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Prototypical development and evaluation of an internet-based learning and tutoring platform for emergency medical services

Master Thesis

For attainment of the academic degree of
Master of Science in Engineering (MSc)

in the Master Programme Digital Healthcare
at St. Pölten University of Applied Sciences

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Hainfeld, 13.09.2023

Declaration

I declare that I have developed and written the enclosed Master Thesis completely by myself, and have not used sources or means without declaration in the text. Any thoughts from others or literal quotations are clearly marked. This work was not used in the same or in a similar version to achieve an academic grading or is being published elsewhere.

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Place, Date   Signature

Preface

As a paramedic, I understand the critical role that continuous education and training play in ensuring that the highest quality of care is provided to the patients. In today's rapidly evolving healthcare landscape, it is essential to stay up to date with the latest advancements and techniques in emergency medical services (EMS) to enhance our skills, knowledge, and effectiveness in the field.

However, the traditional methods of training and education can be time-consuming, expensive, and not always accessible to all EMS professionals, particularly those in remote or rural areas. In this context, an internet-based learning and tutoring platform can provide a convenient, flexible, and cost-effective way to access high-quality training and education resources.

I am highly motivated to use an internet-based learning and tutoring platform to enhance my skills and knowledge as a paramedic. I am eager to learn from experienced instructors, engage with my peers in collaborative learning opportunities, and receive personalized feedback and assessments to continuously improve my performance in the field.

Moreover, I believe that an internet-based learning and tutoring platform can be an excellent way to overcome the geographic and time constraints that often limit our access to training and education resources. As a paramedic working in a rural area, I understand first-hand the challenges of accessing quality training and education, and I am excited about the potential of an internet-based platform to address these challenges.

This preface is a testimonial to the importance of continuous education and training for EMS professionals and highlights the potential of an internet-based learning and tutoring platform to enhance our skills, knowledge, and effectiveness in providing emergency medical services. I hope that my motivation and experience can inspire other EMS professionals to embrace new approaches to learning and training and contribute to the ongoing efforts to improve the quality of care in our field.

Abstract

Emergency Medical Services (EMS) is a crucial component of any healthcare system, providing timely and effective pre-hospital care to critically ill or injured patients. The quality of EMS education and training is critical to the delivery of high-quality patient care. With the widespread availability and use of the Internet, there is a growing interest in the use of Internet-based learning and tutoring platforms for EMS education and training.

The objectives of the master thesis are answered utilising three research questions. The first research question deals with finding out which strengths and weaknesses the online learning platforms for emergency services have and how systems can be improved. Furthermore, one goal is to show which functional, content-related, and technical requirements the learning platform must fulfil before developing the prototype. Finally, the prototype will be evaluated utilising a standardized test to assess usability.

To answer the research questions, expert interviews as well as usability tests with experienced rescue service personnel will be conducted and the prototype of the learning platform will be built based on a WordPress website.

Results:

- Online learning platforms can be a valuable tool for EMS training and education. Some challenges need to be addressed, such as ensuring the quality of the content, providing opportunities for learner interaction, and ensuring that the platforms are accessible to all learners.
- The results of the UEQ usability test indicate that the prototype outperforms the current Red Cross platform. On average, the prototype scored a mean of 1,2 and the kurse.roteskreuz.at platform a mean of 0,66 across all the categories. Delta value average is 0,54 which translates to an average percentual difference of 88%.
- Multiple functional and technical requirements (Usability, user Interaction, user role management, assessment and feedback, easy backend interface) must be met to develop a prototypical online learning platform for EMS.

Keywords: emergency medical services, emergency medical services training, paramedic training, primary care, WordPress

Kurzfassung

Der Rettungsdienst ist ein entscheidender Bestandteil jedes Gesundheitssystems, da er kritisch kranken oder verletzten Patienten eine schnelle und wirksame präklinische Versorgung bietet. Die Qualität der Aus- und Weiterbildung des Rettungsdienstpersonals ist entscheidend für eine qualitativ hochwertige Patient*Innenversorgung. Mit der weit verbreiteten Verfügbarkeit und Nutzung des Internets wächst das Interesse an der Nutzung von internetbasierten Lernplattformen für die Aus- und Weiterbildung.

Die Ziele der Masterarbeit werden mittels drei Forschungsfragen beantwortet. Die erste Forschungsfrage befasst sich damit, herauszufinden, welche Stärken und Schwächen die Online-Lernplattformen für den Rettungsdienst aufweisen und wie Systeme verbessert werden können. Des Weiteren ist ein Ziel, vor Entwicklung des Prototyps aufzuzeigen, welche funktionellen, inhaltlichen als auch technischen Anforderungen die Lernplattform erfüllen muss. Zuletzt wird der Prototyp mittels eines standardisierten Tests evaluiert, um die Usability zu bewerten.

