replicate real-life situations and challenges, enabling teachers to gain first-hand perspectives and develop key skills such as empathy. The vision of the VRTEACHER project was to foster the personal and professional development of teachers through systematic practical and experiential VR-based training.

Virtual Reality-based Teacher Training

In recent years, education has witnessed a significant shift towards integrating immersive computer-based training tools to boost knowledge and skills acquisition. This trend highlights the growing interest in leveraging VR environments to innovate teaching and learning. VR offers a unique and compelling educational

experience by immersing learners in a simulated environment that replicates real-world scenarios through the use of specialized hardware, such as head-mounted displays. One of the key advantages of VR in education is its ability to provide experiential learning opportunities that go beyond traditional classroom settings. By placing the trainees in virtual environments that mimic real-world contexts, they can actively participate in simulations, experiments, and problem-solving activities. This hands-on and immersive approach allows learners to develop practical skills, critical thinking abilities, and a deeper understanding of complex concepts.

Research on the use of VR in teacher education is still in its early stages, with a limited yet growing body of evidence highlighting its potential. Some attempts have been made to create virtual classrooms for experimentation using large-screen displays instead of VR equipment like head-mounted displays (HMD glasses). Examples of such attempts can be found in studies by Andreassen and Haciomeroglu (2009), Dieker et al. (2007, 2008, 2015), and Ke et al. (2016).

Bailenson et al. (2008) examined how social behaviours and visual cues in a VR teaching scenario affected learning. Their study revealed that participants tended to overlook peripheral virtual students, but implementing a notification system helped distribute their attention more evenly. Similarly, Lugin et al. (2016) developed an immersive VR system aimed at improving teachers' classroom management skills, particularly in handling disruptive behaviour. While the results indicated the system's effectiveness for teacher training, trainees reported experiencing stress due to the simulated student behaviours.

Manouchou et al. (2016) developed a prototype VR classroom training environment that allowed teachers to experience students' vision disorders, offering them a firsthand perspective of being visually impaired. Stavroulia et al. (2016) focused on training teachers in identifying and distinguishing bullying incidents, utilizing VR to simulate bullying scenarios and teach appropriate responses. These early attempts demonstrate the potential of VR in teacher education; however, further research and advancements are necessary to refine and expand the applications of VR in this domain, addressing challenges such as stress-inducing situations and optimizing user attention and engagement.

VRTEACHER Project: Scope and Aims

The VRTEACHER project (<https://www.vrteacher.eu/>) was an Erasmus+ KA2 project (2020-1-CY01-KA226-SCH-082707) that took place from June 2021 to May 2023. The project involved six partners: Cyprus University of Technology (Cyprus / Coordinator); University of the Aegean (Greece); Universidad Carlos III de Madrid (Spain); Fundación Siglo22 (Spain); Future In Perspective Limited (Ireland); and Commonwealth Centre for Connected Learning (Malta).

The VRTEACHER project aimed to strengthen teacher education through the integration of VR-based practices. The project was conceived as a response to the COVID-19 pandemic and sought to provide a solution to the crisis by harnessing the power of VR technology. By leveraging VR, the project aimed to support teachers in adapting to the new educational landscape and equip them with the necessary skills to effectively navigate crisis situations, including the challenges posed by the pandemic.

Equally important is that the VRTEACHER project was also developed as a response to the recognized need for practical training and hands-on experiences in teacher education. Traditional teacher training programs often focus on theoretical knowledge and pedagogical strategies, leaving teachers ill-prepared for the practical challenges they encounter in real classrooms. Additionally, the pandemic had a profound impact on the practical training of teachers as it necessitated social distancing measures and the closure of educational institutions resulting in the suspension or limitation of in-person practical training for teachers. Traditional methods of observing and participating in classroom activities, conducting teaching practice, and receiving feedback from experienced educators were disrupted, leading to a significant gap in hands-on training opportunities. The project aimed to bridge this gap by providing teachers with a virtual training tool that offers immersive and real-life classroom scenarios. By using VR technology, teachers can engage in interactive and experiential learning, gaining valuable practical experience in a safe and controlled environment. This hands-on approach allows teachers to develop their skills, build confidence, and refine their teaching techniques. Furthermore, the project recognized the importance of preparing teachers for the unexpected, which is a crucial aspect of their professional development, and VR offers a promising solution in this regard.

