Educational escape rooms and their potential use in the BMT study-program

Bachelor Thesis

Bachelor Course on Media Technology
at St. Pölten University of Applied Sciences

Submitted by:
Lukas Heinzl
mt201010

Advisor: Dipl.-Ing. Stefanie Größbacher, BSc

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Declaration

I assure that

- I have written this work independently, have not used other sources and aids than those indicated and have not made use of any other unauthorized assistance.

- I have not yet submitted this topic to an assessor in Austria or abroad for assessment or in any form as an examination paper.

- this work corresponds to the work assessed by the assessor.

Date: _____ Signature: _____

Abstract

This bachelor thesis is about escape games and how they can be used within the Media Technology study-program at the St. Pölten UAS. The existing research suggests that escape games can be successfully applied in education. The focus of this study is to evaluate their use within the study program. This was done through a two-step process.

First, students, lecturers and researchers from the study-program were surveyed about their existing experience with escape games, as well as which lectures from the study-program they would find suitable for the use of an escape game. Then, a lecture was selected and an escape game, based on the subject's contents, created. The game was then tested with eleven participants.

The user tests revealed that the game was beneficial for strengthening already learned knowledge and skills. However, it was not suitable for learning about new things. They also revealed the importance of clear guidelines, as well as good usability of and feedback from the game itself.

Kurzfassung

Diese Bachelorarbeit befasst sich mit Escape-Games und wie sie im Studiengang Medientechnik an der FH St. Pölten eingesetzt werden können. Die vorhandene Forschungslage lässt darauf schließen, dass Escape-Games erfolgreich in der Lehre eingesetzt werden können. Der Fokus dieser Arbeit liegt in der Evaluation der Nützlichkeit solcher Spiele im Studiengang. Dies wurde durch einen zweiteiligen Prozess bewerkstelligt.

Als erstes wurden Student*Innen, Lehrbeauftragte und Researcher des Studiengangs mittels einer Online-Umfrage nach ihren Erfahrungen mit Escape-Games befragt. Weiters mussten sie angeben, welche Lehrveranstaltungen ihrer Meinung nach für den Einsatz von Escape-Games in Frage kämen. Darauf aufbauend wurde eine Lehrveranstaltung ausgewählt und, basierend auf deren Inhalten, ein Escape-Game erstellt. Das Spiel wurde im Anschluss mit elf Testpersonen evaluiert.

Die Tests zeigten, dass sich das Spiel als nützlich für das Festigen von bereits gelerntem Wissen und gelernter Fähigkeiten erweißt. Es brachte jedoch keine Vorteile für das Erlernen von neuem Wissen. Weiters zeigten sie die Wichtigkeit von klaren Spielanweisungen, sowie von guter Usability des Spiels.

Contents

1 Introduction

Escape rooms have been popular for over a decade now. After their start in Japan in 2007, escape rooms increased in number and spread to Europe, North America and Australia (Pan et al. 2017). This thesis is about the use and potential of escape rooms in an educational context. Escape rooms are single or multi-player games with the aim to exit locked rooms by solving puzzles (Krekhov et al. 2021). Commonly based in the real world, players must solve puzzles to progress to the next room. Most escape rooms are story-driven and follow a coherent theme in the design of the rooms and puzzles. They provide an immersive, challenging, and fun experience for players.

While escape rooms have established themselves as a new past-time for a lot of people, their use in education has yet to see more widespread adoption. Research on the potential of escape rooms in education is still in its infancy. However, in recent years the pace of research has picked up and more studies are emerging. The existing research can be split into two groups:

1. General research about the design and potential of educational escape rooms

2. The application and nuances of escape rooms in specific areas

One example of the second group is a course, held in the winter semester of 2019/20 by a group of lecturers at the University of Freiburg. In this course students learned about designing and building embedded systems by creating a real-life escape room. Pfeifer et al. (2021) concluded that the course was generally considered a success by students, instructors and players.

1.1 Research questions and goals

This thesis is mainly focused on research about the first group. Its goal was to determine the usefulness of escape rooms within the Media Technology study-program at the St. Pölten UAS.

The thesis had two specific questions to answer:

1. Which subjects / topics from the Media Technology study-program are suitable for the use of escape rooms as a teaching / learning method?

2. In what way do escape rooms provide a benefit for one of these subjects / topics?

Answering the first question was accomplished through the use of a questionnaire. The target group consisted of people from varying backgrounds within the study-program in order to get a more widespread coverage of different subjects / topics. The people in question were asked about their existing experiences with escape rooms, which topics they could imagine being suitable for escape rooms and in what specific subjects from the study-program they would like to see escape rooms used as a teaching / learning method.

Picking the most named / requested subject from part one, an escape room was designed and tested. Players had to escape from the room and then answer questions about their experience. They were further questioned about what they learned and if the escape room was beneficial in understanding the underlying subject.

First, answering these questions provides an overview of which subjects from the study-program can be further examined in the future. Second, the escape room, that was built in the second part, can be refined and used within the actual lecture. Lastly, tapping into this new-found knowledge allows escape rooms to become more widely adopted in education. Not only can it provide a more fun experience for students but it also has the potential to ease the learning process for certain subjects.

1.2 Structure and process

This thesis is split into three parts. In the first one, existing research about the topic is examined. This ranges from general research about escape rooms to research about their use in education. It provides an overview of what the current state-of-the art is and what can be learned and applied to this thesis.

The second part answers the first research question. It provides insights into the process of how the questionnaire was created and analyzed. It concludes with the selection of a subject for the third part.

The third part examines the design of the escape room, its learning goals and how it can be evaluated. At the end, the results of the user tests are presented and analyzed. The thesis finishes with an overall conclusion and what further research needs to be conducted on the matter.

2 Existing Research

This chapter highlights the existing research about the topic of escape rooms. It covers research about escape rooms in general, as well as research about their use in education. The chapter is split into three parts:

1. Summary of general research

2. Summary of research about applying escape rooms in specific areas

3. Conclusion and correlation to and usefulness for this thesis

2.1 General research

Escape rooms come in many different variations. From story-driven to purely logic-based, on-site to board and computer games, they all share the same idea. However, there is not a lot of consensus about how to talk about them. Krekhov et al. (2021) addressed this issue by creating an atomic puzzle taxonomy based on existing research and their analysis of 39 escape room games, which bridges the gap between the analog and digital domains. Furthermore, they also argued that although a narrative is not essential for a successful escape room game, it can increase players' immersion and motivation. Their findings showed that interesting puzzles and challenges were the primary motivators for players.

Another important aspect of the creation of escape rooms is accessibility. Playing an escape room as a leisure activity should be something that everyone can do. When using them in education it is even more important that all students can effectively participate and learn. Menzies (2019) researched the accessibility of escape rooms. Through the use of an online questionnaire, participants were asked to provide insights into their experiences with accessibility in escape rooms. The target group involved both designers and players, with a mean age of 22 years across everyone who completed the survey. Their study revealed that accessibility was lacking in escape rooms, resulting in the exclusion or reduced participation of users with disabilities, despite the expectation that technology could mitigate such accessibility issues.

Escape rooms are almost always played as a team. Good communication and collaboration are key to successfully escaping in time. These factors are also important to ensure that players enjoy playing the game. In their paper, Pan et al. (2017) investigated the dynamics of group play and collaboration in escape rooms, as well as how the design of escape rooms influences collaboration. They recruited players to play a room at a local escape room facility. The teams consisted of two to five players. Guided by a semi-structured observational checklist, one researcher accompanied each team into the escape room to observe game play and collect notes. They collected and analyzed the data from these notes, a handwritten questionnaire and interview notes. Analysis of the data revealed that leadership roles were established quickly, with experienced players often taking on leadership roles. Furthermore, they also discovered that escape rooms offer opportunities for practicing collaboration skills, and could potentially be used to teach specific types of workplace or school training that involve collaboration, which is particularly relevant to this thesis.

Before being able to play an escape room it needs to be designed. While escape rooms for leisure activities mostly focus on the experience and enjoyment, educational escape rooms need to also provide a sufficient learning experience. In their article, Reuter et al. (2020) synthesized existing literature to guide the creation and design of educational escape rooms. According to previous research, educational escape rooms are adaptable to any teaching area and are designed to promote active learning, communication, creativity, collaboration, critical thinking, motivation, and tolerance for frustration. To ensure that an educational escape room is effective, it is important to evaluate the educational needs of the players. Furthermore, the challenge level of an escape room must be appropriately balanced, as overly difficult challenges can lead to frustration while overly easy ones can cause boredom. The authors recommend an evaluation in the form of a debate to analyze what students have learned and to determine any necessary adaptations to the escape room game.

Another approach to designing escape rooms is provided by Heikkinen and Shumeyko (2016). They adapt the Experience Pyramid Model, which claims to provide a holistic overview of an experience at all of its stages, analyzing it in regard to its potential usefulness in the process of designing a real life escape room. The model, created by Sanna Tarssanen, takes the whole customer journey into consideration and aims at providing structure for creating an engaging experience. According to them, it is possible to consider room escape as an educational experience due to its potential to create an ideal environment for nonconscious learning and skills development. They also assert that a successful escape room game teaches players multiple things. However, they highlight that all of this is only achievable if the game provides a wholesome experience that stimulates not only the senses but also the mind. To ensure a steady progression and smooth game flow, they suggest that the difficulty level of a room should increase gradually.

Heikkinen and Shumeyko (2016) used the experience pyramid model for designing an example escape room. However, they did not get to implement and test it due to unforeseen events within their partner company. The design of the room is crucial to the overall experience as challenges are an integral part of any escape game, but they must be valid and fit within the story line. They also argue that there is currently no established model or universal tool for escape room design and suggest that their study can serve as a foundation for future designers. The authors concluded that the Experience Pyramid model works effectively in the escape room industry and can be observed in many existing escape rooms. They argued that the model does not introduce anything novel to the design of escape rooms, but it offers a more streamlined and structured foundation for creating a comprehensive and captivating experience.

P.-Y. Li et al. (2018) evaluated the use of escape rooms in "maker courses". Four groups consisting of a total of 21 first-year students from their university were tasked with collaborating on making something. Mainly looking at the "number of group members", "difficulty of tasks", and "skill of collaboration" as key factors, they concluded that groups of more than 5 students had trouble reaching consensus when facing choices. Furthermore, their results showed that there was no direct relevance between the difficulty of tasks and the number of group members.

2.2 Application in specific areas

This section provides an overview of how escape rooms have been applied in an educational context. A summary of the contents, goals and outcomes for each study is listed.

Lien et al. (2019) used an educational escape game for teaching the concept of the law of the lever. They tested a variety of quizzes, such as multiple-choice, fill-in and matching. According to their findings, it is suggested that there was an improvement in student's learning achievement. However, it was indicated that, if game-based learning is not carefully designed with cognitive interaction in mind, it could result in "too much play, too little learning."

In another study C.-T. Li et al. (2020) tested an educational escape room with 38 junior high students to help teach them CPR[1]. The escape room was effective in enabling students to link their learning content with real life, as compared to the unidirectional and interaction-lacking knowledge transmission of instructional videos. The students had to help a person with cardiac arrest in-game. Before and after playing the game they had to part-take in a test with ten multiple choice questions in order to test student's knowledge before and after playing the game.

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[1] Cardiopulmonary resuscitation

Indicated by the results, they conclude their study by stating that the game offered an enjoyable game flow experience for students, and that they perceived the game to be useful for learning and easy to play. Furthermore, they state that an improvement in the student's learning achievement can be seen.