Um die Forschungsfragen zu beantworten, werden Expert*Inneninterviews sowie Usability-Tests mit erfahrenem Rettungsdienstpersonal durchgeführt sowie der Prototyp der Lernplattform auf Basis einer WordPress-Website aufgebaut.

Ergebnisse:

- Online-Lernplattformen können ein wertvolles Instrument für die Aus- und Fortbildung im Rettungsdienst sein. Herausforderungen: Sicherung der Qualität der Inhalte, Interaktionen zwischen Teilnehmern, Einfacher Zugang für alle Lernenden
- Die Ergebnisse des UEQ-Tests des Prototyps zeigen besser Ergebnisse gegenüber der Plattform des Roten Kreuzes. Ø Prototyp: 1,2; Ø kurse.roteskreuz.at: 0,66. Ø Delta: 0,54, Ø prozentualen Differenz: 88%
- Mehrere funktionale und technische Anforderungen müssen erfüllt werden, um eine prototypische Online-Lernplattform für EMS zu entwickeln. Diese umfassen Benutzerfreundlichkeit, Benutzerinteraktion, Benutzerrollenmanagement, Bewertung und Feedback sowie eine einfache Backend-Schnittstelle.

Schlüsselwörter: Rettungsdienst, Ausbildung im Rettungsdienst, Ausbildung, Sanitäter, Primärversorgung, WordPress

Table of Content

1 Introduction

The goal of this thesis is to highlight the benefits of online-learning in the sector of emergency medical services by developing and evaluating a cross-organizational prototype of a learning-platform that helps trainees and tutors to enhance and improve the learning outcome as well as the overall learning experience. The main issue is the current state of online-learning tools in this sector.

1.1 Motivation and Explanation of the Problem

The current state of learning platforms in the field of emergency services in Austria lacks important features. As of now, it is challenging for tutors to set up a modern, interesting, and valuable online-learning-experience for trainees in the aforementioned field. In Austria, there is no cross-organisational online learning platform for the ambulance service. Each organisation uses its own learning platform to provide content for its trainees. Currently, there are many challenges in terms of usability as well as design. A cross-organisational platform could enable both tutors and trainees to learn, share and become better paramedics more efficiently.

1.2 Research Questions

Research question #1: What are the strengths and weaknesses of the currently available online education and learning systems (for emergency medical services) and how can they be improved?

Research question #2: How do the respondents of the questionnaire and usability test assess (prototypical) learning and tutoring platforms for emergency medical services, and do they recognise their added value?

Research question #3: What are the functional and technical requirements towards building a prototypical internet-based learning and tutoring platform for emergency medical services?

1.3 Method / Research Strategy

This thesis outlines the prototypical development of an internet-based learning and tutoring platform. Related work and background-literature will be provided using a literature review. Engaging in a comprehensive literature review is an indispensable step in the development of a prototype for a learning platform, for several reasons. Firstly, it facilitates information acquisition and idea generation by providing insights into current developments, best practices, and innovative approaches within the realm of learning platforms. This enables the accumulation of ideas that can enrich and enhance the prototype development. Secondly, it prevents redundancy by identifying existing types of learning platforms and their functionalities, ensuring that the prototype offers unique and valuable features.

The technical part will be implemented using various web-development tools such as WordPress, CSS, JS, HTML, and PHP. The website will be hosted on a dedicated webserver. To enhance the user experience and evaluate the prototype in a meaningful way, a logo as well as a sample learning video will be created and added to the course-platform. An upcoming section will provide a more in-depth exploration of the technical specifications. This will involve a detailed examination of the specific technical requirements, components, and architecture that will underpin the development and functionality of the prototype learning platform.

The requirements of the system will be evaluated through expert interviews conducted via an online survey, which was created using Google Forms. Google Forms is free to use and allows efficient distribution of the survey via a link, as well as easy data collection and data evaluation. Emergency Medical Technicians, paramedics, paramedic / EMT instructors, and practical tutors will then evaluate and test the system in a standardized usability test (UEQ – User Experience Questionnaire). The evaluation details are presented in the following Table 1.

