

# A DIGITAL ESCAPE ROOM FOR EDUCATION— GAMIFICATION OF THE SUBJECT “KNOWLEDGE MANAGEMENT” FOR STUDENTS OF INFORMATION SYSTEMS

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## Abstract

Knowledge Management is one subject in the bachelor’s degree in information systems at the Nuremberg Institute of Technology. For this subject, a digital escape room was implemented on the platform Moodle. Two pilot groups evaluated the online game before it was used in the course. The evaluation results showed that the learning process was assisted for those people who like quizzes. On the other hand, not all topics can be mapped in online quizzes. Even though Moodle has only limited development possibilities for online games, its option to guide through the game with visibility restrictions was especially helpful for the implementation.

## Motivation

The use of educational learning games reinforces knowledge as well as problem solving, collaboration, and communication skills (Dicheva et al., 2015, p. 75). Results of a longitudinal study show that gamification has a positive effect on students’ knowledge retention (Putz et al., 2020). As López-Belmonte, Segura-Robles, Fuentes-Cabrera, and Parra-González point out, “within gamification, flipped learning and problem-based learning, escape rooms can be found as a technical aspect, which is focused on providing enigmas and tracks for the various educational content” (2020, p. 1).

*Knowledge Management* is one subject in the bachelor’s degree in information systems at the Nuremberg Institute of Technology. One objective of this course is the process of how to gain knowledge. Therefore, the idea to develop an escape room for this subject has been raised. The content of the escape room should be the topics worked on the subject *Knowledge Management*. The challenge posed by this idea was to develop an educational digital escape room for this subject on the e-learning platform Moodle, which was already available at the Nuremberg Institute of Technology. Within this project, the following questions were investigated:

- Is it possible to implement an escape room on Moodle? Which features can be used to implement different kinds of puzzles? Is Moodle a recommendable platform for it?
- Which kind of contents are suitable to design puzzles? Which contents of the subject *Knowledge Management* can be selected for it?
- Is an escape room a reasonable idea for teaching these specific topics for the selected group of students in information systems?

In the next section, this article first explains the concepts of digital escape rooms and the e-learning platform Moodle. The following section describes some examples of the solution implemented. This is followed by an evaluation of the project by test groups and a conclusion.

## Background

### Digital Escape Rooms

A traditional escape room is a game “where people are locked into a room and have to find a way to escape by finding clues [...] in it, and solving puzzles” (Cambridge Dictionary, 2021). A digital escape room is an online game in which tasks have to be solved online to reach a defined goal (Grande-de-Prado, García-Martín, Baelo, & Abella-García, 2021) by following a story line. Nowadays, there are many different kinds of escape rooms: physical escape rooms in a building, city escape games, board games, and digital escape rooms. In digital escape rooms, players follow a story line and have to solve different digital tasks to achieve a defined goal.

When playing in a traditional, real-world escape room, the users learn more and more about the initial background story over the course of the game. Usually, teams solve the puzzles together. When a team first enters the room, all participants have to analyze the inventory. With the information and clues already acquired, the area can be explored to find puzzles which open paths to subsequent areas. Once a puzzle has been found, it must be solved successfully. Digital escape games follow the same principles. They can be designed for single players as well as for teams.

Escape room developers can map the path of the game either in a linear fashion or dynamically. Nicholson (2015) identified four ways of organizing the puzzles: open structures, sequential structures, path-based structures and hybrid structures:

In an open structure, the players can solve different puzzles at the same time. All other puzzles need to be solved before the last one. The sequential structure presents the puzzles one after another; solving a puzzle unlocks the next, until the meta-puzzle can be solved. The path-based structure consists of several paths of puzzles. Combining some of the basic structures produces

a complex, hybrid structure, which may take, for example, the form of a pyramid. (Veldkamp et al., 2020, p.2)

A trend to educational escape rooms is remarked in a meta study by Fotaris and Mastoras (2019, p. 240-242). While 72.1 % of their investigated studies match the field higher education, only 14.7% of them are in the area information and communication technologies. The subject “*Knowledge Management*” belongs to this area. However, only 10.6 % of the studies describe digital escape rooms.