Playing an escape room can teach a lot of different skills. However, creating one can give students a lot of insights into how to design an escape room, as well as what technologies can be used. Most real-life escape rooms rely on micro controllers and embedded systems to provide interactable elements. Pfeifer et al. (2021) taught the creation of such systems by tasking their students with the creation of an escape room. After picking an on-campus location and preparing the rooms with the necessary basic infrastructure, they created a first draft of the story line. The students were split into different groups, each responsible for one part of the task. Through continuous integration, the groups got together in mandatory meetings to update each other on their progress. Each week, the progress of the game was monitored by assigning two individuals, either students or invited guests, to enter the room and attempt to solve the puzzles at their current stage of development. Their feedback was then shared with the entire course. It was evident that the course was well received, as there were students who frequently asked for permission to use the room and technical resources beyond the regular course hours. This demonstrated their strong desire to complete their individual projects. The researchers' analysis of student feedback suggested that the students had gained a significant amount of knowledge through the course. They also noted that, unlike other project-based courses, the course's emphasis on a shared goal helped students develop soft skills that are essential for contributing to larger projects.

In computer science, troubleshooting is a very important skill. This especially applies to debugging software. Michaeli and Romeike (2020) investigated debugging traits that students already have. In order to carry out their study, the researchers designed a live-action escape room that included several troubleshooting exercises related to debugging. To monitor participants' actions and conversations, a surveillance camera was installed in the room and used to record both video and audio. They tested their escape rooms in seven different locations, with about 150 students playing in total. According to the researchers, a portion of the students who participated in the study had prior experience with escape room games. This could have given them an advantage in terms of meta-factors such as how to efficiently search a room or how to map specific locks to certain exercises based on the solution's number of inputs. The researchers came to the conclusion that the troubleshooting behaviour exhibited by students in the study resembled that of novices in debugging. They also observed that students tended to search the room for additional clues that could help them with future exercises, which may have led them to give up on a particular task temporarily and shift their focus to another exercise.

Based on the work of (Heikkinen and Shumeyko 2016) the study of Karageorgiou et al. (2020) evaluated the usage of educational escape rooms using the Experience Pyramid model. After playing the escape room the participants were asked to take part in an online survey, which consisted of 6 parts. The contents of this survey were based on the checklist Heikkinen & Shumeyko proposed to use when creating an escape room based on the Experience Pyramid Model. Furthermore, they interviewed a student, who participated in all phases of the project, to gain additional information. All in all, their results show that the checklist from (Heikkinen and Shumeyko 2016) can be used to evaluate the experience of escape room players.

The paper from Kahila et al. (2020) highlights the use of escape rooms for practicing computational thinking. They based the contents of their game on *Bebras Challenge*[2]. The researchers observed that during initial tests the players could easily become confused and lose their sense of immersion in the game if there was no clear guidance provided at the start. To address this issue, they used a hybrid approach for the room design, incorporating three CT-related problems as digital games on Android tablets to supplement the physical room puzzles. While they found the results of using escape rooms in education to be promising, they note that there are still many unanswered questions about the effectiveness of this approach.

The usefulness of educational escape rooms for teaching cryptography was examined by Seebauer et al. (2020). They first evaluated the existing knowledge of the students with a questionnaire. As part of the study, students were tasked with solving five cryptographic challenges within a 60-minute time limit in order to obtain a code that would unlock a box containing the key to the room. After completing the escape room, students were given a debriefing on its purpose and were asked to complete a post-questionnaire that evaluated their basic understanding of cryptography. The researchers noted that the allotted time frame for completing the tasks was too short, and that participants often struggled to determine when they had completed one task and could move on to the next.

Bierbooms et al. (2020) explored the use of escape rooms in *eMental Health*. The researchers employed a variety of evaluation methods, including questionnaires, interviews, and two co-design sessions, to determine the potential use of escape rooms as a learning tool. These evaluations uncovered several specific factors that make escape rooms an appealing option. Participants suggested that physical escape rooms might be better received than digital ones. Based on the feedback gathered, the researchers concluded that there is ample opportunity to continue developing escape rooms as a tool for learning.

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[2]https://www.bebraschallenge.org/ - Challenge focussing on informatics and computational thinking

Williams (2018) conducted a study to outline a curricular approach that helped their students learn how to effectively work in teams. The motivation for this study was the belief that many employers consider college graduates to be unprepared for team environments. As part of this approach, students were assigned to small teams with a designated leader, and were tasked with solving puzzles. After each puzzle was solved, the students would reflect on their problem-solving strategies and the actions of the team leader and participants. They noted that over time, the students improved their communication and problem-solving skills. The paper concludes that based on the outcomes of this approach, it is worth exploring the potential for further development and formal assessment.

2.3 Analysis and summary

In conclusion, the research highlighted above shows that escape rooms can be used in education. These papers have in common that they do not go into much detail about how their escape rooms where created or evaluated. Only one paper focused on the creation of an escape game. In regard to the topic of this thesis, the paper from Pfeifer et al. (2021) could be interesting for the courses *Tangible User Interfaces* and *Physical Computing* as they focus on micro controllers.

Almost all of the mentioned studies used questionnaires and interviews with participants to gather insights about the usefulness of the escape room. This proved useful in most studies, providing enough insights into the participant's opinions. Therefore, for the rest of this thesis, questionnaires will serve as the main information gathering and evaluation tool. They will focus on gathering information about how participants enjoyed and experienced the escape room, as well as to gather general information about them. The next chapter will use a survey to gather information about people's existing experience with (educational) escape rooms as well as to determine what topic should be picked and turned into an escape game. The escape game itself will be evaluated with a questionnaire and a small interview with each participant.

3 Topic selection and evaluation

This chapter describes the process of finding a suitable topic from the Media Technology study-program. The selected topic was then turned into an escape game and tested with participants.

Through the use of a questionnaire participants got to provide input about which topics or lectures from the study-program they would find suitable or interesting for the use of escape games. The questionnaire also served as a source for information about general experience with escape games. This chapter highlights the questionnaire and its contents, how it was designed and how the results contributed to the selection of a topic. It concludes with the final selection of a topic and highlights the next steps.

3.1 Designing the questionnaire

To get a better understanding of the existing experience of students and lecturers with escape games as well as to narrow down the list of suitable topics a questionnaire was used. It was sent out to all students, lecturers and researchers associated with the study-program. The questionnaire can be found in the appendix: Lecture selection questionnaire It is split into four parts:

1. General information

2. Existing experience

3. Preferred / suitable topics

4. Final thoughts and feedback

3.1.1 General information

This part served for collecting general demographic information (age, gender) about the participants. Furthermore, the relationship (student, lecturer, researcher) to the study-program had to be specified.

3.1.2 Existing experience

This part collected information about participant's existing experience with escape games. This can be either within education or in a leisure context. The collected information included:

- Number of escape games played

- Type(s) of escape games played

- Experience with *playing* an escape game within an educational context

- Experience with *creating* an escape game within an educational context

Regarding the types of escape games, the following selection was provided. However, participants had the option to enter their own answer as well.

- Real life escape room

- Board / card game

- Digital escape game

- Virtual reality escape game (at home)

- Virtual reality escape game (at a dedicated facility)

The questions about existing experience playing / creating an escape game within an educational context had the following general structure:

1. Have you played / created an escape room?

2. If yes, what was your experience like?

3. If no, would you like to play / create an escape room?

3.1.3 Preferred / suitable topics

This section was the main focus of the questionnaire. It featured a list of lectures for each semester. Participants could mark each lecture if they think it would be suitable for *playing* and / or *creating* an escape game within the lecture. To keep the survey brief not all lectures from the study-program were listed. However, participants could enter other lectures if they found them suitable. Lastly, they could provide a short explanation about their selection. This, together with the quantitative amount of votes for the lectures, was used to determine which lecture to further examine in the following chapters.

The following provides insight into the pre-selected lectures for the questionnaire and why they were chosen. In general, these reasons were used to pre-select a lecture:

1. The lecture is about a complex topic that can be split up into smaller sub-topics (like puzzles)

2. The lecture has a focus on interaction

3. The lecture has a focus on teamwork / communication

Each lecture listed below contains a number in parenthesis referencing one of the above-mentioned reasons. An asterisk symbolises a special reason, mentioned below each lecture.

1st semester

From a total of eleven lectures, the following five were pre-selected:

- Introduction to Network Technology (1)

- Introduction to Programming 1 (1)

- Mathematical and physical Foundations (1)

- Mediahistory and -ethics (*)

- Teamwork and Communication (3)

Mediahistory and -ethics is a very broad lecture. It offers students a lot of freedom with how they can express themselves. Therefore, escape games could be suitable for this lecture.

2nd semester

From a total of 13 lectures, the following six were pre-selected:

- Operatingsystems (1)

- Introduction to Programming 2 (1)

- Introduction to Web Technologies (1)

- Foundations of Usability (1, 2)

- Mathematical and electrotechnical Foundations (1)

- Personal Goals and Communication (3)

3rd semester

From a total of 18 lectures, the following three were pre-selected:

- Project work (3)

- Information design (*)

- Psychological and sociological Foundations (1)

Information design could benefit from escape games as they provide a unique way to explore a topic and therefore visualize data / information.

4th semester

From a total of 18 lectures, the following five were pre-selected:

- Contextual Design and Accessibility (*)

- Physical Computing (2)

- Tangible User Interfaces (2)

- AV-Installations (2)

- Interactive Audio-/Videosystems (2)

Contextual Design and Accessibility could use escape games for testing the topic at hand. As mentioned by Menzies (2019), "accessibility is lacking in escape rooms leading to the exclusion or reduced participation of users with disabilities".

5th / 6th semester

Only the *Project coaching* lecture from the *MediaLab* has been selected. This lecture has been pre-selected as it has a focus on teamwork / communication (3).

3.1.4 Final thoughts and feedback

The questionnaire concluded with participants having the option to provide further feedback and thoughts about the topic if they desire to do so. Furthermore, they had the opportunity to provide contact details if they wish to participate in the testing of the escape game.

3.2 Evaluation

This section focuses on the evaluation of the questionnaire, presenting all the data and possible conclusions. The selection of which topic was picked and further examined in this thesis is discussed in the next section.