Table 1: Evaluation details

Evaluation type	Number of participants	Expert skills / roles	Mode	Estimated time per evaluation
Expert Interview	16	Experienced Paramedic / EMT, Paramedic / EMT instructor, practical tutor	Online via Google Forms Survey	15 minutes
Usability Test UEQ (User Experience Questionnaire)	7	Paramedic / EMT. Paramedic / EMT instructor, practical tutor	Online via Google Forms Survey	15 minutes

1.4 Terminology

CMS: A CMS, or Content Management System, is a software application that allows users to create, manage, and publish digital content, such as web pages, blog posts, and multimedia files. It typically includes tools for content creation, editing, and organization, as well as features for managing user access and permissions. Some popular CMS platforms include WordPress, Drupal, and Joomla. (*What Is a Content Management System (CMS)?*, 2023)

CSS: CSS (Cascading Style Sheets) is a stylesheet language used to define the presentation and visual styling of HTML elements. It allows developers to create visually appealing and responsive web pages and can be used to control things like font styles, colours, spacing, and layout. (*CSS Basics - Learn Web Development | MDN*, 2023)

EMT: Emergency Medical Technician

Emergency Medical Services (EMS): The system of emergency medical care provided by trained professionals in response to accidents, injuries, and other medical emergencies. EMS includes a wide range of services, such as ambulance transportation, pre-hospital care, and emergency medical dispatch. (*What Is EMS? | Maine Emergency Medical Services*, n.d.)

HTML: HTML (Hypertext Markup Language) is the standard markup language used to create web pages. It is the foundation of all websites and defines the structure, content, and layout of web pages using tags and attributes. (*HTML Basics - Learn Web Development | MDN*, 2023)

Internet-Based Learning: The use of web-based technologies and tools to deliver educational content and facilitate learning. This includes online courses, webinars, virtual classrooms, and other forms of digital learning. (*Internet-Based Learning - an Overview | ScienceDirect Topics*, n.d.)

Prototypical Development: The process of creating an initial version or prototype of – in this case - an internet-based learning and tutoring platform for emergency medical services. This involves the identification of the platform's key features, functionality, and user interface design. (*Prototype Development*, 2020)

UEQ: UserExperienceQuestionnaire (usability test)

User Interface Design: The process of designing the visual and interactive elements of the platform, including the layout, colour scheme, navigation, and other aspects that impact the user experience. (*What Is User Interface (UI) Design?*, n.d.)

WordPress: WordPress is a free and open-source content management system (CMS) that allows users to create and manage websites, blogs, and other digital content. It is one of the most popular CMS platforms in use today and is known for its user-friendly interface and extensive plugin library. (*What Is WordPress? Explained for Beginners*, n.d.)

2 Background and Related Work

To investigate the benefits and drawbacks of online education in general as well as of online education for emergency medical services, several studies have been conducted by researchers across different educational fields. This chapter provides an overview of the current landscape of online education and training, exploring the challenges and opportunities that exist in this domain. Furthermore, existing e-learning platforms for online emergency medical education in Austria will be briefly analysed.

2.1 Current Challenges and Opportunities in Online Education and Training

This chapter explores the current state of online education and training. It looks at the challenges and barriers faced by learners, trainers, and institutions. Online education has drawbacks alongside its benefits.

Communication:

The advantages of online education have gained prominence in modern pedagogy due to the flexibility, independent study opportunities, enhanced motivation, and strict control it offers. Online teaching and e-learning are effective tools for sharing knowledge, surpassing traditional methods, and accommodating individual needs. E-learning fosters easy communication between teachers and students, engagingly delivering academic material. It's been found beneficial across various contexts, providing equal access to information, and enabling education for those with disabilities (Rawashdeh et al., 2021).

The absence of crucial face-to-face communication stands out as a significant downside of e-learning, affecting interactions among peers and between teachers and learners (Islam et al., 2015).

Accessibility:

Technical difficulties and complexity pose challenges, as do decreases in motivation, negative personal self-education experiences, potential for unlawful behaviour, and additional financial burdens on students and teachers (Dalgaly, 2020). E-learning, while advantageous, may result in limited interactivity due to distance and contemplation, particularly in comparison to traditional education

methods. Face-to-face encounters and interactions with instructors are often lacking, which can diminish the effectiveness of e-learning (Arkorful, 2014).

Assessments conducted online may lead to reduced control over cheating and plagiarism (Arkorful, 2014). Prolonged screen usage in e-learning can lead to social isolation among students (Rawashdeh et al., 2021). Notably, the absence of vital face-to-face communication is a significant downside of e-learning, impacting interactions between peers and between teachers and learners (Islam et al., 2015).

E-learning's positive impact on knowledge sharing, customization, and accessibility is contrasted by challenges such as limited interactivity due to distance, a decrease in face-to-face interaction, and a lack of control over academic integrity (Arkorful, 2014).

Technical:

Online education's advantages include flexibility, independent study opportunities, motivation enhancement, and strict control. However, technical difficulties and complexity, reduced motivation, negative self-education experiences, potential for unlawful behaviour, and added financial burdens on students and teachers are among its disadvantages (Dalgaly, 2020).

Blended learning, particularly through video clips, enhances technical and non-technical skills acquisition (Yaylaci & Guven, 2021). E-learning platforms facilitate improved communication among students and teachers, especially for part-time and full-time students regardless of location (Radu et al., 2011). Moreover, e-learning encourages self-reliance, transforming teachers into guides (Joshua et al., 2016), and offers advantages like streamlined course management, reminders, and analysis (Al-Handhali et al., 2020).