VRTEACHER Objectives and Target Audience

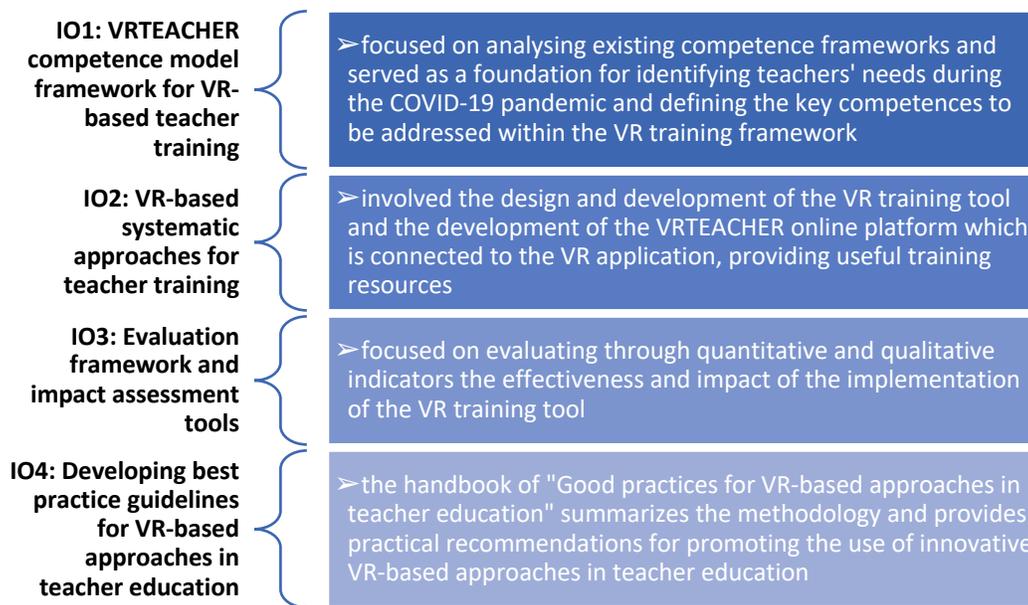
The main objectives of the project were to: i) advance the state of the art in the relatively new area of VR-based teacher training; ii) develop a VR training framework specifically designed for teachers; iii) identify and address the specific needs and challenges faced by teachers during the pandemic; iv) design and develop VR training scenarios that meet the requirements and needs of teachers; v) enhance teachers' practical skills and preparedness for unexpected situations through VR simulations and scenarios; vi) foster empathy and perspective-taking skills among teachers through immersive VR experiences; and vii) support teachers' continuous professional development and lifelong learning.

The primary target groups for the VRTEACHER project were in-service teachers and pre-service higher education students, PhD candidates, etc., who are the next generation of teachers.

The achievement of the aforementioned goals relied on the intellectual outputs (IOs) of the project, which were carefully designed to address specific needs and contribute to the overall goals of the project. The project consisted of four intellectual outputs, which are presented in Figure 1.

Figure 1

VRTEACHER project intellectual outputs



The VRTEACHER Application

The VR application is freely accessible and open to all users without charge through the project's website (<https://www.vrteacher.eu/>). The application runs on any Android mobile device with Android version 7.0 (API level 24) or newer and requires 604 MB of device storage. The application was developed using UNITY (version 2020.3.22). Apart from UNITY, additional software such as Autodesk Maya, Adobe Photoshop, Autodesk Character Generator, mixamo.com, the SALSA plug-in for Unity, and the Google Cardboard XR plugin for Unity, were used for creating the virtual environment, the assets, the animated humans, and the interaction. Furthermore, the application requires low-cost VR headsets compatible with Android phones.

When starting the application for the first time, the user is asked to select basic settings such as language, username, and country. In the main menu, the user can navigate through different menus, and select one of the three VR scenarios. When the user launches a VR Scenario, a message appears on the screen indicating that the device must be placed in a VR headset. After a few seconds, the virtual environment appears, and the scenario starts (Figure 2). The user can explore the virtual environment using gaze movements and interact with the 3D user interface using a gaze-controlled cursor (Yu et al., 2021). By incorporating eye gaze as an input modality VRTEACHER application, allowed users to interact with the virtual world more seamlessly and naturally. It eliminated the need for complex controllers or input devices, enabling a more immersive and hands-free experience.

The VRTEACHER application was designed as a multilingual tool to cater to the diverse language needs of teachers. The application is available in English, Greek and Spanish languages to serve the needs of the partner countries.

Figure 2

Starting button in the main scene

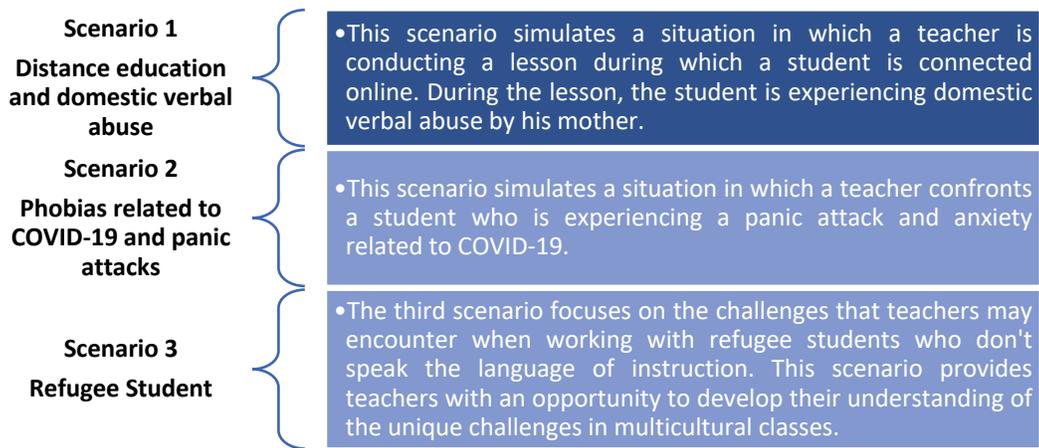


Training Scenarios

The VRTEACHER application offers three scenarios that simulate real-world classroom scenarios, each with its own set of challenges and learning outcomes. Figure 3 presents the three scenarios and a short description of them.