3.2.1 General information

In total, the questionnaire was sent to 570 people (331 students, 239 lecturers / researchers) with 55 people participating.
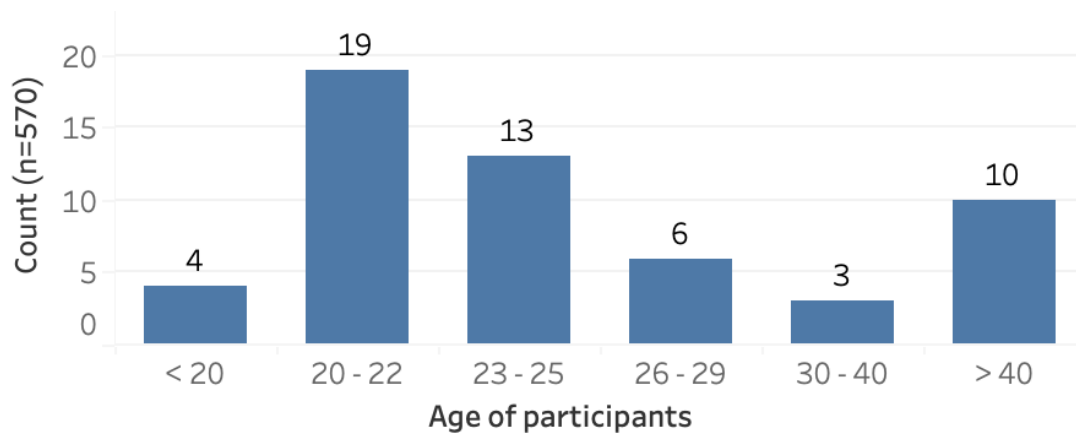

Figure 3.1. Distribution of age, n = 570

The majority of participants were between 20 and 25 years old. The third largest group was the above-40 group. 26 participants were female, 25 male, 1 non-binary and 3 people preferred not to answer the question about their gender.
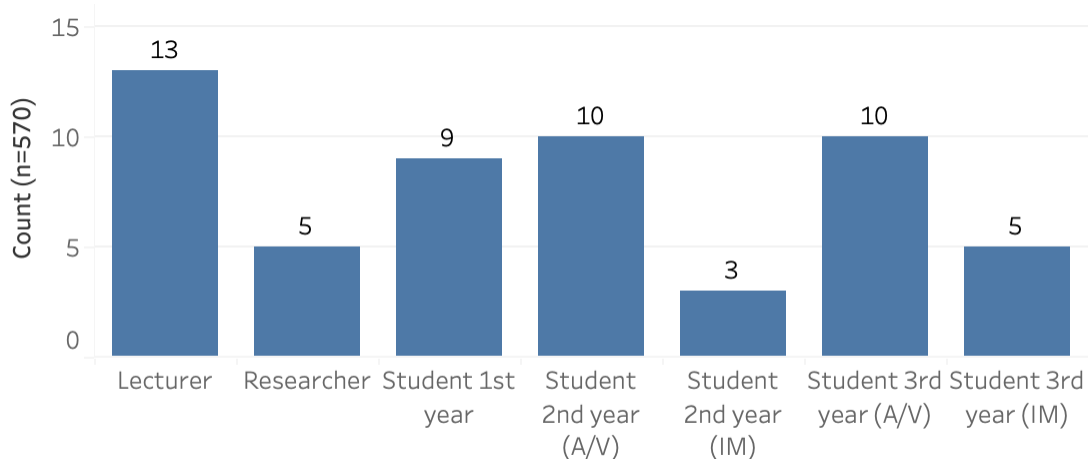

Figure 3.2. Distribution of the participant's position within the study-program, n = 570

The largest participant group were the lecturers. However, in total only 18 lecturers / researchers participated, compared to 37 students. Students from the Audio / Video (AV) specialization participated in greater numbers compared to students from the Interactive Media (IM) specialization. This can be, at least partially, attributed to the fact that more students are attending AV rather than IM.

3.2.2 Existing experience

As the following figure shows, the vast majority of participants already had experience with playing escape games. 60% had already played two or more escape games so far. However, only a single person had played and two people created an escape game within an educational context.
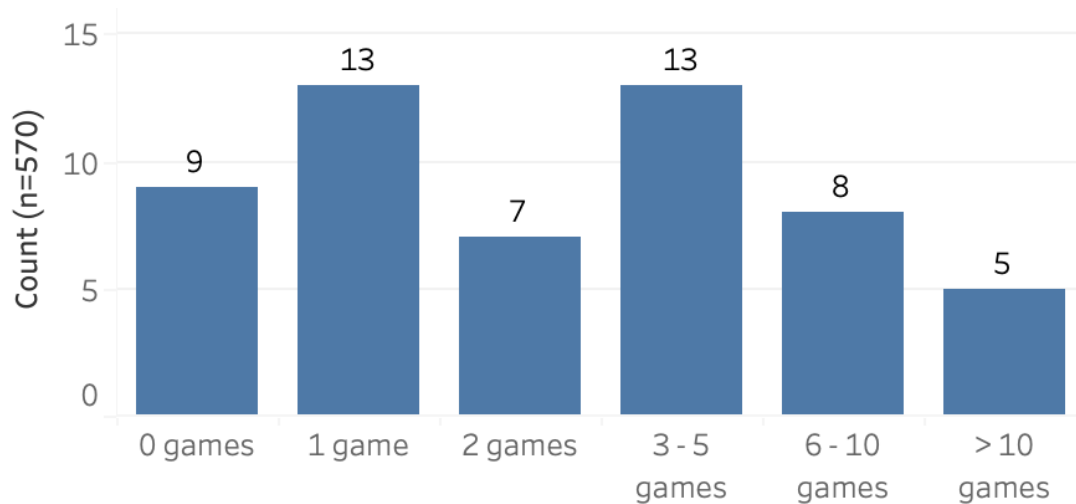

Figure 3.3. Distribution of the amount of played escape games, n = 570

The one person who had played an educational escape game before stated that it was a nice learning experience but that the format did not help too much, partially because they had already learned about the topic and because the escape game was not graded. The experiences from the two people who had previously created an escape game, within an educational context, were mostly positive, as well. However, not many conclusions can be drawn from their short answers. All participants stated that they would like to play an escape game in class, but only 44 would want to create one.

The vast majority of participants had played real-life escape rooms or board / card games. Only less than a quarter had played digital escape games, with even fewer having played one in virtual reality. Two people specified other types of escape games. This included an escape game based on a book as well as a joke answer that will not be further examined.
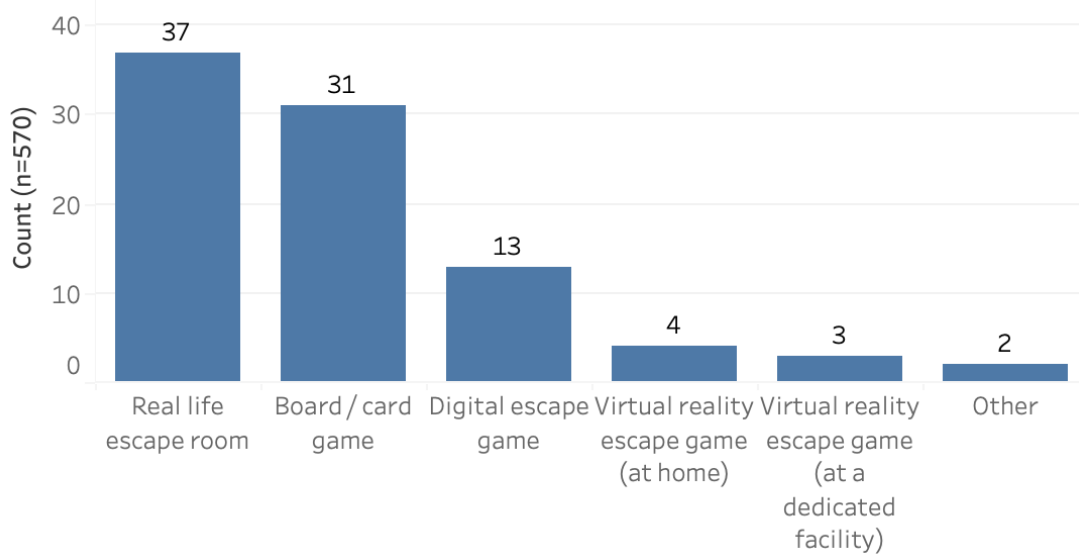
Figure 3.4. Distribution of played types of escape games, n = 570

3.2.3 Preferred / **suitable topics**

The following shows the results of the pre-selected lectures. Afterwards any noteworthy lectures suggested by the participants are listed. At the end the participant's comments on their selection are summarized and the overall results analyzed.

1st semester

All 55 participants were eligible to vote.

Lecture	Play	Create
Teamwork and Communication	41 (75%)	24 (44%)
Introduction to Network Technology	38 (69%)	16 (29%)
Introduction to Programming 1	34 (62%)	34 (62%)
Mathematical and physical Foundations	30 (55%)	15 (27%)
Mediahistory and -ethics	22 (40%)	32 (58%)

Table 3.1. Results of the lecture selection of the 1st semester

2nd semester

46 of the 55 participants were eligible to vote.

Lecture	Play	Create
Personal Goals and Communication	33 (72%)	21 (46%)
Mathematical and electrotechnical Foundations	27 (59%)	15 (33%)
Foundations of Usability	26 (57%)	30 (65%)
Introduction to Programming 2	25 (54%)	29 (63%)
Introduction to Web Technologies	25 (54%)	20 (43%)
Operatingsystems	22 (48%)	13 (28%)

Table 3.2. Results of the lecture selection of the 2nd semester

3rd semester

46 of the 55 participants were eligible to vote.

Lecture	Play	Create
Psychological and sociological Foundations	17 (37%)	9 (20%)
Information design	12 (26%)	11 (24%)
Project work	7 (15%)	24 (52%)

Table 3.3. Results of the lecture selection of the 3rd semester

4th semester

33 of the 55 participants were eligible to vote.

Lecture	Play	Create
AV-Installations	23 (70%)	20 (61%)
Interactive Audio-/ Videosystems	23 (70%)	25 (76%)
Contextual Design and Accessibility	17 (52%)	17 (52%)
Physical Computing	13 (39%)	14 (42%)
Tangible User Interfaces	10 (30%)	18 (55%)

Table 3.4. Results of the lecture selection of the 4th semester

5th / 6th semester

33 of the 55 participants were eligible to vote.

Lecture	Play	Create
Project coaching	15 (45%)	17 (52%)

Table 3.5. Results of the lecture selection of the 5th / 6th semester

Further suggested lectures

15 participants suggested other lectures, but only one was mentioned more than once. This was the elective module / MediaLab *Digital Game Production*. It was suggested because a digital escape game could be created as a (semester) project within this lecture.

Participant's comments

The comments of the participants reflected the numerical results shown in the above tables. Most argued that lectures based on communication or which are more complex in general would be more suitable for playing escape games. Furthermore, lectures that already focus on creating something or at least on some aspect of creation (like usability, for example) are more suitable for creating an escape game. Comments about specific lectures were mostly about *Introduction to Programming (1 / 2)* and *Introduction to Network Technology*. It should be noted that the comments were more about the general usefulness of escape games rather than the reasons for picking specific lectures. This was due to the question being inadequately phrased.

Analysis and notes

First of all, it should be noted that lectures in earlier semesters had more votes on average. The reason for this was because participants, who were in earlier semesters, haven't had the lectures listed in later semesters. Therefore, using the absolute amount of votes for the final selection is not suitable. The value in parenthesis indicates the relative amount of votes (rounded to the nearest integer) in relation to the amount of eligible voters. This can, however, be imprecise, because the survey did not block people who were not eligible to vote on a certain semester from voting.

Overall, the two most voted lectures int the *playing* category were the two communication-based lectures *Teamwork and Communication* and *Personal Goals and Communication*. They fit with the theme of using escape games as team-building exercises. The most voted lectures in the *creating* category focus on interaction or software development (like *Interactive Audio-/ Videosystems* or *Introduction to Programming (1 / 2)*). In general, the more niche the topic of a lecture is, the less votes it received.

3.2.4 Final thoughts and feedback

20 participants shared extra feedback / thoughts about the topic. Most shared their interest in using escape games in education. Some hinted at the possible challenges in implementing escape games within the current curriculum of the study-program, as well as possible time constraints for lecturers. 27 people offered to participate in the testing of the to-be-built escape game.

3.3 Conclusion and topic selection

After presenting and commenting on the results of the questionnaire, a lecture has to be selected for further examination. A topic from the selected lecture is picked and turned into an escape game. It is then tested with participants from the same target group as the questionnaire (students, lecturers and researchers from the Media Technology study-program).

While the questionnaire covered both the play and creation aspect of escape games, only the play aspect is used for the selection process. This is due to two reasons:

1. Playing an escape game can be tested more easily than creating one

2. Participants indicated that they prefer playing an escape game rather than creating one

Therefore a list of the top ten (out of all 20) lectures, sorted by the relative amount of votes for play, is used.