Advantages of online education

In recent years, online education has emerged as a transformative force in the field of learning and instruction. This section delves into the myriad benefits that online education brings to the forefront of modern pedagogy. As technology continues to reshape the landscape of education, understanding these advantages becomes crucial for educators and students alike. Online education in general offers a variety of advantages:

- Flexibility
- Opportunity to study independently of time and location.
- Enhanced motivation and involvement
- Strict control

- Increasing balance between education and work/family/friends/duties
  (Dalgaly, 2020)

Disadvantages of online education

In the previous section, the benefits of online education were briefly covered, now the disadvantages are highlighted in the subsequent chapter. While online education presents a host of opportunities, it is imperative to address the challenges and drawbacks that accompany this evolving mode of learning. This section delves briefly into the potential disadvantages that educators, students, and institutions must consider when navigating the landscape of online education.

- Technical difficulties / Complexity in technology
- Decrease of motivation and discipline
- Negative personal experience of self-education
- Possibility for unlawful behaviour
- Additional financial impact for students and teachers (hardware, internet connection)
- Lack of face-to-face communication
  (Dalgaly, 2020)

A table comparing the advantages and disadvantages is presented on the next page in Table 2.

Comparison table: Advantages vs. disadvantages of online education (Dalgaly, 2020)

Table 2: Advantages vs. disadvantages of online education (Dalgaly, 2020)

Advantages of online education	Disadvantages of online education
Flexibility	Technical difficulties / Complexity in technology
Opportunity to study independently of time and location.	Decrease of motivation and discipline
Enhanced motivation and involvement	Negative personal experience of self-education
Strict control	Possibility for unlawful behaviour

Increasing balance between education and work/family/friends/duties	Additional financial impact for students and teachers (hardware, internet connection)
	Lack of face-to-face communication

2.2 Overview of Internet-based Learning and Tutoring Platforms for EMS in Austria

In Austria, several internet-bases learning and tutoring platforms for emergency medical services exist. Each organization offers its own individual platform. Even though the platforms are well established, access to the content is exclusive to members of the organizations.

Internet-based learning platforms by the following Austrian organizations have been briefly analysed:

- Austrian Red Cross (Österreichisches Rotes Kreuz)
- Worker's Samaritan Federation Austria (Arbeiter-Samariter-Bund Österreich)
- Vienna's Emergency Medical Service (Berufsrettung Wien)

Access to the learning content by persons outside the individual organisation is therefore not possible. A key benefit is that for login, the existing username and password which is used for other services like the roster can be used. Therefore, there is no need to register newly on a dedicated platform.

Both the Red Cross and the Workers' Samaritan Federation (Arbeiter-Samariter-Bund) utilize the **Moodle** platform for the implementation of their respective learning platforms. This shared choice of using Moodle underscores its effectiveness as a versatile and widely adopted tool for delivering educational content in a user-friendly online environment.

Austrian Red Cross

The Austrian Red Cross uses the Moodle-Platform to provide digital content to their trainees. The platform is tried and tested and can be accessed by members of the Austrian Red Cross only. The course-contents are tailored to the education and training of the Austrian Red Cross and matches the in-class lessons. E-learning content such as courses and tests are designed well, but the platform itself has

issues regarding the responsive web design on mobile devices (see Figure 1). Some content is not visible without the need for a horizontal scroll.
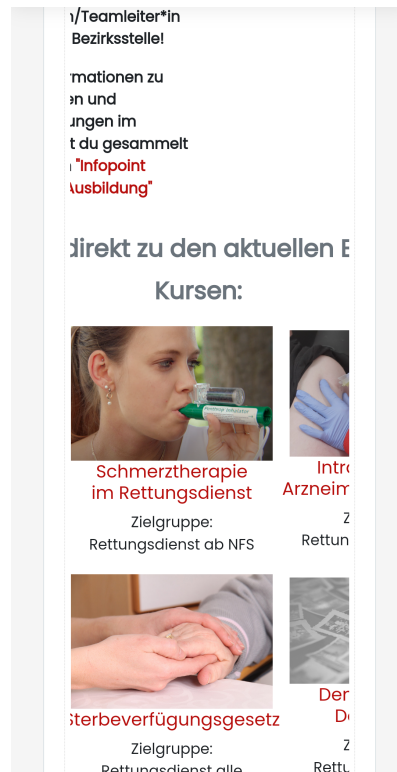

Figure 1: Responsive-design issue on mobile device

Worker's Samaritan Federation Austria

The online learning platform of the Samaritan Association closely resembles that of the Red Cross. Both platforms share striking similarities in terms of structure, content delivery, and user interface.