Figure 3

The three scenarios developed in the VR application



Perspective-taking

For all three scenarios, the VR tool offers teachers the ability to experience the scenario both from the perspective of the teacher, but also from the perspective of the virtual student involved in the incident. This feature aims to provide teachers with a deeper understanding of the student's experiences and challenges and to experience the impact of their teaching methods from the student's point of view. The main benefit of perspective-taking lies in promoting empathy by allowing users to step into the shoes of their students and experience the world through their eyes. By experiencing different perspectives, users can develop a more empathetic and understanding mindset, fostering tolerance and open-mindedness. Figure 4 below presents the view of the classroom through the eyes of the teacher, and Figure 5 presents the perspective of the student in his bedroom participating in the lesson remotely.

Figure 4

Through the eyes of the teacher



Figure 5

Through the eyes of the student



Implementation and Results

VR-based training and all scenarios had a positive impact on teachers, making them more supportive, empathetic, and better equipped to address the challenges faced by their students. The application received positive feedback from participants related to the realistic and impactful nature of the virtual scenarios, which helped them develop new skills, improve their decision-making abilities, and think

critically about their teaching practices. The VR tool has effectively influenced teachers' perspectives on engaging remote learners and addressing the challenges of bullying and abuse at home (scenario 1). The tool raised awareness of various forms of abuse that students may face at home, making teachers more aware of these realities.

The VR training experience has significantly raised teacher's awareness related to students' psychological distress and phobias arising from events like the COVID-19 pandemic (scenario 2). It has provided teachers with a unique opportunity to experience and comprehend the challenges these students face, which may be dangerous, difficult, or impossible to replicate in real-life situations. Teachers have recognised the importance of developing collaboration and social skills, fostering interpersonal relationships, and creating a safe environment for students.

Equally important is that VR-based training has significantly impacted teachers' perspectives on engaging students from different cultural backgrounds in the classroom (scenario 3). Experiencing students' perspectives allows teachers to better understand challenges related to language barriers and cultural differences. The scenario emphasized the importance of diversity and inclusion, highlighting the need for teachers to be mindful and treat all students equally. The scenario also highlighted the need for additional training to assist teachers in effectively integrating students from different cultural backgrounds.

Another important outcome deals with the long-term impact of the VR-based training, which was assessed four weeks after the end of the trainings. The findings indicate that participants' positive changes in attitudes were sustained and not just temporary. Teachers had the opportunity to further explore and analyse the VR scenarios, encouraging critical thinking and self-reflection concerning their own teaching practices. The introduction of VR likely sparked discussions among teachers, allowing for the exchange of perspectives and experiences related to the encountered scenarios when they returned to their schools. The success of the VR-based training in all partner countries indicates its potential for broader implementation and adaptation in other educational contexts.

Conclusions

The VRTEACHER project has emerged as a ground-breaking initiative that harnesses the power of VR to revolutionize teacher training and respond to the needs highlighted by the COVID-19 pandemic. The project was designed to provide teachers with VR-based immersive learning experiences that enhance their competences, such as empathy, and through virtual scenarios that simulate real-world classroom challenges. By assuming the role of both teacher and student,

participants gained valuable insights into the challenges, emotions, and experiences that students face. This experience fosters empathy and perspective-taking, enabling teachers to better understand their students' needs and tailor their instructional approaches accordingly.

The use of VR in teacher training offers several notable benefits, including practical training and hands-on experiences in a risk-free setting enabling teachers to build their teaching confidence and improve classroom management competences. VR-based training facilitates experiential learning by enabling teachers to step into the shoes of their students. Through immersive simulations, educators can gain first-hand insights into the perspectives and challenges faced by students, fostering empathy and understanding. This experiential approach enhances their ability to address diverse learning needs, adapt teaching strategies, and create inclusive classroom environments. As VR continues to advance, its integration into teacher education holds immense potential for transforming teaching practices and ultimately improving the quality of education.

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BLOCKCHAIN-BASED COMPANIES' USE OF SOCIAL MEDIA TO RAISE CLIMATE CRISIS AWARENESS: CONTENT ANALYSIS OF SINGLE EARTH TWITTER ACCOUNT

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Abstract

This study aims to explore how blockchain-based companies leverage social media to raise awareness about the climate crisis and combat its effects. To address these questions, the study first discusses the utilisation of blockchain technology in the fight against the climate crisis, as well as how Single Earth, a specific blockchain-based company, raises climate awareness on social media, specifically on Twitter (now marketed as X). The research focuses on analysing the content of 295 tweets shared by Single Earth in 2022-3, and the collected data is analysed using MAXQDA and Microsoft Excel. The analysis of the Twitter content reveals the company's strong emphasis on promoting climate-related information and encouraging the adoption of greentech solutions. This research contributes to a better understanding of how blockchain-based companies utilise social media platforms to foster climate awareness and advocate for greentech initiatives.