The meta study of Veldkamp et al. (2020) investigated the learning efforts of educational escape rooms. Their research included the extent to which the following goals were reached by educational escape rooms:

- to explore an active learning environment
- to increase students’ motivation and/or engagement
- to foster learning and
- practicing or developing teamwork and communication skills. (Veldkamp et al. 2020, p. 8).

Makri, Vlachopoulos, and Martina (2021) did a systematic literature review on digital educational escape rooms. They found that digital educational escape rooms exist in various contexts. They consider that digital escape rooms are a suitable way to improve the access to training, communication, and interaction. The largest representation of the publications belongs to European countries. They presume that in those countries, designers seem to show a preference in recommending more game-based learning activities in educational surroundings. The most commonly chosen target group of their study are higher education students, whereas a smaller representation of secondary and primary education students was noticed.

Ang et al. (2020) shift a physical escape room, due to the covid pandemic, to a digital escape room for a first year Chemistry course. They used Google Forms for the implementation of their digital escape room. Their students’ feedback indicates that both types of escape rooms reinforce and motivate learning. Their survey results also show that the students prefer the physical escape room because of the real-world environment.

Lathwesen and Belova (2021) focus their literature review on escape rooms in Science, Technology, Engineering, and Mathematics (STEM) teaching and learning. They state that there is a need for more easily adaptable escape rooms as well as for more empirical evidence on their actual effects.

This not-exhaustive list indicates that there are many implementations of educational escape rooms in different areas. One area is higher education. A number of the escape rooms are in solely digital form rather than in the real-world.

One challenge for the implementation of a digital escape room is the choice of a suitable platform. In this investigation, the aim is to develop a digital escape room using a common educational platform.

## Moodle and H5P

Moodle “is an online educational platform that provides custom learning environments for students” (TechTerms, 2022). Moodle (Modular Object-Oriented Dynamic Learning Environment) is used for configuring and conducting internet-based courses. Gamage, Ayres, and Behrend (2022) conducted a systematic review of trends in using Moodle for teaching and learning. Their review shows that Moodle is mainly used within STEM disciplines in higher education. They state that Moodle effectively improves students’ performance, satisfaction and engagement. Moodle is increasingly being used as a platform for adaptive and collaborative learning and to improve online assessments.

Elements usable for gamification are quizzes and interactive content H5P (HTML5 Package). H5P is a free open source software for creating interactive contents. There are types of content already available and these include, for example, videos, presentations with embedded quizzes and memory games.

## Implementation

Typical for escape rooms is a fictive context for the puzzles. Therefore, a storyline adapted to the target group of students was developed. The story starts with the invitation of an applicant to a job interview. A fictive company is introduced with a pamphlet about the company, a fictive company website, image videos, and a job advertisement. Some of the content provided includes hints to solve the quizzes that follow. The introduction story guides players through the interview phase. However, surprisingly, the applicant is left alone in an office and has to find a way out of the building. At this point, the escape game starts and the user has to solve different quizzes to leave the building. In the course of the game, the user walks through different virtual rooms. By solving puzzles in each room, at the end of the game, the user finally reaches the building exit.

In order to implement the course progressively, the Moodle feature *activity progress* was used. Participants are guided successively through the escape room and do not have access to all materials when they start. The Moodle course has been structured in such a way that only the introduction and the prologue can be viewed at the beginning. Each chapter of the escape room is a separate course *section*. This is a Moodle design option, in which visibility can be linked to *activity progress*. After successfully completing the tasks in the section, a query is located at the end of each section which unlocks the next part of the course if it is answered correctly.