Vienna's Emergency Medical Service

Vienna's Emergency Medical Service offers a valuable resource through monthly online educational videos on YouTube, available to the public at no cost. Training courses are otherwise often associated with costs for the participants or the rescue organisation behind them. All participants who take part in the online event live will receive a certificate of further training in accordance with SanG (Paramedic act, German: "Sanitätergesetz"). These videos cover a range of topics related to medical emergencies, empowering everyone with accessible and informative content to enhance their knowledge and response skills.

3 Requirements / Methods

This chapter discusses the research design and approach for the development of the online learning platform. The first section provides an overview of the research design, which is the plan for conducting the research for this master thesis. The second section discusses the data, collection methods, which are the techniques used to collect data as well as the data analysis methods, which are the techniques used to analyse the data.

3.1 Research Design and Approach

To develop the prototypical internet-based learning and tutoring platform, a combination of several web-development tools will be used. The main website will be built using WordPress, and further cascading style sheets (CSS), JavaScript (JS), Hyper Text Markup Language (HTML), and Hypertext Preprocessor (PHP) will be used to adjust the visual as well as the backend-properties of the site if necessary. To implement the online tutoring platform itself, existing WordPress Plugins will be used. The exact Plug-In has yet to be determined as part of the literature research. The website will be hosted on a dedicated webserver where specific backend server parameters will be adjusted to correspond to the requirements of the aforementioned tools. In addition to that, a logo will be created using Adobe Illustrator and a sample video will be produced to fill the platform with a first learning content for the users to evaluate.

First, the requirements of the system to be developed are evaluated by means of structured expert interviews. The interviews will be performed using an online survey consisting of 17 questions. The duration per expert interview survey was calculated to be about 15 minutes.

In addition, the usability will be assessed. A standardised usability test (User Experience Questionnaire) is used as a key performance indicator for this qualitative usability test.

Experts for these questionnaires are experienced paramedics or emergency medical technicians who have at least 5 years of experience in their respective work environments. All experts regularly use the online learning platforms of their respective organisations (Red Cross, Arbeiter Samariterbund, etc.). They are familiar with how to use them. Furthermore, some experts aid in paramedic and

EMT education as practical instructors or practical tutors and thus have ample experience in training and education. All paramedics and EMTs need to maintain and improve their skills regularly, and therefore can provide valuable insights into the importance of a well implemented online learning platform.

N = 16 for the expert interview questionnaire

N = 7 for the UEQ usability test

Method: Literature review, questionnaire (expert interview) and usability test (UEQ)

3.1.1 Data Collection and Analysis Methods

To evaluate the needs and requirements of the online learning platform, expert interviews were conducted using an **online survey**. The survey consists of multiple choice, single choice, and essay questions. The answers were translated to English for this thesis, all the participants performed the questionnaire in German. The interview was carried out in German as it was unclear how proficient some participants were in English. Furthermore, the technical terminology used in German was already familiar to the participants. All multiple-choice questions had the option to give one free form text answer to give the expert a further option to answer. The detailed questions and answer options can be found in the appendix of this thesis.

The decision to conduct the expert interviews as well as the user experience questionnaire online was grounded in several key reasons. Firstly, the online format offered a significant level of convenience and flexibility for both the interviewees and the research team. This approach eliminated geographical constraints, enabling experts from diverse locations to participate without the need for travel. Furthermore, the digital nature streamlined data collection and management. Additionally, the online form allowed for efficient scheduling and coordination, making it easier to accommodate the busy schedules of the experts. This flexibility increased the likelihood of securing participation from individuals who might have otherwise faced logistical challenges in attending in-person interviews.

The questionnaires for the expert interviews were distributed online via link to the experts. The experts received the link either by email or by WhatsApp chat with the exact instructions and a short explanation about the background and the purpose of the data or the interview. The link was sent to 24 experts, 16 of whom took part in the expert interview. This corresponds to a response rate of 66.6%.

For this thesis, German questions and answers are displayed in *italic letters* in the following subchapter. The expert interview survey was sent out to experienced paramedics who are on active duty as paramedics in the field and / or active as paramedic instructors or paramedic tutors.

The decision to incorporate the **User Experience Questionnaire (UEQ)** into this master thesis was rooted in several compelling reasons that closely align with the research objectives and methodologies. The UEQ, renowned as a well-established tool for evaluating user experience, was selected for its robust capabilities and contributions to the study's framework (UEQ Team, 2023).

At the forefront, the UEQ offers a standardized and recognized approach to evaluating user experience. Its carefully structured scales and items provide a clear framework for collecting data pertaining to diverse aspects of user perception, ranging from attractiveness to novelty. This standardized nature ensures consistency in data collection and analysis, contributing to the research's reliability and credibility (UEQ Team, 2023).