Introduction

Increasing greenhouse gas emissions, deforestation, and the rapid depletion of natural resources, among other anthropogenic activities, pose a serious threat to the Earth's ecosystem. Finding ways to leverage technology to solve these severe global problems, which are a significant cause for concern, has become an important research topic. Within this framework, although the use of blockchain has predominantly been highlighted in fintech over the past decade, interest in blockchain technology to combat the climate crisis is growing day by day.

The use of blockchain can indeed facilitate several measures in addressing the global issue, including improving corporate accountability, establishing networks that involve all societal stakeholders, tracking and reporting real-time ecological footprint data across supply chains, and monitoring and verifying energy

production, consumption, and carbon emissions (European Commission, 2022; Chen, 2018).

The applications of blockchain technology and the pace of its adoption still evolve. However, it is believed that blockchain can play a crucial role in addressing the climate crisis due to its potential benefits and various applications. The adoption and support of this technology in combating the climate crisis are also critical for issues such as social transformation and employment. This study aims to explore how blockchain-based greentech companies use social media to raise awareness about climate change. Additionally, it discusses the types of content categories (educational, promotional, etc.) these companies use more frequently on social media, the specific goals of raising awareness, and the hashtags utilised to reach a wider audience. To answer these questions, this study reports on a content analysis of 295 tweets shared by Single Earth, a blockchain-based company that tokenises the ecological value of lands and aims to preserve biodiversity.

Leveraging Blockchain Technology in Combating Climate Crisis

Blockchain technology is commonly defined as a technology that enables secure and accessible digital transactions to take place through a peer-to-peer (P2P) distributed ledger, without the need for approval or permission from a central authority. This technology has the potential to be utilised in various fields, ranging from healthcare to education, and can also be leveraged to address the challenges posed by the climate crisis.

Bada et al. (2021) argue that blockchain technology promotes the adoption of renewable (green) energy sources in power generation and distribution by facilitating peer-to-peer (P2P) energy trading between energy producers and consumers. In addition to energy production processes, blockchain is also utilised for monitoring waste management processes and enhancing transparency in waste flows. It is further employed to improve the efficiency of waste management and increase recycling rates. Furthermore, the application of blockchain technology in forestry and other natural resource sectors for monitoring and verifying compliance with sustainability standards contributes to the reduction of illegal logging, species extinction, and illicit activities (Pal et al., 2022). Additionally, carbon credits can be recorded as assets on a blockchain network, enabling real-time and transparent tracking of carbon footprints.

Howson (2020) draws attention to the use of blockchain to monitor and manage energy production and consumption, promoting the efficient use of renewable energy sources by creating distributed energy networks. Blockchain-based solutions are being developed for traceability of natural resources, verification of compliance with sustainability standards, and supply chain management.

However, the use of blockchain technology in tackling the climate crisis is still under development. In addition to the positive practices in which blockchain is used, there are also concerns and limitations to this technology. For example, among the current challenges such as data storage and legitimacy, sustainability, which is frequently emphasised in the fight against the climate crisis, is a matter of debate due to the large energy consumption that results from the decentralisation feature of blockchain being processed by each element in the node (Hassani et al., 2019, pp. 30- 34).

In other words, transparency, reliability, traceability, verifiability, data sharing, collaboration, green finance, and innovation are seen as positive features in the use of blockchain technology (Di Pierro, 2017). On the other hand, high energy consumption, scalability problems, legal and regulatory issues, and technological compatibility raise questions about blockchain technology. These positive features and limitations reflect the potential of blockchain technology in tackling the climate crisis and the challenges to be considered (Parmentola et al., 2022; Schinckus, 2020; Aithal & Aithal, 2016; De Vries, 2018; Gupta et al., 2021). With the development and improvements of technology, negative practices can be reduced while positive practices can be further strengthened.

The Role of Blockchain-Based Companies on Climate Crisis Awareness

The fact that blockchain-based companies offer solutions for climate crisis awareness is closely related to the increasing popularity of blockchain technology through cryptocurrencies. Although the first blockchain application, Bitcoin, was developed in 2009, the emergence of blockchain-based companies for climate crisis awareness only took place a few years later. From 2015 onwards, there has been greater discussion and awareness of the potential of blockchain technology in tackling the climate crisis. It was during this period that some companies started to offer blockchain-based solutions to the climate crisis. In particular, blockchain-based projects have been developed in areas such as carbon monitoring and carbon trading, renewable energy, resource tracking, and sustainable supply chain management (Howson, 2020).

In the early days of blockchain technology, companies operating in this space often emerged as pioneering and innovative start-ups. However, over time, large organizations and industry leaders have also started to develop blockchain-based climate crisis solutions. In recent years, many companies have focused on raising awareness and providing sustainability solutions by using blockchain technology in the fight against the climate crisis (Iravani et al., 2017; Schulz and Feist, 2021).

The activities and solutions of blockchain-based companies for climate crisis awareness are accepted as a process that develops in parallel with technology (Ali

et al., 2020). In this context, the concept of green technology is a very important issue. The main purpose of green technology is to make environmentally friendly innovations to protect people's interests. Therefore, the aim of green technology is to meet the needs of society in a way that causes no toxic or adverse effects on the environment. However, there are many criticisms of green technology. The most common of these is greenwashing (Torelli et al., 2020). Greenwashing is defined as presenting a product, brand or institution as if it is environmentalist, making misleading advertisements with unfounded environmental claims, and including these claims in marketing communication activities and even on product packaging. At this point, it is important to understand what it means to be greentech. Greentech covers all sub-titles such as integration with the natural environment, competence, efficiency, fairness, full cost calculation, communication, participation, common sense and flexibility in connection with sustainability. The most well-known blockchain-based greentech companies for climate crisis awareness are companies such as Power Ledger, CarbonX, Climatecoin, Provenance, WePower and Single.Earth (Aktas, 2022). It works with a system that connects nature and economy by using big data and artificial intelligence-based methods (Single.Earth, (2023).