Lecture	Play
Teamwork and Communication	75%
Personal Goals and Communication	72%
Interactive Audio-/ Videosystems	70%
AV-Installations	70%
Introduction to Network Technology	69%
Introduction to Programming 1	62%
Mathematical and electrotechnical Foundations	59%
Foundations of Usability	57%
Mathematical and physical Foundations	55%

Table 3.6. Top ten lectures sorted by relative votes for play

Testing the escape game is done one participant at a time, rather than by a team. Therefore, the top two lectures will be discarded from the selection process, due to them being communication- / team-based lectures. For further examination, the next three lectures on the list are looked at, since they almost all have the same score. This leaves the following lectures for discussion:

- Interactive Audio-/ Videosystems

- AV-Installations

- Introduction to Network Technology

From these remaining lectures, only one had been mentioned in the open feedback questions: *Introduction to Network Technology*. Multiple times participants had mentioned this lecture as being suitable for playing an escape game. A few concrete examples of which topics from the lecture could be used had been mentioned. The lecture also has a few other qualities that the other two don't have:

- It takes place in the first semester, meaning all student participants have experienced it.

- It is a fundamental lecture within the study-program, regardless of the specialization taken in later semesters.

- It can be split up into smaller topics that intertwine with each other, like puzzles in escape games.

- I have more personal experience with it, making the creation of an escape game about this topic easier.

Due to the above-mentioned reasons, the lecture *Introduction to Network Technology* is selected for further examination. The next chapter will highlight how the escape game will look like, which specific topics from the lecture it will be about and what type of escape game it will be.

4 Puzzle design and room flow

This chapter highlights the contents of the escape game, what puzzles it contains and how it is designed. Furthermore, the strategy used for testing the escape game is described.

4.1 Definition of learning goals

As discussed in the previous chapter, the selected lecture for building an escape game is *Introduction to Network Technology* from the first semester of the study-program. This section provides information about the contents of the lecture, which topics could be turned into puzzles and what kind of puzzles could be used. At the end, a concrete list of topics and their learning goals is provided. The actual design and layout of the escape game is part of the next section.

4.1.1 Contents of the lecture

The data sheet for this lecture, which is not publicly available[1], lists the following skills that students should acquire in this course:

- Describe the components and functionality of networks

- Independently build and configure simple networks

- Describe terms from the world of IT-networks, as well as their basic concepts and LAN-services

- Describe the components and their purpose

- Manage small company-networks (max. 100 devices)

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[1] Data sheets are only available to staff members of the university, which I am

Furthermore, the data sheet explicitly lists the following topics:

- Basics of network technologies

- Protocols, especially TCP/IP

- Routing

- Configuration of network components

The data sheet only provides a small overview of the contents of the lecture. To further describe what is being taught, the following list contains all topics that are currently part of the lecture and the final exam.

- Network models (ISO/OSI layer model)

- Ethernet

- IP (v4, v6)

- ARP

- Routing

- TCP

- Transmission-media (wired, wireless)

- NAT

- DNS

4.1.2 Potential topics and puzzles

Due to the nature of network technology being layer-based, the topics provide a natural progression and dependency structure for puzzles. For example, to provide access to the World Wide Web, a working network connection is required. This can be either a wired or wireless connection. Being able to communicate on the network requires routing and TCP/IP. Therefore, designing the escape game with these layers and dependencies in mind can provide participants insights into the layer-based structure of networks.

Most network components require special configuration. A recurring puzzle type can be the entering of commands and parameters in order to configure various components. This provides participants with knowledge about the nuances of different components, protocols, and services. It also provides training in reading configuration manuals.

Two general puzzle types can be used within the escape game: Finding needed parts and unlocking locks with pin codes. While not directly related to the topic at hand, these two puzzle types serve as a general way of moving the game forward.

4.1.3 Final topic and puzzle selection

The escape game is split into four rooms. These correlate with layers from the ISO/OSI seven-layer model. All rooms are independent from each other. Once the next room has been entered, participants can no-longer go back to the previous. The following lists the contents of each room, as well as its learning goals.

Room 1 - Physical Layer

This room features the construction of Ethernet cables, entering pin codes and installing a wireless access point. Its purpose is to show the basics of how networks are physically constructed without going into the details of configuring the involved components.

Room 2 - Data Link Layer

Part of this room is finding and installing a switch and connecting multiple devices to it. It involves first steps of troubleshooting, including the unblocking of a device from network access. Its purpose is to provide first insights into the construction of small networks, configuration of components and troubleshooting.

Room 3 - Network Layer

This room focuses on the configuration of routers. Participants need to provide routing between multiple devices. DHCP needs to be configured on the router. Furthermore, the importance of subnets and how they work is highlighted.

Room 4 - Application Layer

Featuring multiple computers and network devices, participants need to access data on a server in order to unlock the exit. They need to configure the access to specific ports on the router. At the end, they need to start a service on the server, which unlocks the exit. This room provides insight into higher-level configurations, as well as troubleshooting network infrastructure for applications.

4.2 Escape game design

This section highlights the design and implementation of the escape game. It provides insights into the flow of the rooms, how the puzzles depend on each other and what each puzzle / room teaches the participants. It concludes with a finished implementation of the escape game. How the escape game was tested and its effectiveness evaluated is part of the next section.

The escape game was created as a digital point-and-click game. It runs in the web browser and uses standard web technologies like HTML5, CSS3 and Typescript. Even though only 13 out of the 55 participants from the questionnaire answered that they had played a digital escape game before, there are several advantages over a traditional escape room:

- Participants can play from anywhere, needing just an internet connection

- Developing a software-based escape game takes less effort than building a physical room

- Digital escape games can be replayed quickly by simply restarting the software

Due to the special needs of the topic the game was created from scratch. The source code is open source and can be found on *GitHub*. The details of the implementation are not part of this thesis.

4.2.1 Puzzle and room structure

The following shows the structure of the puzzles and rooms. For each room the items, which can be found, are listed. Furthermore, a screenshot of the final implementation of each room is shown. Lastly, a flowchart is provided, showing the order in which the puzzles need to be solved. The flowcharts were created using *Lucidchart*. The escape game is almost completely linear.

Room 1 - Physical Layer

The first room focuses on the Physical Layer of the ISO/OSI model. It features very few items and serves as a first, small on-boarding room to the escape game. The following items can be found in this room. The letters in brackets correspond to the items in the screenshot.

- Raw Ethernet cable [A]

- 2 RJ45 plugs (can be infinitely reused for crimping) [B]

- Crimping tool [C]

- RJ45 wall outlet (static) [D]

- Code device (static) [E]

- Cabinet with pin-lock (static) [F]

- Wireless access point anchor (static) [G]

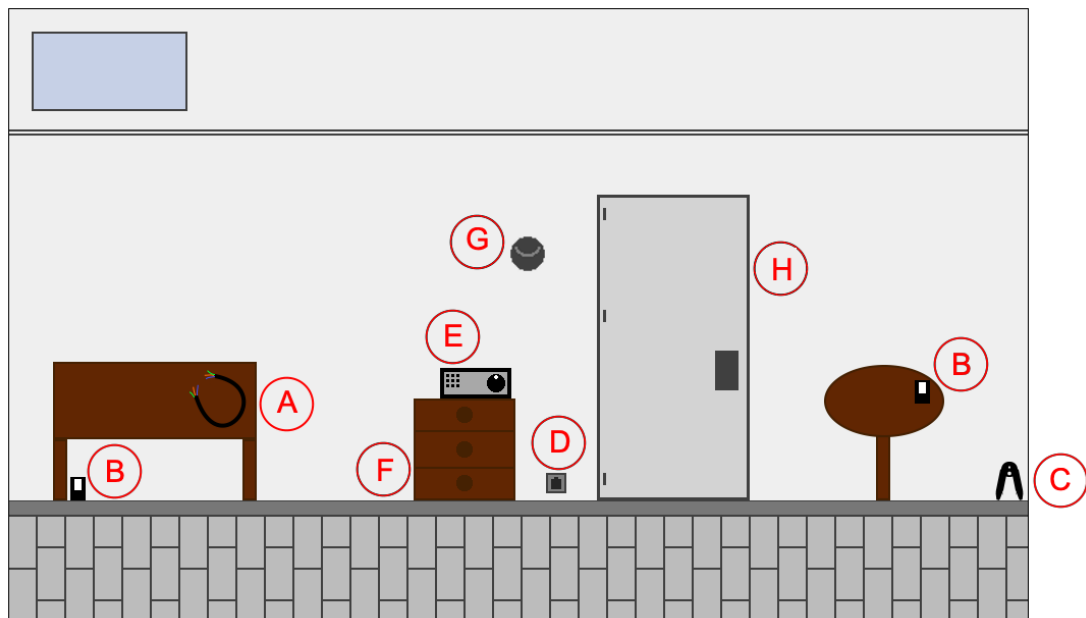- Wireless access point [inside cabinet]

- Door (static) [H]

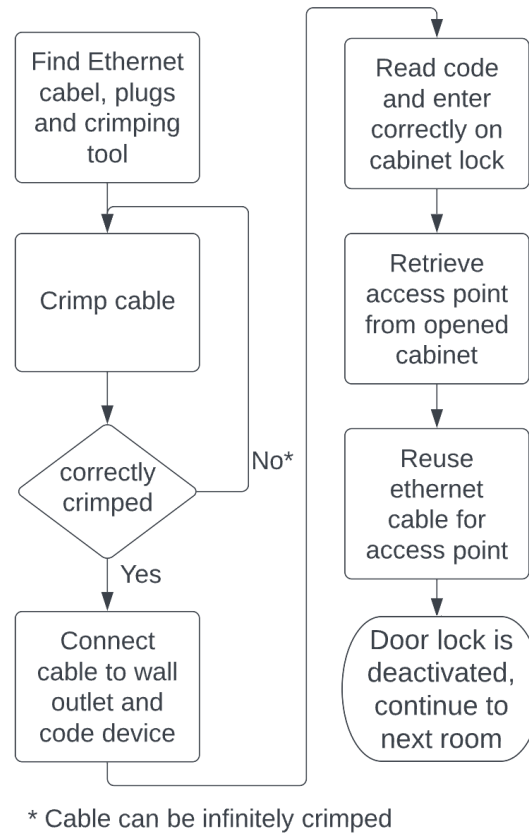*Figure 4.1.* Screenshot of room 1

* Cable can be infinitely crimped

Figure 4.2. Flowchart for room 1

Room 2 - Data Link Layer

The second room introduces switches, which allow multiple devices to be connected together on the same network. Participants need to setup a small network in order to unlock the door. The following items can be found in this room:

- Network rack with patch panel (static) [A]

- Switch [B]

- 3 Ethernet patch cables [C]

- 5 RJ45 wall outlets (static, only some are needed) [D]

- Security server (static) [E]

- Door (static) [F]

- Vault (static) [G]