3.2 Expert Interview Questionnaire Results

This chapter presents the in-depth findings from expert interviews, offering valuable insights and opinions from paramedics and emergency technicians in their respective fields. **These results form a basis for the development and furthermore for discussion, and recommendations in the following chapters.**

Question 1: Please indicate your current position in the ambulance service.

Bitte geben Sie Ihre derzeitige Funktion im Rettungsdienst an.
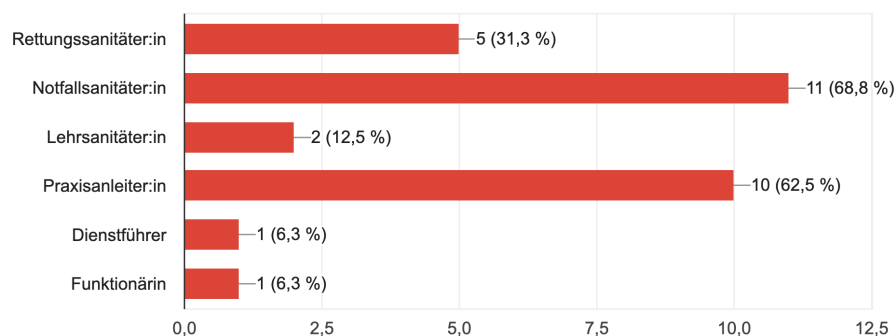16 Antworten

Figure 2: Answers from question 1 in German

- 11 out of 16 participants are EMT-Basic
- 5 out of 16 participants are EMT-Intermediate or paramedic.
- 2 out of 16 participants are practical instructors.
- 10 out of 16 participants are paramedic tutors.

The results of this show the distribution of skill / educational levels in emergency medical services. Correlations between the personal requirements according to their skill / education.

Question 2: Where do you see the advantages and disadvantages of an e-learning platform for emergency services?

Advantages of e-learning platforms:

- Content can be followed at any time and at low threshold, independent of physical presence.
- Flexibility enables continuing education at any time.
- Forums promote discussion and interaction between participants and teachers.
- Content can always be kept up to date.
- Home office and general digitalization are possible.
- Content can be read more quickly using shortcuts.
- Accessible anywhere and anytime, unlike books.
- Interactive media offer more pedagogically valuable learning opportunities.
- Flexibility and scope of teaching units are advantages.

Disadvantages of e-learning platforms:

- Distraction and lack of user attention.
- Privacy concerns.
- Not accessible to all due to account systems.
- Potentially poor preparation of content.
- Restriction of use to non-responsive websites.
- Investment reluctance in the absence of commercial success.
- Personal contact and valuable discussion points may be lost.
- Lack of flexibility in learning program design.
- Difficulty in verifying knowledge and possible risk of cheating.
- Difficulty of accessibility for older generations.
- Practical references and exercises may be missing.
- No real conversation is possible.

- Motivation problems compared to face-to-face courses.

In summary, e-learning platforms offer many advantages, such as flexibility, easy access to up-to-date knowledge, and the possibility of interactive learning. However, they also have disadvantages, including the lack of hands-on practice and possible difficulties in motivating participants.

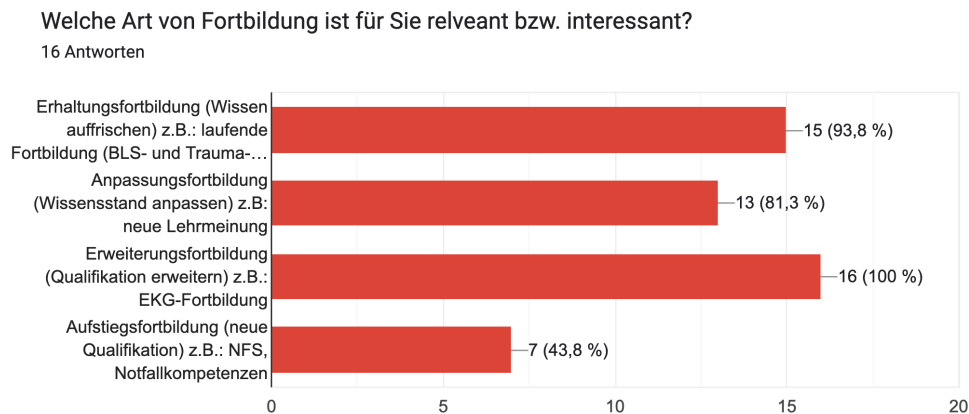**Question 3:** What type of training is relevant or interesting to you?

Welche Art von Fortbildung ist für Sie relveant bzw. interessant?
16 Antworten

Figure 3: Answers from question 3 in German

The goal of this question was to see which type of training interests the experts the most. The prototypical e-learning platform will be built upon the results. The functional as well as the technical requirements must meet these interests.