The Role of Social Media in Promoting Climate Crisis Awareness

Considering the role of social media in raising awareness about the climate crisis, news, reports, and information regarding the climate crisis are rapidly disseminated to a large number of users through social media. Social media tools facilitate the organisation of climate crisis awareness campaigns and events, effectively increasing awareness through hashtag campaigns, content sharing, videos, and visuals. Social media platforms effectively depict the impacts of climate change, fostering emotional connections through compelling infographics and documentaries. Through activism, individuals can voice their concerns to governments, international business owners, and political actors, advocating against the climate crisis, establishing anti-eco-massacre communities, and fostering collective action (Kunelius & Roosvall, 2021; Becken et al., 2021; Parry & Poland, 2019).

However, social media also has limitations. Issues such as misinformation, the rapid spread of false information, and limited online activism can hinder the effectiveness of social media in addressing the climate crisis. Consequently, it is essential to verify sources, seek reliable information, and carry out actual actions in the real world alongside social media engagement.

Methodology

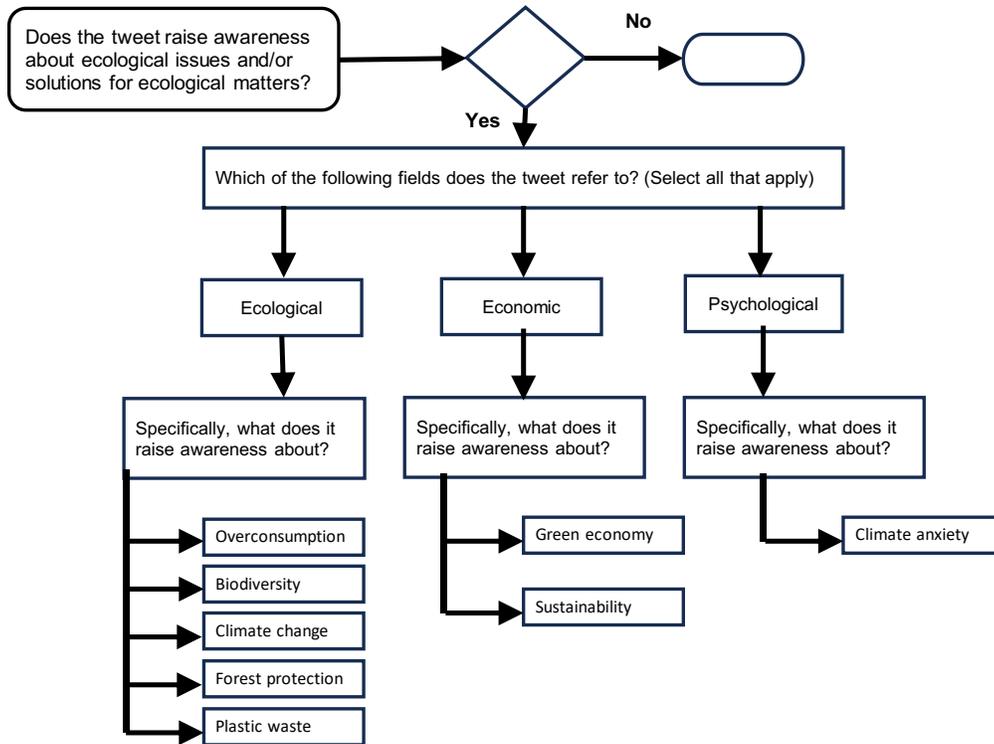
This study examines the content (tweets, retweets, replies) shared on Twitter (currently branded as “X”) by Single Earth, a company using blockchain technology, to assess the blockchain-based companies' efforts to raise awareness about the climate crisis on social media. It employs content analysis techniques that provide replicable and valid inferences to generate new insights and acquire information about practical actions (Krippendorff, 2018).

The research is limited to the company's Twitter profile as it allows both the use of ecological and political content in agenda setting (Erben, 2019) and the public interaction of Single Earth with its stakeholders. A total of 295 tweets providing comprehensive data regarding the company's activities and agenda were collected from @SingleEarth1 between August 16, 2022, and February 23, 2023, through vicinitas.io. The collected data were subsequently analysed using MAXQDA and Microsoft Excel.