For example, if users solve multiple puzzles in one section, they receive digits for each puzzle. These digits have to be entered into a virtual padlock on a door, as shown in Figure 1. This door lock is a Moodle activity (*quiz*) linked to activity progress. This means that after successfully entering the numbers in the correct order, the next section will be unlocked, and then be visible in the Moodle course. This structure of the sections continues until the end of the course. In case users have difficulties finishing the escape room, helpful clues are located at the end of each section. These clues are structured in three levels. Therefore, the users can decide whether and how much help they need.

**Figure 1**

*Padlock*



While examining different kinds of puzzles, it became clear that there are two sorts of them: puzzles containing text and puzzles with pictures. One task of the project was to select suitable topics of the subject *Knowledge Management* for the escape room. Some contents are visualized in the presentation charts as maps, processes, models etc. Other contents are provided in text form. The topics of the subject *Knowledge Management* were assigned to the respective type of puzzle, depending on their format.

Moodle offers different possibilities to implement puzzles. One easy alternative is to use *quizzes*. There are different setting options and question types available. Restrictions can be assigned to each quiz to specify the number of attempts allowed and the assessment method used. The *grade boundary* specifies the minimum score required to pass a test. This can be linked to *activity completion*, which unlocks further course content when a defined score is reached. One option allows test takers to run the choices multiple times. Either a fixed number or an unlimited number of attempts can be specified. The possible answers to a question can either be randomly mixed or always have the same order. Each test can be configured to

give the user feedback either after every question or at the end of the test. There are different question types, for example, *multiple choice*, *free text*, *true or false* and *fill the gaps*. It is possible to display a feedback message after answers are entered.

Moodle provides several types of resources, which administrators can add to their course. These include the *book module*, where a multi-page work material can be provided like a book, and the possibility to implement links to external websites. With *files* and *directories*, material can be added to the course. A structure can be integrated in a directory in which files can be stored. In the escape room, this is used for the navigation through a folder structure to find a puzzle. The clue to this location is hidden in another puzzle. Files are used quite often in the escape room to inform the user about the story line, mainly in the entry phase. Additionally, some puzzles include files with text passages or images, which contain relevant materials on the Knowledge Management subject.

*Drag-and-drop* is another type of quiz supported by H5P. This function can be used to create tasks that require connections and associations. This is done by dragging images or text fields to specific positions. This kind of puzzle is suitable to ask for models, overview charts, and transfer questions.

“To date, quizzes have evolved from simple multiple-choice questions, true or false, drag-and-drop, dropdown menu selections, to 3D interactive techniques” (Zulkifli et al., 2022, p. 54). In a live escape room, participants are locked in a room and have to escape by solving tasks. In the process, every detail must be examined closely and the environment must be analyzed in order to find every clue. The H5P activity virtual tour (360) makes it possible to transform images into virtual rooms. Multiple images can also be linked to give the user the impression of moving between environments or between different viewpoints within the same room. This H5P feature was mainly used in the Moodle course to break up the predominantly linear structure and capture the feeling of being in a real escape room.

A virtual tour is composed of scenes that have either a 360° image or a normal image as a background. Opening with a starting scene, which is the first thing users see when they enter the H5P activity, any number of additional scenes can be added. Each scene can be customized by adding different functions. With the function *go to scene*, users feel as though they are moving through different rooms, as the images can be linked to each other and allow the user to navigate from one image to the next. Furthermore, it is possible to add texts, images, audio tracks or videos to the 360° images. These appear as a plus symbol at a desired position in the scene. Other options for shaping the virtual space are the similar H5P functions *summary* and *single choice set*. Summary is about choosing the correct statement from a set of statements. The single choice set activity asks the user a question with several pre-defined answer choices where only one is the correct one. Figure 2 shows an

office with a large desk, three armchairs, and a neatly arranged shelf. The task is to look around the virtual room and find clues that could help users to move forward. The 360° image was filled with information in the form of images, texts and videos. Each of these elements was placed appropriately in the room. For example, the company's introduction video runs on the TV, and books with relevant titles are on the shelf. Furthermore, different scenes were implemented, which create the impression of looking at the room from different angles.