- 15 out of 16 participants stated, that maintaining training (refresh knowledge) e.g.: ongoing training (BLS and trauma training) is interesting.
- 13 out of 16 participants stated that adaptation training (adapting the level of knowledge) e.g.: new doctrine is interesting.
- All participants (16 out of 16) stated that knowledge expansion training (expand qualification) e.g.: ECG advanced training is interesting.
- 7 out of 16 participants stated that advanced training (new Qualification) e.g.: emergency paramedic, further emergency competencies is interesting.

Question 4: Which of these types of training would you like to attend via e-learning?

Welche dieser Fortbildungsarten würden Sie gerne per E-Learning besuchen?
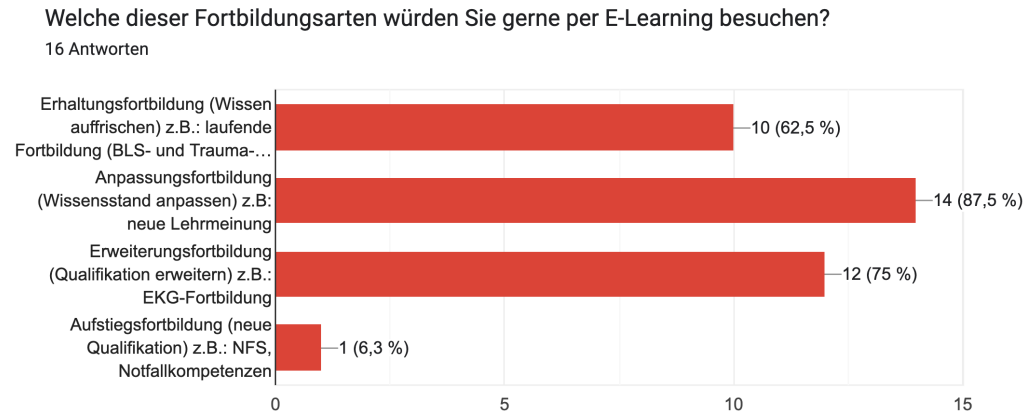16 Antworten

Figure 4: Answers from question 4 in German

Question 4 corresponds to question 3. This question aimed to identify which of the previously mentioned types of training indicated as "interesting" would also be attended online as e-learning. The agreement to also attend the training types via e-learning depended on the training type.

Question 5: What kind of digital learning materials do you prefer?

Welche Art von digitalen Lernmaterialien bevorzugen Sie?
16 Antworten
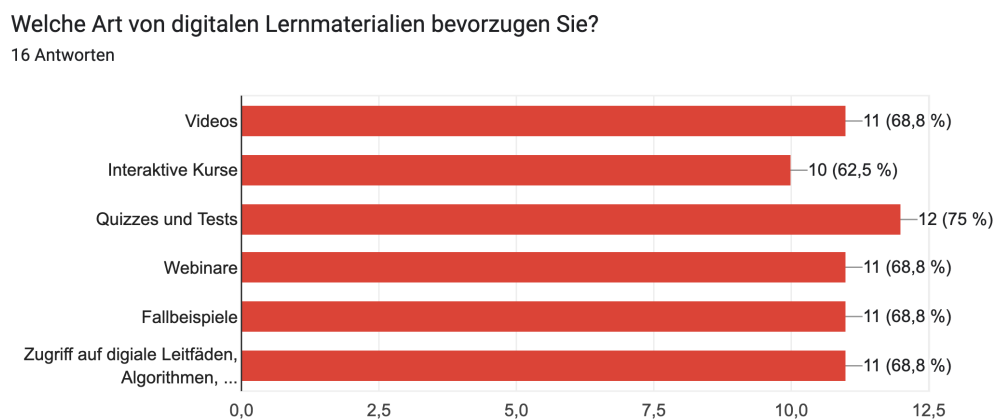
Figure 5: Answers from question 5 in German

- 11 out of 16 experts stated that video, webinars, case studies, and access to digital guidelines and algorithms are the preferred media.
- 10 out of 16 experts stated that interactive courses are preferred.
- 12 out of 16 experts stated that quizzes and tests are preferred.

Question 6: How important is it that the e-learning platform supports multimedia content such as videos, interactive simulations, or virtual scenarios?