The coding of the tweets (content) was conducted by two researchers working together, and any coding differences were resolved through consensus reached through discussions. Initially, draft themes were created, and the tweets were coded based on the media type, basic content type using keywords, target URL, cross-posting, call to action, hashtags, and the type of tweets that received responses. The themes were then reorganised considering the research questions, and some sub-themes were created to establish relationships between the themes (e.g., the relationship between target URLs and cross-posting codes). Each tweet was coded to include at least one theme and multiple themes could be assigned to each tweet. Therefore, there may be a discrepancy between the total number of tweets in the frequency tables and the total number of tweets coded (295). Figure 1 illustrates the process of determining themes and sub-themes, providing an example of how data analysis is conducted within the context of environmental communication. Through a systematic approach, themes are identified based on recurring topics or concepts present in the data, while sub-themes further categorize and refine these overarching themes into more specific components. This figure visually depicts the hierarchical structure of themes and sub-themes, showcasing how they are organized and interconnected. By following this methodology, researchers and practitioners can gain a comprehensive understanding of the underlying patterns and trends in environmental discourse, facilitating more informed decision-making and targeted communication strategies.

Figure 1

Example of determining themes and sub-themes



Note. The figure was created based on the thematic flowchart from the study conducted by Cavazos-Rehg et al. (2019) on tweet content analysis.

Grouping the content shared by blockchain-based companies that prioritise nature preservation on their social media accounts helps facilitate understanding their purpose of social media usage. Six main themes were obtained by coding the tweets, as shown in Table 1 for Single Earth's content.

Table 1*Definitions of Content Themes*

Theme	Definition	Sample Tweet
Educational content about technology	Educational content that enables the audience to understand and embrace the technologies used and developed by the company is included in this category.	Company representatives, are you ready to take your company's ESG strategy to the next level? “Fighting biodiversity loss as part of your company ESG strategy” 📅 18.01 2-3pm CET 📍 register for the link: https://t.co/cTk84IpnCk #ESG #Sustainability
Events	This category includes announcements, information, and updates related to the company's involvement in diverse online/offline events. These events cover a broad spectrum, including AMAs, webinars, conferences, technology events, competitions, competition nominations, tech-summits.	Now is a great time for a refresher! Take a look at our AMA recap and find answers to all sorts of questions regarding MERIT tokens 🙌 #SingleEarth #MERITtoken #TechForGood #ActOnClimate https://t.co/GVKCleiuOc
Cross-posting	The content in this category is created to enhance engagement and attract more followers to the company's other social media accounts.	In @NatureBacked podcast episode "Death of the Client" @virki speaks with @mrmacleod on why it is critical for the environment, #sustainability and the #CircularEconomy to design the end of the consumer experience. https://t.co/FGqXDbhUuS #Engineering #climatechange https://t.co/OpsViBM52t
Raising awareness	This category encompasses the content shared by the company on topics such as the climate crisis, climate change, forest conservation, and nature preservation.	Humanity lives off 1.75 Earths. We need to cap our consumption to how much nature can handle. Without nature, we can't survive. Share it. Let's raise awareness. 🌍 Let's take action. #climateaction #climateactionnow #biodiversity #greeneconomy https://t.co/BbzozVppT5

Theme	Definition	Sample Tweet
Increasing engagement	These are the contents created by the company to increase engagement with its followers, business partners, affiliated organisations, and promote its team. They include content related to special occasions, job postings, and aim to foster interaction.	Thanks for featuring us in the article @AccelerationEc1, we're happy to see more talks of climate protection in the web3 space! □ https://t.co/xX1yeGpoMO #Sustainability #forest
Promoting company token (MERIT)	This category includes tweets shared by the company to promote, popularise, and market its own token called MERIT. It encompasses content aimed at increasing awareness and adoption of MERIT, including MERIT giveaway events.	MERIT is a possibility for individuals to create (and drive!) societal and economic change — if enough people take action, companies, and governments need to follow. Let's turn climate change and biodiversity loss around: https://t.co/0aUABU8XcX https://t.co/d5PpZRZKE6

Table 2 presents an analysis of the various frames utilized by the Single Earth company in its efforts to raise awareness about environmental issues. Frames refer to the specific perspectives or angles through which information is presented to shape public understanding and perception. In this table, different frames employed by Single Earth, such as scientific evidence, human impact narratives, solutions-oriented approaches, and urgency messaging, are outlined and categorized. This analysis provides valuable insights into the company's communication strategies aimed at effectively conveying the importance of environmental awareness and action to its audience. By examining the use of different frames, stakeholders can gain a deeper understanding of how Single Earth seeks to engage and mobilize individuals towards addressing environmental challenges.

Table 2*Raising Awareness Frames*

Theme	Definition	Sample Tweet
Climate anxiety (Emotional/psychological)	Tweets aimed at raising awareness about concerns related to the climate crisis.	<p>🌱 How do handle climate anxiety</p> <p>🌱 What to expect of COP27</p> <p>🌱 Beehero's unique insight into hives & much more on the new NatureBacked episode with Itamar Weizman of Firsttime</p> <p>https://t.co/jKS9wxncFi</p>
Green economy (Economic)	Tweets that raise awareness by focusing on nature preservation or ecological issues rather than economic benefits in relation to the green economy.	<p>It's a start, a strong one.</p> <p>Now, more than ever, all parts have to work together to halt biodiversity loss.</p> <p>Join us in transforming into a green economy. 🌍</p> <p>@CBD_COP15 @UNbiodiversity #COP15 #COP15Announcement #GBFAdoption https://t.co/TEdjo1SaAT</p>
Sustainability (Ecological/Economic)	Tweets posted to create and increase awareness about sustainable living and economy.	<p>Are you taking daily actions to be more sustainable?</p>
Overconsumption (Ecological)	Tweets aimed at raising awareness about overconsumption within the framework of eco-destruction.	<p>Saving up to cover one's needs is reasonable.</p> <p>Yet massive sales campaigns, like Black Friday, can lead to overconsumption and impulsive buying. It shows the refusal to understand that natural resources are limited. ⚠️</p> <p>#GreenFriday #BlackFriday</p> <p>https://t.co/6gxkn6ly5e</p>
Biodiversity (Ecological)	Tweets aimed at raising awareness about the decrease in biodiversity, which is one of the company's main areas of interest and business.	<p>Humankind is finally acknowledging that nature loss poses direct and immediate risks to the global economy and financial system while also magnifying climate risks.</p> <p>Climate change and biodiversity loss are deeply interrelated, not separate problems.</p> <p>#COP15 #biodiversity</p>