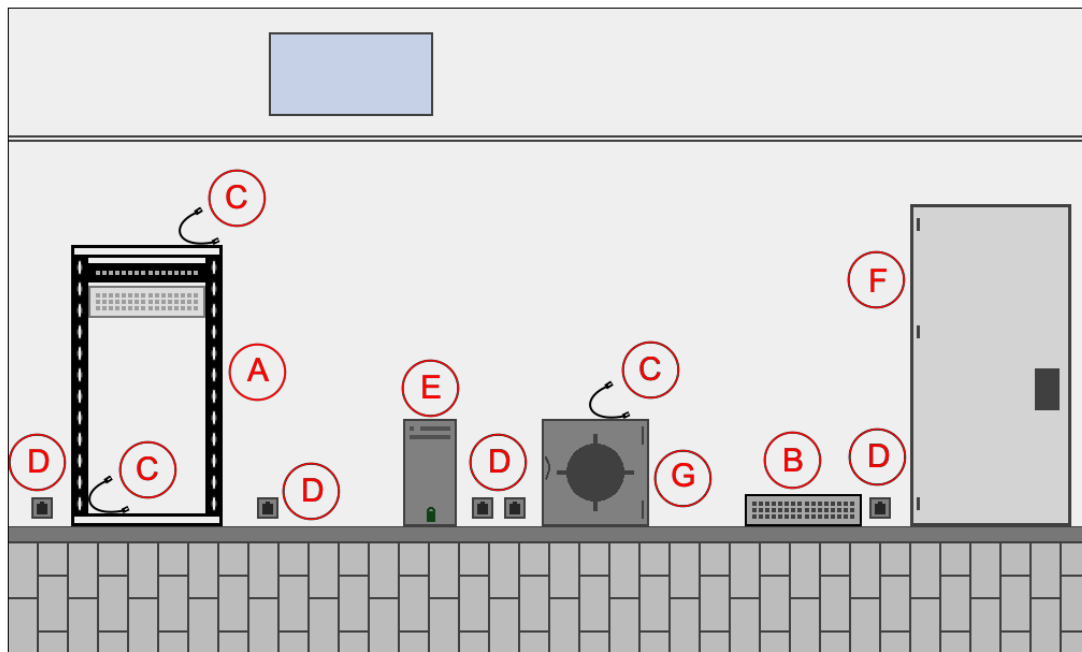- Text-note with security information for switch [inside vault]
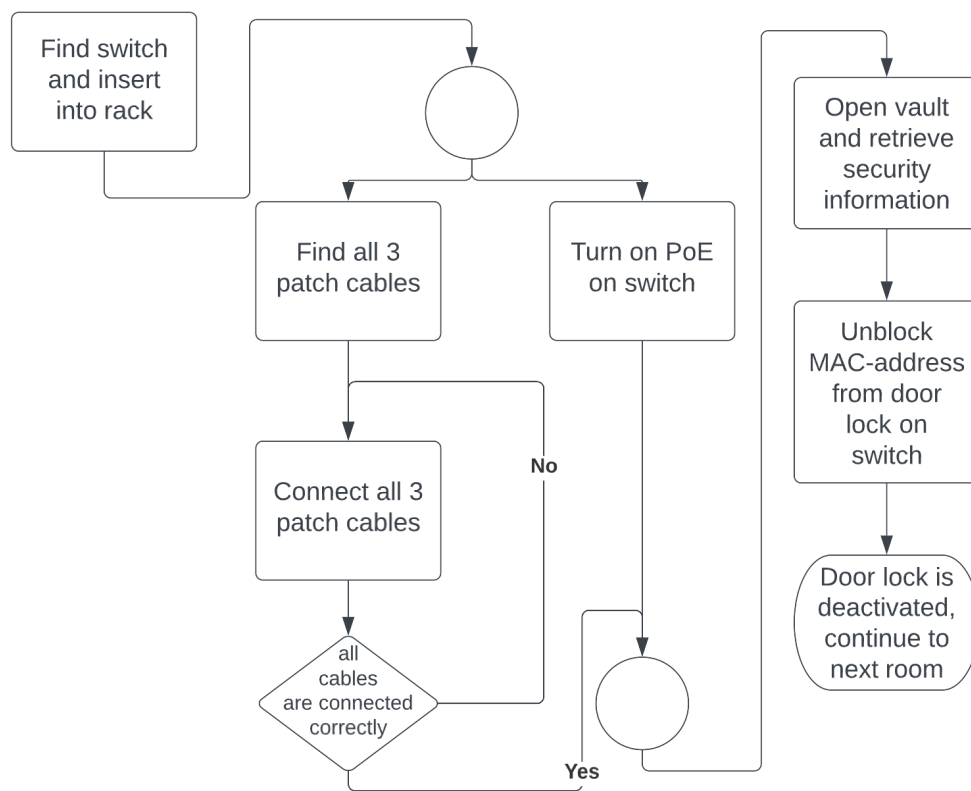
Figure 4.3. Screenshot of room 2

Figure 4.4. Flowchart for room 2

Room 3 - Network Layer

In the third room participants are confronted with routers and IP addresses. They need to configure DHCP and routing between different subnets. The following items can be found in this room:

- Network rack with patch panel (static) [A]

- Router + switch in the rack (static) [B]

- Security device pair [C]

- Cabinet with pin-lock (static) [D]

- Ethernet cable [in cabinet]

- 2 Ethernet patch cables [E]

- 3 RJ45 wall outlets (static, only one needed for door lock) [F]

- Door lock anchor (static) [G]
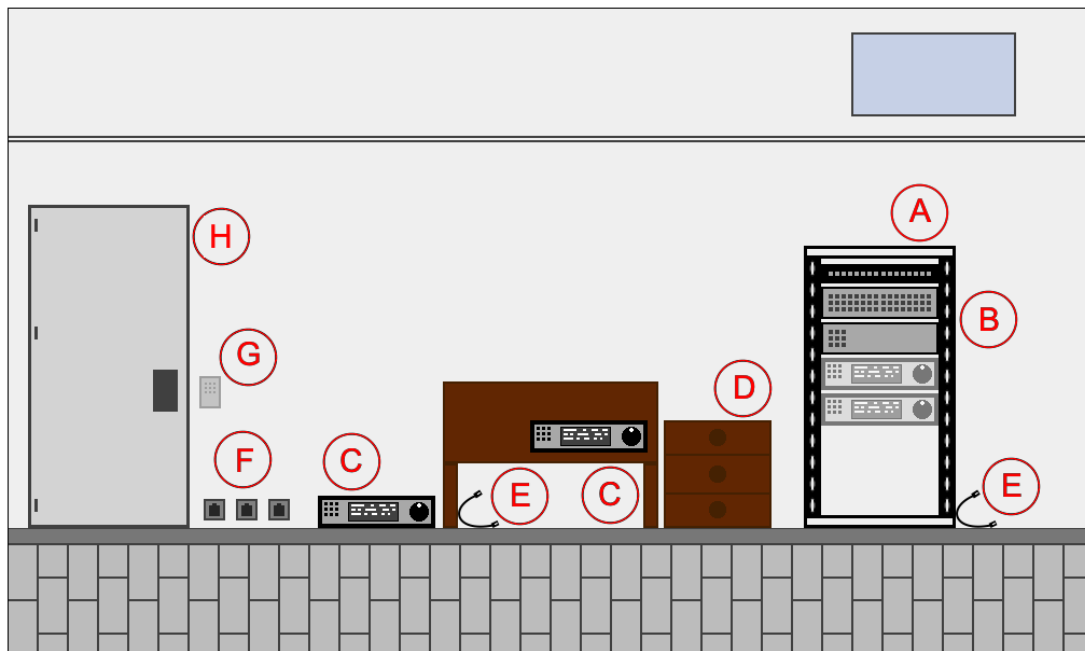
- Door lock [in cabinet]

- Door (static) [H]

Figure 4.5. Screenshot of room 3
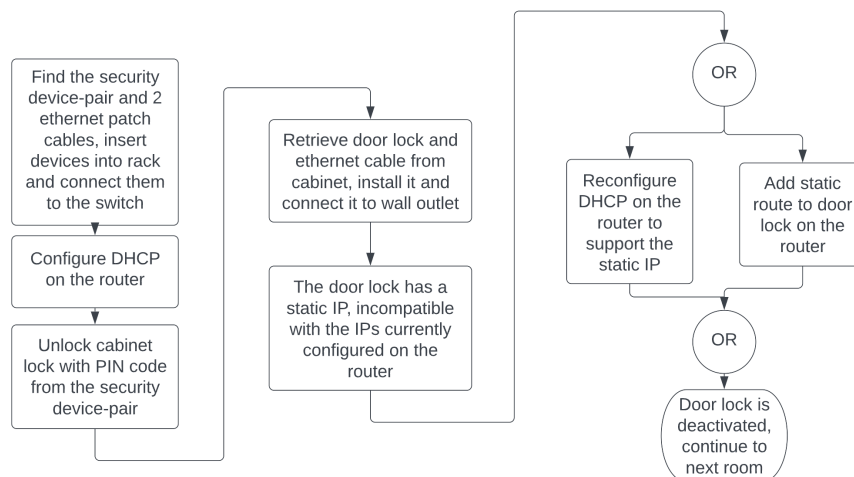
Figure 4.6. Flowchart for room 3

Room 4 - Application Layer

The last room adds applications and traditional computers / servers. Participants need to open ports on the router's firewall in order to access the devices. The following items can be found in this room:

- Network rack (static) [A]

- Router, switch and server in the rack (static) [B]

- Computer (static) [C]

- Text-note with server-credentials [D]

- Door (static) [E]

Figure 4.7. Screenshot of room 4

Figure 4.8. Flowchart for room 4

4.3 Testing strategy
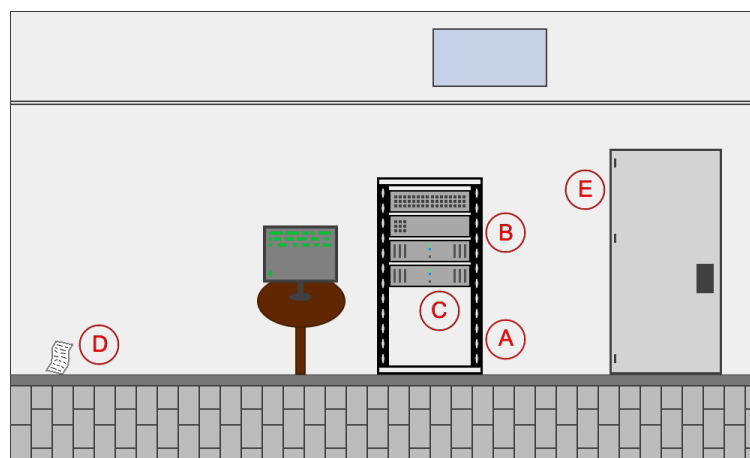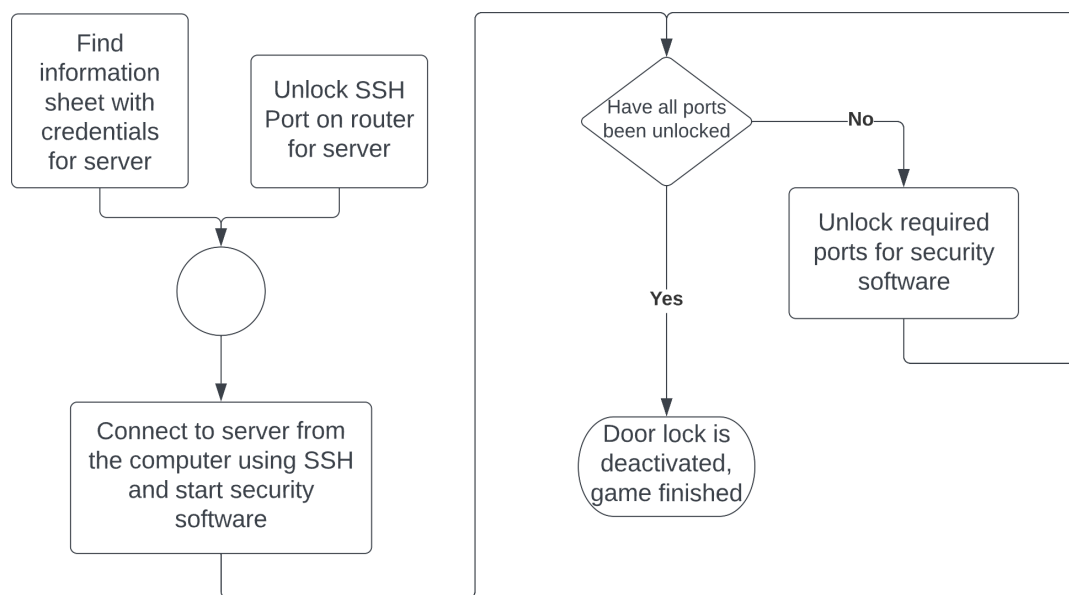
This section describes how the escape game was tested. This mostly consists of two parts: In-game tracking of metrics and a questionnaire. The evaluation of and conclusions drawn from the test are part of the next chapter.