## Figure 2

*360° image of an office room*



The H5P activity *course presentation* is used to show a slide presentation in Moodle. Standard elements such as text, images, and videos can be used, but also a variety of other H5P features, such as *drag-and-drop* or *summary*.

Another H5P functionality of the escape room is the *memory game*. This can be used to create user-defined memories with images and text. There are several options to design puzzles: uncovering two identical pictures, uncovering two pictures that belong together, revealing memory cards with sounds, and uncovering of a term and its description. Furthermore, there is a possibility to send a feedback message to the players after each correct pair is matched. The background images of the cards can be designed as well as the background of the entire memory game.

The H5P function *fill-in-the-blanks* was used to implement tasks in which no answer options are given and an answer text must be entered in a blank field.

This description of the Moodle functions used is not complete. However, it shows that with different Moodle activities, especially H5P elements and the visibility restrictions, a structured digital escape room can be implemented. It has also been

stated that the handling of this escape room is not the handling of a typical gaming app because the navigation is adapted to a learning platform and not to an online game.

## Evaluation

Two small test groups, each of about five people, tested the room before the first application in the students' course. The first test group consisted of the professor and experienced students. The task of this group was to test the technical handling and the difficulty and correctness of the quizzes. The navigation in the Moodle course was an obstacle for some users. Navigation possibilities in Moodle are limited. The only solution was to describe explicitly how the course navigation should be done. The correctness and the grade of difficulty had to be judged. The quizzes and their solutions were all correct. However, the duration of the course was too long (more than two hours). Some quizzes were too difficult. Because of the navigation limits, the user interfaces of some quizzes were too awkward. After this first pilot phase, the duration of some puzzles was shortened and more clues to the solutions were inserted.

The second test group consisted of students of the course *Knowledge Management*. Use of the escape room was an additional offer for them. Surprisingly, only a small group of them joined. It is assumed that this group likes solving puzzles. The task of this test group was to evaluate the time, their learning success, and their motivation. Their feedback was consistently highly rated. However, this group may not be representative for all students. The next cohort of students, who will take part in face to face classes, will use this escape room mandatorily. Thus, representative results can be generated.

## Conclusion

This section answers the research questions of the project. The first question is “Is Moodle a recommendable platform to implement a digital escape room?” The experience of this project is that it is possible to design a digital escape room in Moodle. However, Moodle is a learning platform and not designed for gaming. Restrictions found were:

- The implementation effort was high because workarounds to implement the dependencies between the puzzles had to be done.
- The users stated that the duration of the course was too long because of the long loading times of some puzzles.
- Not all browsers support all H5P elements. Mainly the virtual tour, which is a central element in the course, caused many display problems.



- The dynamic elements in Moodle are limited. Therefore, the course content has to be presented with the provided elements there. This reduces the implementation possibilities.
- Activity tracking is basic for an escape room. Only when users successfully solve quizzes they can enter subsequent areas. The tracking possibilities in Moodle are limited, which also reduces the implementation possibilities.

The second research question is: “Which contents are suitable to design puzzles for an escape room?” Only the puzzles provided influence the contents. The interpretation of text or pictures as a solution is difficult. The interpretation of the texts and pictures provided with the possible answers specified is possible. Thus, open answers cannot yet be implemented.

The last question is “Is an escape room a reasonable idea for teaching?” The small number of voluntary students for the second test group showed that only a few students were willing to invest their time. Those students who took part in the escape room learned a lot about the subject *Knowledge Management*. They had to understand the material presented and to transfer the theory to the case study in the escape game. Therefore, for the group who took part, the escape room was a successful teaching concept. However, other students found that the time necessary to solve the puzzles was too long, especially when compared to the time required for regular learning.

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