Theme	Definition	Sample Tweet
Climate change (Ecological)	Tweets aimed at raising awareness about the climate crisis and climate change.	Did you know about the Yale Climate Opinion Maps 2021? Recommend taking a look! "how Americans' climate change beliefs, risk perceptions, and policy support vary at the state, congressional district, metro area, and county levels" @Yale #ClimateCrisis https://t.co/RO7x2VVeuY
Forest protection (Ecological)	Tweets specifically raising awareness about deforestation and forest conservation.	👍👏 Protecting forests to allow companies to emit CO2 👍👏 Protecting forests to protect forests
Plastics (Ecological)	Tweets specifically raising awareness about the damage caused by plastic waste to nature.	More on #PlasticWaste in our @NatureBacked podcast - Check out new episode where @virki talks with John Felts from @CruzFoam #startups #innovation #environment #savingsoceans https://t.co/y0N2zdrF7G https://t.co/bmeWFhoDRQ

Table 3 presents an analysis of posts categorized by content types. Each post shared by the Single Earth company is categorized into different content categories, such as awareness-raising, promotional, educational, and engagement-focused. This table provides insights into the distribution of content types within the company's social media activities, shedding light on its strategic focus areas and communication objectives. By examining the distribution of posts across these categories, stakeholders can better understand the company's efforts in addressing climate issues, promoting sustainability, and engaging with its audience effectively.

Table 3*Posts by Content Categories*

Theme	N	%
Educational content about technology	36	12
Events	46	16
Cross-posting	51 (Single Earth blog n: 22, Discord channel n: 2, Nature-backed podcast n: 13, Company LinkedIn profile n: 7, Spotify n: 5, YouTube channel n: 2)	17
Raising awareness	161	55
Increasing engagement	17 (Replies n: 16, job posting n: 1)	6
Promoting company token (MERIT)	37 (Promotional MERIT tweets n: 31, MERIT giveaway posts n: 6)	13

More than half (55%) of the 295 posts (including own tweets, retweets, and replies) shared by Single Earth are dedicated to raising awareness about climate change and related issues (refer to Table 4). This is followed by cross-posting tweets, accounting for 17%, and tweets about events, comprising 16%.

Table 4*Raising Awareness Frames*

Theme	N (%)	Sample Tweet
Climate anxiety (Emotional/psychological)	2 (0.67%)	<ul style="list-style-type: none"> 🌱 How do handle climate anxiety 🌱 What to expect of COP27 🌱 Beehero's unique insight into hives & much more on the new NatureBacked episode with Itamar Weizman of Firsttime https://t.co/jKS9wxncFi
Green economy (Economic)	29 (10%)	Do you know what nature-backed economy is? #economy #TechForGood
Sustainability (Economic+ecological)	6 (2%)	Are you taking daily actions to be more sustainable?

Theme	N (%)	Sample Tweet
Overconsumption (Ecological)	11 (4%)	<p>● Black Friday? I'm not buying it. ●</p> <p>This is a list of tips we made for Black Friday to raise awareness of conscious consumerism, but it's really credible all year round.</p> <p>Share it. Use the tips. Let's make a difference.</p> <p>& do you have any more tips?</p> <p>#GreenFriday #sustainable https://t.co/vqpDhs95jm</p>
Biodiversity (Ecological)	39 (13%)	<p>Climate change is a known threat, but #BiodiversityLoss is much less talked about. Yet they both threaten humankind's survival on Earth.</p> <p>We're thrilled to introduce the excellent work (in progress) of our science team:</p> <p>https://t.co/pRrOREbLBb</p> <p>@VanShaya @arildodias_eco</p>
Nature preservation (Ecological)	18 (6%)	<p>🌲 Our interview #1 of 2022 🌟</p> <p>"Listen to how @MeritValdsalu and her team are creating an economy that rewards landowners for preserving nature."</p> <p>https://t.co/xruTyrweYA</p> <p>#NordicFintechMagazine #ClimateAction #Sustainability https://t.co/keGD8QddVx</p>
Climate change (Ecological)	33 (11%)	<p>"There is no waste in nature - that's a manmade construct," says Joanne Rodriguez, founder of @mycocycle</p> <p>"And so, looking for solutions in nature to solve these problems is critical to how we battle this climate change."</p> <p>New ep of @Naturebacked:</p> <p>https://t.co/qxDeY92kbU</p> <p>@virki</p>
Forest protection (Ecological)	19 (6%)	<p>➡ Just 28% of forests globally are in very good health.</p> <p>Source: Ecosystem Integrity Index by @SingleEarth1 https://t.co/d3NgImGq3X</p>