Participants received an instruction sheet containing a brief overview of all the topics covered by the escape game. This mimics the slides provided during the actual course, which students would have access to. The sheet serves as a refresher about the contents of the course, since most participants had the course some time ago and may not remember the contents as well. The sheet can be found in the appendix: Instruction sheet

The test begins with a small briefing about the topic and test. Participants need to fill out the general section of the questionnaire. Then, they have two minutes to read through the instruction sheet. Afterwards, they play through the escape game with a time-limit of ten minutes. Filling out the questionnaire between rooms does not count towards this time-limit. After the play-through, there are five minutes for a debriefing and interview. In total, one test takes about 25 minutes, with a five minute buffer between tests.

The tests were conducted in-person and participants were supervised. Whenever participants got stuck for a longer period of time within the game, they were asked if they wanted a small hint. If they encountered a bug within the game, they were told that they did and how to fix the error. Apart from that, no actions were taken during the test.

4.3.1 In-game metrics

Because the escape game is digital, it is easy to track various metrics during game-play. These can be exported from the game as a JSON-file and analyzed. The collected data from the user tests can be found in the appendix: In-game statistics. The following general metrics were tracked during the entire game:

- Time to complete escape game

- Time to complete each room

- Total number of clicks

- Total number of clicks in each room

These serve as general-purpose statistics for comparing different playthroughs. The time needed and number of clicks between the rooms track how difficult each room is. While these are not concrete indicators that a room and its puzzles may be more difficult, they do provide some insights.

To get a better understanding of the actions taken by participants, most interactable items track their own metrics alongside the above-mentioned ones. The following is a non-exhaustive list of metrics that are being tracked.

Crimping tool

The crimping tool tracks how often a cable has been incorrectly crimped.

Wall outlets

The RJ45 wall outlets track how often a cable has been plugged and unplugged.

Locks

All locks track how many tries it took before the correct code was entered.

Switch and Router

These devices track how often required passwords were entered before the correct one was entered. Furthermore, they track how often their configurations have been changed.

4.3.2 Questionnaire

The second part of the testing strategy is a questionnaire. It is split into two main parts: In the first, participants answer questions on their own. The second part is a short interview with the participants about their experience. The questionnaire can be found in the appendix: User test questionnaire. The following describes the structure in more detail.

General information

The questionnaire starts with collecting general data about the participants. This section has the same structure as the questionnaire from the previous chapter. It includes age, gender and the participant's relationship to the study-program.

Mission briefing

To provide a small background story for the escape game, a mission briefing is presented:

> You have been trapped in the net-labs at the St. Pölten UAS with seemingly no way out. You notice some spare equipment lying around and a door labeled "Exit". As you start to move around the room a 10 minute timer starts counting down. Determined to get out you use your knowledge from the "Introduction to Network Technology" course from the first semester, together with a helpful sheet of paper you found (the instruction sheet) and get going.

Per-room questions

Each room has its dedicated section within the questionnaire. Each section features the following questions:

1. Did you finish the room?

2. On a scale of 1 (not really) to 7 (very), how enjoyable was the room to play?

3. On a scale of 1 (easy) to 7 (hard), how difficult was the room?

4. Please provide some insights into your difficulty rating.

5. Was anything unclear? If yes, what?

6. Did you encounter any errors in the game? If yes, which?

7. Do you have anything else to report on this room?

Debriefing and interview

After the escape game has been played, participants get to provide general feedback. They can rate the overall difficulty of the escape game, their learning experience and provide any remaining feedback they have. In the end, participants take part in an interview, where they can provide spoken feedback about the escape game and test.

5 Analysis and conclusion

This chapter starts with listing the results from the user test. Then, the results are analyzed and conclusions drawn. At the end, comments about possible future studies are made.

Only relevant statistics, which were tracked by the game, will be listed in this chapter. An overview of all statistics can be found in the appendix: In-game statistics

5.1 User test results

In total, eleven people participated in the test. As with the survey from the previous chapter, the majority of participants were between 20 and 25 years old. Eight participants were male, two female and one identified as "gender apathetic".
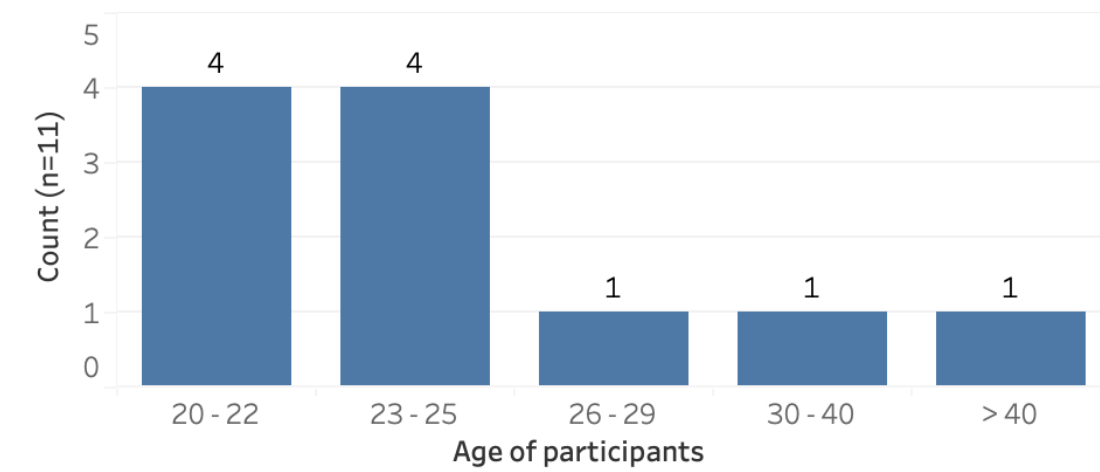

Figure 5.1. Distribution of age, n = 11

The participants were almost evenly split across the different groups. There was at least one participant per group.
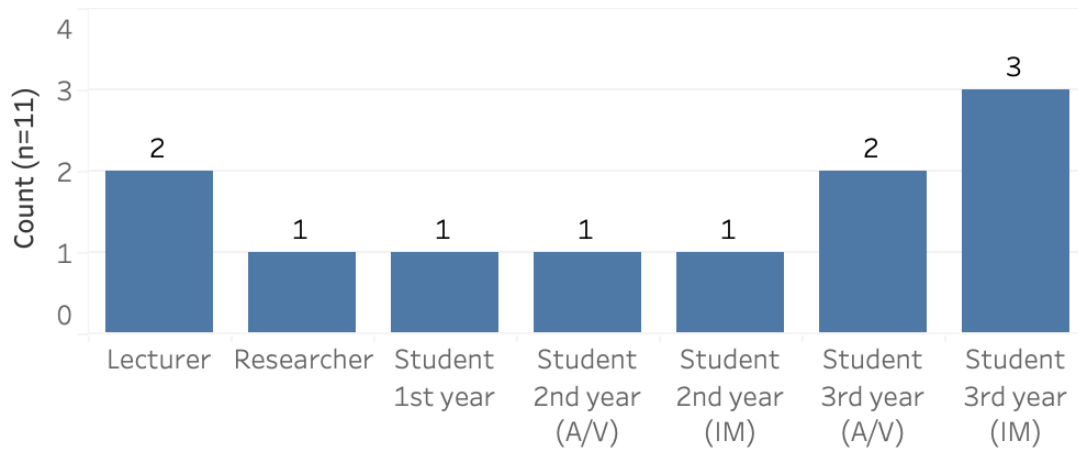

Figure 5.2. Distribution of the participant's position within the study-program, n = 11

One researcher had studied Media Technology at the university and was familiar with the lecture. One lecturer has their expertise in software development. The other one is specialised on *Industry 4.0*. All three managed to get to room 2, with the researcher and one lecturer getting as far as room 3.

5.1.1 Room 1

All participants finished the first room. On a scale of one (not really) to seven (very) the participants rated the room's enjoyability with an average of 5.64, with a minimum of three, a maximum of seven and a standard deviation of 1.07. Regarding the difficulty rating, using the same scale, the room received an average of 3.64, with a minimum of two, a maximum of six and a standard deviation of 1.23.

The fastest room completion took 1:59 minutes, the slowest 7:37. On average the room was completed in 4:19. This means that participants needed, on average, almost half of the total time for the first room. The other statistics that were tracked by the game do not reveal anything significant.

The participant's comments revealed that getting used to the game took a bit of time at first. After the interactions were clear however, almost everyone quickly solved the room. One unclear part was how the crimping tool worked. Some found it confusing that the same pattern had to be entered twice. However, only one person needed two tries to solve the crimping puzzle and another person needed three.

5.1.2 Room 2

The second room was completed by seven of the eleven participants. It received an average enjoyability rating of 5.27, with a minimum of three, a maximum of seven and a standard deviation of 1.05. Its difficulty rating was 5.45 on average, three at minimum and seven at maximum with a standard deviation of 1.23. This suggests that the room was ever so slightly less enjoyable while being a little bit more difficult.

The participants that finished the room took an average of 3:35 minutes to do so. The fastest completion took 1:43, the slowest 5:44.

The participants noted the increased number of interactable objects in the room, which overwhelmed them at first. Some were confused by the introduction of new devices and how they work. Two participants encountered a bug where the same network device could be connected twice, which should not be possible. However, this was not game-breaking.

5.1.3 Room 3

The third room was completed by one of the seven participants that made it to this room. It received an average enjoyability rating of 5.2, with a minimum of three, a maximum of six and a standard deviation of 1.17. Its difficulty rating was 6.33 on average, five at minimum and seven at maximum with a standard deviation of 0.75. The room was almost unanimously perceived as being more difficult, with the enjoyability dropping slightly further down. The one participant that finished the room took 5:12 minutes to do so.

The comments showed that the introduction of new devices was again a bit challenging. The tasks revolving around routing were the most challenging ones of the room. One participant commented that the section on the instruction sheet regarding IP addresses could have been more detailed. Two participants almost completed the room, needing only one or two more steps before finishing it. They failed due to a lack of time.

5.1.4 Room 4

No one completed this room. Since only one participant got to this room and had 1:06 left to explore it, there is not enough data to evaluate it. The one participant that had a look through it stated that the computers, which were introduced in this room, added even more complexity but that they would have probably managed to solve it with more time.

Two other participants explored the room after the official test was over and reported that it would have been interesting to play. One said that they would have been more comfortable with the tasks because they have more experience with software than with hardware.

5.1.5 Overall rating and feedback

The escape game in total received an average difficulty rating of five, with a minimum of 3, a maximum of seven and a standard deviation of 1.35. Taking the average of the average difficulty rating for each room equates to 5.14. Therefore, the overall difficulty rating is almost the same as all the rooms combined. The following table provides an overview of all difficulty ratings.