Theme	N (%)	Sample Tweet
Plastics (Ecological)	3 (1%)	More on #PlasticWaste in our @NatureBacked podcast - Check out new episode where @virki talks with John Felts from @CruzFoam #startups #innovation #environment #savingoceans https://t.co/y0N2zdrF7G https://t.co/bmeWFhoDRQ

The analysed tweets of Single Earth aimed at raising awareness in three specific areas: economic, ecological, and psychological. Although there is some overlap in these three areas in certain tweets, as evidenced in Table 4, there are distinct domains where each framework prominently emerges. Biodiversity and climate change themes are the most prominent areas for raising awareness. However, it is worth noting that climate anxiety is the least addressed issue, with only two posts dedicated to this particular topic.

Table 5 reveals that Single Earth generated 77% of the 295 analysed tweets. This significant portion includes tweets shared from the company's public profile. Additionally, 10% of the tweets analysed were responses to other user profiles.

Table 5

Tweet Type

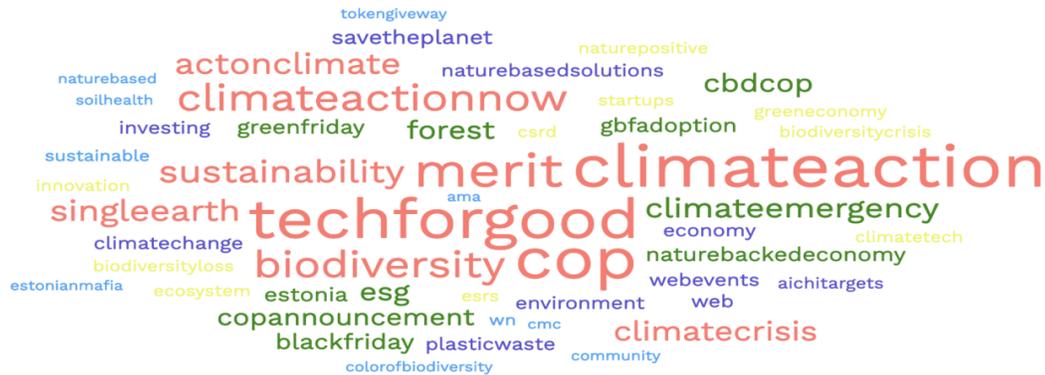
Theme	N (%)
Tweet	189 (64%)
Reply to others	29 (10%)
Reply to self	9 (3%)
Retweet	68 (23%)

Hashtags play a crucial role in classifying the topics and events that Twitter users are interested in, thus enhancing the accessibility of relevant content. While coding the tweets, at least one code was created for the hashtags in all 295 examined posts. However, it is important to note that only the hashtags found within the content produced by Single Earth (tweets and replies) are included in the hashtag cloud. Thus, a more specific frame was obtained regarding the interests of the audience targeted by the company. Figure 2 highlights several prominent hashtags related to

climate issues, namely #climateaction, #climateactionnow, #sustainability, #actonclimate, and #climatecrisis.

Figure 2

Hashtag Cloud



Discussion and Conclusion

This research on how blockchain-based companies utilise social media to raise awareness about the climate crisis and its effects analyses the Twitter content (including tweets, retweets, and replies) shared by Single Earth, a blockchain-based company, to evaluate its endeavours in leveraging social media to raise awareness about the climate crisis among blockchain companies. The noteworthy findings of the research can be listed as follows:

1. Single Earth company primarily focuses its posts (tweets, retweets, and replies) on raising awareness about climate issues. This observation aligns with the statement found on the company's website: “On a mission to incorporate nature conservation into everyday life to tackle climate change and biodiversity loss” (Single Earth, 2023).
2. Tweets have included podcasts, articles supported by scientific data from various news websites, and blog posts to increase awareness. Scientific studies are frequently referenced, indicating a scientific and educational approach towards nature preservation and raising awareness.
3. In addition, educational content regarding greentech is an important aspect. The adoption of greentech by stakeholders not only enhances the profitability of companies like Single Earth but also strategically positions them at an advantage.

4. The company's direct interaction with its followers appears to be limited, with a greater focus on event organisers and company executives engaging with international organisations through retweets. This approach may be seen as business-friendly, as it fosters collaboration with farmers.
5. Biodiversity and climate change are key focal points in the company's mission, as they prioritise raising awareness about these issues. While not being a non-governmental organisation, the company also endeavours to raise awareness about the green economy. However, it is worth noting that they have relatively minimal engagement with topics such as climate migration and climate anxiety, which are prominent discussions within the context of the climate crisis.

Thus, the company's primary focus is to engage users interested in the climate crisis and sustainability, with a particular emphasis on achieving climate action objectives. In its social media efforts, the company frequently employs the hashtag #techforgood to attract individuals interested in the intersection of technology and climate action. Additionally, the company actively promotes its own product, the token called MERIT, utilising the hashtag #merit through various promotional activities.

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