	Min	Average	Max	SD
Room 1	2	3.64	6	1.23
Room 2	3	5.45	7	1.23
Room 3	5	6.33	7	0.75
Room 4		Not enough data		
Average	3.33	5.14	6.67	1.07
Entire game	3	5	7	1.35

Table 5.1. Difficulty ratings

The participants were asked to rank their learning experience from one (bad) to seven (good). The results show an average rating of 3.64, with a minimum of two, a maximum of six and a standard deviation of 1.23. The participant's comments about these ratings reveal that most did not learn anything new. However, the majority stated that the escape game helped them with practicing their skills. A more detailed analysis follows in the next section.

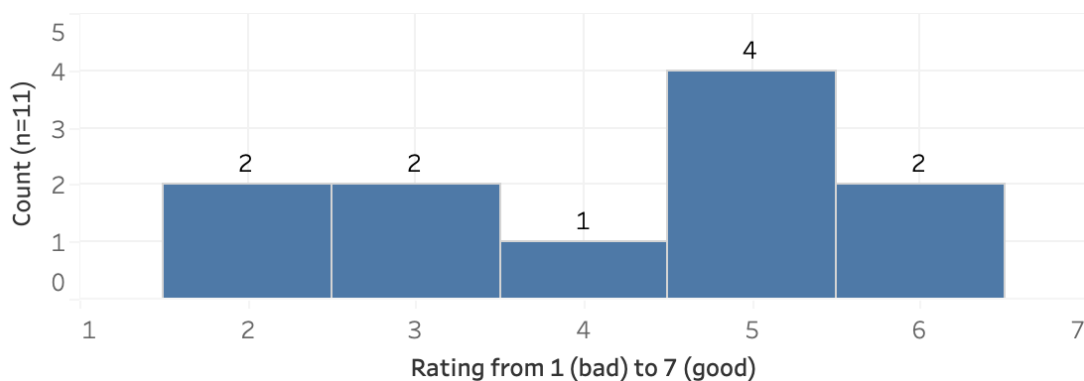*Figure 5.3.* Distribution of the participant's rating of their learning experience, n = 11

The participants had the opportunity to share any remaining feedback they had. Most stated that the concept itself was very intriguing and better for learning the topic than regular classes. One participant noted that the escape game is nice for learning the topic in a stress-free environment, but would not be suitable as an exam tool.

5.1.6 Interview

After finishing the escape game and filling out the questionnaire, the participants got interviewed briefly about their experience. The most important comments will be analyzed in the next section. All participants were asked about the potential of a physical version of the escape game. Almost everyone stated that a physical version of the escape game could provide more hands-on training with actual components. However, this could be more overwhelming as well. The digital version has multiple benefits, such as being able to be played from any location, at any time. One participant noted that it could be used as a training exercise, where students try to finish the game and afterwards there is a discussion with a lecturer where solutions are presented. Furthermore, the digital game has the benefit of being more simplistic, offering the opportunity to alleviate some physical challenges and focus more on the puzzles.

5.2 Test analysis

Overall the escape game was very well received. However, there was one fundamental issue that the user tests revealed: usability. At first, most participants struggled with the controls of the game. Often times there was insufficient feedback from the game as to what the current game state is. For example: It was hard to tell which devices were already connected. The state handling of the devices was also too abstract, which led to more confusion about what needs to be done. As an example, in the second room "Power over Ethernet" needed to be activated on the switch in order to activate the vault. The vault also needed a connection to the wall outlet, which needed to be connected to the switch on the patch panel. Regardless of which of these things was missing, the vault only told the player that it did not have a network connection.

The overall experience and learning effect could have been dramatically improved by implementing more detailed as well as visual instead of text-based feedback. Furthermore, a small introduction level, which taught the user the basic interactions, could have helped. In general, the participants could have focused more on the game and its contents and have more time available if the game controls and feedback would have been clearer and easier to understand.

The participant's feedback suggests, that the game would be suitable as an additional learning tool for students. After learning about some components in a theoretical lecture they could be tasked with playing the game until the next lesson. One participant noted that being able to play the game between classes, which can sometimes be a few weeks apart, would have helped them to keep engaged to the topic and not forget what they learned as easily.

5.3 Conclusion and future work

In conclusion, the research question "In what way do escape rooms provide a benefit for one of these subjects / topics?" can be answered as follows. The escape game provided the element of gamification, which is more engaging for students. It has the benefit that it can be played at any time, from any location. It provides students the opportunity to play around with the subjects and components of the lecture, without the need to own and setup actual components at home and without the need to be on-campus. Furthermore, the game provides enough abstraction from physical components, which allows students to focus on the essentials.

It can be concluded, that the lecture *Introduction to Network Technology* can benefit from a digital escape game, because it provides students with more opportunities to deal with the contents of the subject. It can be used as a tool for students to strengthen their already existing skills and knowledge. However, the user tests and feedback suggest that it is not a good tool for learning new things.

The tests showed the importance of good usability. If the underlying game mechanics and interactions are not clear and intuitive then the learning experience is diminished. In the worst case this could lead to increasing student's frustration instead of providing a fun way to engage with the topic. Therefore, rigorous testing of the game, by multiple people with different backgrounds, is very important.

For a future study, the escape game could be tested as a real-life escape room. As the participant's feedback suggests, a physical version could provide the benefit of gaining hands-on experience with the actual components themselves. Furthermore, it would be interesting to test the digital game without a time-limit. This would remove the stress-component from the game and could provide players with more opportunities for trial-and-error as well as testing out different setups and configurations. The game could also be expanded with a sophisticated hint and information system. This could provide students with feedback and explanations, further improving the learning experience.

Overall, this thesis showed that escape rooms can be used in education. The Media Technology study-program at the St. Pölten UAS has many lectures which could be suitable for the use of escape rooms. Because of the nuances of each lecture and topic, the contents of the escape rooms have to be developed from scratch. However, the basic interaction system, showcased in the digital escape game used in this thesis, could serve as a basis for other escape games in different lectures.

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List of Figures

List of Tables
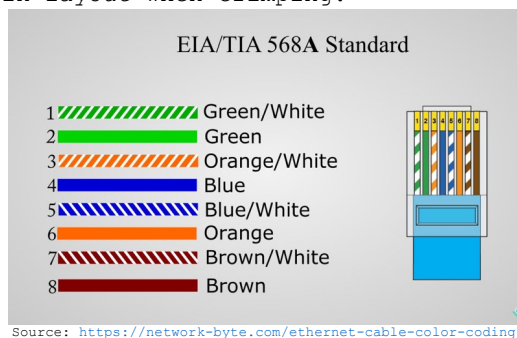
Appendices

A Instruction sheet

This sheet is part of the
escape game "Escape the net-labs".

Instruction sheet

This sheet contains useful information helping you escape from
the net-labs. Handle with care and do not share with
unauthorized personnel.

Crimping instructions
Should you find yourself in the need of an Ethernet cable, but
only have the raw materials, you can build one yourself. Use
the correct pin-layout when crimping.

EIA/TIA 568**A** Standard

1	Green/White
2	Green
3	Orange/White
4	Blue
5	Blue/White
6	Orange
7	Brown/White
8	Brown

Source: https://network-byte.com/ethernet-cable-color-coding/

Security dodging
For a successful escape from the labs, you need to bust
through some security measures. Should a device not get a
network connection ensure that all ports have been opened and
the device's MAC-address is not blocked.

IP crash-course
Dealing with IP-addresses can be daunting. Configure DHCP with
subnets that have enough addresses available for all devices.
When in doubt, resort to classful subnets:

Class	NetID	Subnet Mask	Number of blocks	Number of IP-addresses per block
A	10.x.x.x	255.0.0.0	128	16m
B	128.0.x.x	255.255.0.0	16k	65k
C	192.168.0.x	255.255.255.0	2m	256

When configuring static routes make sure to specify via which
device the other network needs to be routed. If a router
connects multiple networks, use 127.0.0.1 (the router itself).

Important commands
When working on machines, type "help" to get a list of
commands. The most important ones are "ls" for listing files,
"cat" for showing the contents of a file and "ssh user@ip" for
connecting to another machine. To start a program type
"./program_name".

General info
Always follow the common troubleshooting steps and remember
your training. Good luck!

B In-game statistics

The following tables show all statistics that were tracked in-game. They are provided as-is, without any further comments or analysis. One implementation note: All statistics use zero-based indices for the room number, except for the time-left statistics. This is due to an order-of-operations error, where the room number was increased before recording the statistic. Time statistics are in seconds.

General

Statistic	Count	Min	Avg	Max
totalClickCount	11	119	238.55	307

Table B.1. General statistics

Room 1

Statistic	Count	Min	Avg	Max
room0ClickCount	11	60	85.55	141
wallOutletWall Outlet 1Room0Connected	11	2	2.55	5
wallOutletWall Outlet 1Room0Disconnected	11	1	1.55	4
failedCrimpAttemptsRoom0	2	1	1.5	2
cabinetCabinetCodeEnteredWrongCountRoom0	1	1	1	1
timeLeftAfterRoom1	11	143	340.55	481

Table B.2. Room 1 statistics

Room 2

Statistic	Count	Min	Avg	Max
room1ClickCount	11	34	106.27	171
patchesInPanelPatch PanelRoom1	11	1	4.82	12
unpatchesInPanelPatch PanelRoom1	7	1	3.43	9
switchRoom1WrongSecurityPassword	5	1	2.6	6
wallOutletWall Outlet 1Room1Disconnected	2	1	1	1
wallOutletWall Outlet 1Room1Connected	2	1	1	1
wallOutletWall Outlet 2Room1Disconnected	5	1	2	5
wallOutletWall Outlet 2Room1Connected	4	1	2	4
wallOutletWall Outlet 3Room1Disconnected	4	1	1.25	2
wallOutletWall Outlet 3Room1Connected	4	1	1.25	2
timeLeftAfterRoom2	7	29	158.86	378

Table B.3. Room 2 statistics

Room 3

Statistic	Count	Min	Avg	Max
room2ClickCount	7	23	68.43	159
patchesInPanelPatch PanelRoom2	5	2	2.4	4
unpatchesInPanelPatch PanelRoom2	1	2	2	2
routerRoom2AddedNewRoutes	2	1	1	1
routerRoom2FailedNewRoutes	1	4	4	4
wallOutletWall Outlet 1Room2Connected	2	1	1	1
wallOutletWall Outlet 1Room2Disconnected	1	1	1	1
wallOutletWall Outlet 2Room2Connected	1	1	1	1
wallOutletWall Outlet 2Room2Disconnected	1	1	1	1
wallOutletWall Outlet 3Room2Connected	1	1	1	1
timeLeftAfterRoom3	1	66	66	66

Table B.4. Room 3 statistics

Room 4

Statistic	Count	Min	Avg	Max
room3ClickCount	1	35	35	35

Table B.5. Room 4 statistics

C Lecture selection questionnaire

See included PDF from questionnaire on the next page.

Educational escape rooms and their potential use in the BMT study-program

Questionnaire about "What subjects/topics from the Mediatechnology study-program are suitable for the use of escape rooms as a teaching/learning method?".

Bachelor thesis by Lukas Heinzl (mt201010)

* Gibt eine erforderliche Frage an

Introduction

Welcome to this questionnaire!
It is part of the bachelor thesis of Lukas Heinzl, focussing on the use of escape games in education, or more specifically, within the St. Pölten UAS study-program "Media Technology".

The first part of this thesis involves selecting a lecture from the program (this questionnaire). In the second part, an escape game focussing on the selected lecture will be built (either digitally or physically) and tested.

You will get to vote on lectures from the study program and argue why they would be a good fit for the use of escape games.
The lecture with the most positive votes and best reasons will be picked for further examination.

Filling out this questionnaire will take approximately **10 minutes**.
Please take your time with reading and answering the questions.
Thank you for your participation!

- Lukas

General information

General information about yourself and your experience with escape games.

1. Age *

   Markieren Sie nur ein Oval.

   ○ < 20

   ○ 20 - 22

   ○ 23 - 25

   ○ 26 - 29

   ○ 30 - 40

   ○ > 40

2. Gender *

   Markieren Sie nur ein Oval.

   ○ Male

   ○ Female

   ○ Non-Binary

   ○ Prefer not to say

   ○ Sonstiges: _____

3. Your position within the study-program. If multiple positions apply, please choose *
   the one you spend the majority of your time in.

   Markieren Sie nur ein Oval.

   ○ Student 1st year

   ○ Student 2nd year (A/V)

   ○ Student 2nd year (IM)

   ○ Student 3rd year (A/V)

   ○ Student 3rd year (IM)

   ○ Lecturer

   ○ Researcher

4. How many escape games have you played so far? *

   Markieren Sie nur ein Oval.

   - ⚪ 0
   - ⚪ 1
   - ⚪ 2
   - ⚪ 3 - 5
   - ⚪ 6 - 10
   - ⚪ > 10

5. What type of escape games have you played?

   Wählen Sie alle zutreffenden Antworten aus.

   - ☐ Real life escape room
   - ☐ Board / card game
   - ☐ Digital escape game
   - ☐ Virtual reality escape game (at home)
   - ☐ Virtual reality escape game (at a dedicated facility)
   - ☐ Sonstiges: _____

6. Have you **played** an escape room within a class / lecture in order to learn about a topic? *

   Markieren Sie nur ein Oval.

   - ⚪ Yes
   - ⚪ No

7. **If yes**, what was your experience like? Did it help with the learning process?

   _____

   _____

   _____

   _____

8. **If no**, would you like to play an escape room to learn about a topic in class?

Markieren Sie nur ein Oval.

○ Yes

○ No

9. Have you **created** an escape room within a class / lecture in order to learn about * a topic?

Markieren Sie nur ein Oval.

○ Yes

○ No

10. **If yes**, what was your experience like? Did it help with the learning process?

_____

_____

_____

_____

_____

11. **If no**, would you like to create an escape room to learn about a topic in class?

Markieren Sie nur ein Oval.

○ Yes

○ No

Topic selection

Select and argue which lectures from the study-program would be suitable for escape games.

Escape games can be used in two ways in an educational context:

- **Playing** an escape game
- **Creating** an escape game

By playing an escape game, students can learn about a topic in a different way than usual teaching methods.
Creating an escape game can be used to teach students about the design/technical aspects of escape games.

Not all lectures from the study-program are listed below. If you think that an unlisted lecture would be suitable you are able to specify it further down below.

12. Which lectures would you find suitable for an escape game in the first semester?

Wählen Sie alle zutreffenden Antworten aus.

	Play	Create
Introduction to Network Technology	☐	☐
Introduction to Programming 1	☐	☐
Mathematical and physical Foundations	☐	☐
Mediahistory and -ethics	☐	☐
Teamwork and Communication	☐	☐

13. Which lectures would you find suitable for an escape game in the second semester?

Wählen Sie alle zutreffenden Antworten aus.

	Play	Create
Operatingsystems	☐	☐
Introduction to Programming 2	☐	☐
Introduction to Web Technologies	☐	☐
Foundations of Usability	☐	☐
Mathematical and electrotechnical Foundations	☐	☐
Personal Goals and Communication	☐	☐

14. Which lectures would you find suitable for an escape game in the third semester?

Wählen Sie alle zutreffenden Antworten aus.

	Play	Create
Project work	☐	☐
Information design (IM)	☐	☐
Psychological and sociological Foundations (IM)	☐	☐

15. Which lectures would you find suitable for an escape game in the fourth semester?

Wählen Sie alle zutreffenden Antworten aus.

	Play	Create
Contextual Design and Accessibility (IM)	☐	☐
Physical Computing (IM)	☐	☐
Tangible User Interfaces (IM)	☐	☐
AV-Installations (AV)	☐	☐
Interactive Audio-/Videosystems (AV)	☐	☐

16. Which lectures would you find suitable for an escape game in the fifth/sixth semester?

Wählen Sie alle zutreffenden Antworten aus.

	Play	Create
Project coaching	☐	☐

17. Please specify any lectures that you would find suitable for an escape game that were not listed above

_____

_____

_____

_____

18. Please provide more detail about your above selection *

_____

_____

_____

_____

_____

Final thoughts

Your final thoughts and feedback.

19. Do you have any general feedback / insights to share about this topic?

_____

_____

_____

_____

_____

20. If you would like to participate in the second part of this thesis (playing the built escape game), please enter any contact information (your full name, FH-Mail, tel-number, etc.) below. Thank you!

_____

Thank you for your participation, you have helped me a lot!

Have a nice day.
- Lukas

D User test questionnaire

The online-survey used for the user tests can be found on the next page. Furthermore, all participants were asked the following questions at the end of the test:

- What was your thought-process during the last room?

- Did the game provide enough feedback?

- Do you think there would be a benefit to playing this escape game in real-life?

Educational escape rooms and their potential use in the BMT study-program

Questionnaire supporting the test of the escape game about "Introduction to Network Technology".

Bachelor thesis by Lukas Heinzl (mt201010)

Gibt eine erforderliche Frage an

Introduction

Welcome to this questionnaire!
It is part of the bachelor thesis of Lukas Heinzl, focussing on the use of escape games in education, or more specifically, within the St. Pölten UAS study-program "Media Technology".

You are taking part in a user test, playing a digital escape game and answering questions about it.

The entire test will take approximately **25 minutes**.
Please take your time with reading and answering the questions.
Thank you for your participation!

- Lukas

General information

General information about yourself. Please fill this out before starting the game.

1. Age *

   Markieren Sie nur ein Oval.

   - ( ) < 20
   - ( ) 20 - 22
   - ( ) 23 - 25
   - ( ) 26 - 29
   - ( ) 30 - 40
   - ( ) > 40

2. Gender *

Markieren Sie nur ein Oval.

◯ Male

◯ Female

◯ Non-Binary

◯ Prefer not to say

◯ Sonstiges: _____

3. Your position within the study-program. If multiple positions apply, please choose * the one you spend the majority of your time in.

Markieren Sie nur ein Oval.

◯ Student 1st year

◯ Student 2nd year (A/V)

◯ Student 2nd year (IM)

◯ Student 3rd year (A/V)

◯ Student 3rd year (IM)

◯ Lecturer

◯ Researcher

Mission briefing

You have been trapped in the net-labs at the St. Pölten UAS with seemingly no way out. You notice some spare equipment lying around and a door labeled "Exit". As you start to move around the room a 10 minute timer starts counting down. Determined to get out you use your knowledge from the "Introduction to Network Technology" course from the first semester, together with a helpful sheet of paper you found (the instruction sheet) and get going.

Good luck!

Questions about room 1

Please fill out this section **after** completing the room.

4. Did you finish the room? *

    Markieren Sie nur ein Oval.

    ( ) Yes

    ( ) No

5. How enjoyable was the room to play?

    Markieren Sie nur ein Oval.

    Not really

    1 ( )

    2 ( )

    3 ( )

    4 ( )

    5 ( )

    6 ( )

    7 ( )

    Very

6. How difficult was the room?

Markieren Sie nur ein Oval.

Easy

1 ⬭

2 ⬭

3 ⬭

4 ⬭

5 ⬭

6 ⬭

7 ⬭

Hard

7. Please provide some insights into your difficulty rating

_____

_____

_____

_____

_____

8. Was anything unclear? If yes, what?

_____

_____

_____

_____

_____

9. Did you encounter any errors in the game? If yes, which?

_____

_____

_____

_____

_____

10. Do you have anything else to report on this room?

_____

_____

_____

_____

_____

Questions about room 2

Please fill out this section **after** completing the room.

11. Did you finish the room? *

Markieren Sie nur ein Oval.

◯ Yes

◯ No

12. How enjoyable was the room to play?

Markieren Sie nur ein Oval.

Not really

1 ⬭

2 ⬭

3 ⬭

4 ⬭

5 ⬭

6 ⬭

7 ⬭

Very

13. How difficult was the room?

Easy

1 ⬭

2 ⬭

3 ⬭

4 ⬭

5 ⬭

6 ⬭

7 ⬭

Hard

14. Please provide some insights into your difficulty rating

_____

_____

_____

_____

_____

15. Was anything unclear? If yes, what?

_____

_____

_____

_____

_____

16. Did you encounter any errors in the game? If yes, which?

_____

_____

_____

_____

_____

17. Do you have anything else to report on this room?

_____

_____

_____

_____

_____

Questions about room 3

Please fill out this section **after** completing the room.

18. Did you finish the room? *

Markieren Sie nur ein Oval.

◯ Yes

◯ No

19. How enjoyable was the room to play?

Markieren Sie nur ein Oval.

Not really

1 ⬭

2 ⬭

3 ⬭

4 ⬭

5 ⬭

6 ⬭

7 ⬭

Very

20. How difficult was the room?

Easy

1 ⬭

2 ⬭

3 ⬭

4 ⬭

5 ⬭

6 ⬭

7 ⬭

Hard

21. Please provide some insights into your difficulty rating

_____

_____

_____

_____

_____

22. Was anything unclear? If yes, what?

_____

_____

_____

_____

_____

23. Did you encounter any errors in the game? If yes, which?

_____

_____

_____

_____

_____

24. Do you have anything else to report on this room?

_____

_____

_____

_____

Questions about room 4

Please fill out this section **after** completing the room.

25. Did you finish the room? *

Markieren Sie nur ein Oval.

◯ Yes

◯ No

26. How enjoyable was the room to play?

Markieren Sie nur ein Oval.

Not really

1 ⬭

2 ⬭

3 ⬭

4 ⬭

5 ⬭

6 ⬭

7 ⬭

Very

27. How difficult was the room?

Markieren Sie nur ein Oval.

Easy

1 ⬭

2 ⬭

3 ⬭

4 ⬭

5 ⬭

6 ⬭

7 ⬭

Hard

28. Please provide some insights into your difficulty rating

_____

_____

_____

_____

_____

29. Was anything unclear? If yes, what?

_____

_____

_____

_____

_____

30. Did you encounter any errors in the game? If yes, which?

_____

_____

_____

_____

_____

31. Do you have anything else to report on this room?

_____

_____

_____

_____

_____

Overall rating and experience

Please provide any feedback you have about the **entire** escape game.

32. How difficult was the escape game overall? *

Markieren Sie nur ein Oval.

Easy

1 ⬭

2 ⬭

3 ⬭

4 ⬭

5 ⬭

6 ⬭

7 ⬭

Hard

33. How would you rate your learning experience? *

Bad, have not learned a lot

1 ◯

2 ◯

3 ◯

4 ◯

5 ◯

6 ◯

7 ◯

Good, have learned a lot

34. Please provide some insights about your rating *

_____

_____

_____

_____

_____

Final thoughts and feedback

Please provide any remaining thoughts and feedback you have regarding the test and escape game.

35.   Is there anything else you want to share?

_____

_____

_____

_____

_____

Thank you!
You will now have the opportunity to share more feedback in person during a short interview.

Thank you for your time and for participating!

- Lukas

Google Formulare