Wie wichtig ist es, dass die E-Learning-Plattform multimediale Inhalte wie Videos, interaktive Simulationen oder virtuelle Szenarien unterstützt?
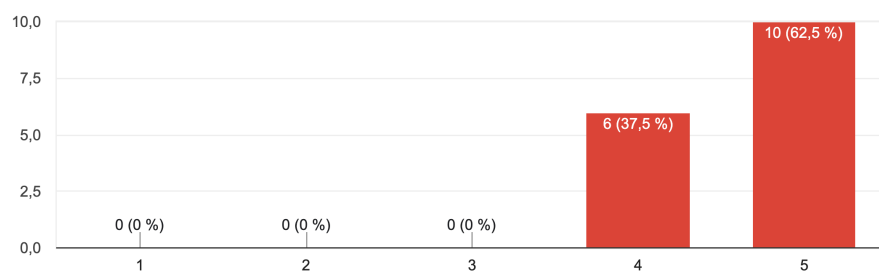
16 Antworten

Figure 6: Answers from question 6 in German

Question 6 shows that it is highly important for experts that online learning platforms support interactive simulations, videos, and virtual scenarios. 10 of the 16 experts stated that it is "very important", the rest (6 of the 16 experts) stated that it is important.

Question 7: What approaches to improving the kurse.roteskreuz.at platform would you like to see?

- Improve usability on mobile devices, including better responsiveness and a new responsive UI.
- Better overview of the content offered by reducing many submenus and making the course search clearer.
- Introduction of "recent courses" on the home page and recommendations for similar courses to make navigation easier.
- Course content should not open in new windows to increase usability.
- Revising the presentation of course content to have a more serious effect and avoid a childish presentation.
- Caching course content in case a course cannot be completed immediately.
- Offering time-independent courses to allow more flexibility for participants.

- Better differentiation of different types of courses, such as "advanced courses" and "advanced training," through filters and clear labeling.
- Introduction of standardized learning tracking to make it easier to track personal successes and learning progress.
- More interactive elements to improve the user experience and make learning more engaging.
- Making it easier for learners to upload materials.
- Avoid unnecessary clicks and difficulties when completing training to ensure that learning content is delivered effectively.

Question 8: What aspects do you like about the kurse.roteskreuz.at platform?

- Easy to use and allows login via MIP credentials.
- Well-maintained and offers a clear layout, allowing access to content anywhere.
- Accessible free of charge through the organization.
- Certificates of attendance are received immediately following the course.
- The design and clarity are rated positively.
- The platform offers access to a variety of learning content, even after a longer period of time.
- The "interactive" courses, which include various content and case studies, are highlighted particularly positively.
- The possibility to complete courses via e-learning and thus save long distances is appreciated.
- The integration of the roster and course registration works well.
- The platform offers exclusive digital content not available elsewhere.
- Recently, the platform has improved greatly and a larger offering that is not mandatory would be desirable.
- Direct connection or creation of users from Active Directory is a positive feature.

Question 9: To what extent should the e-learning platform promote social interaction and collaboration among participants or between instructors and participants?

Inwiefern sollte die E-Learning-Plattform soziale Interaktion und Kollaboration zwischen den Teilnehmern bzw. zwischen Lehrenden und Teilnehmern fördern?
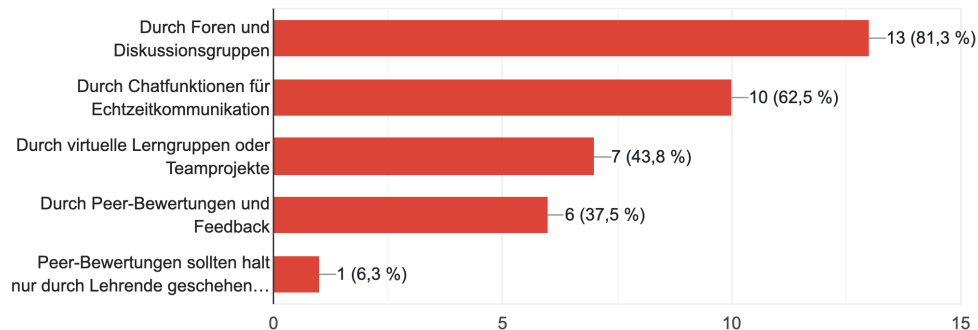
16 Antworten

Figure 7: Answers from question 9 in German

The aim of question 9 was to find out in which way social interactions and collaborations between participants and between participants and teachers should take place. Forums and discussion groups, chats with real-time communication as well as virtual learning groups and team projects were supported by 13, 10, and 7 of the 16 experts respectively. 6 out of 16 stated that peer review and feedback.

One expert stated in a free form answer: *"Peer reviews should ideally be conducted by instructors. This is why I didn't choose the forum, as otherwise, anyone could share their opinions, and I'm only interested in those of the teaching staff. (…)*

Question 10: Learning and training while on duty: Would a system where you could earn "credits" on an ongoing basis be of interest? Example: Attend ongoing online training while on duty, earning credits - these credits could be used as an aspect of advancement from EMT to paramedic, for example.

Lernen und Fortbilden während der Dienstzeit: Wäre ein System, in dem Sie sich laufend "Credits" erarbeiten könnten, interessant? Beispiel: Im Die... für den Aufstieg von RS auf NFS verwendet werden.
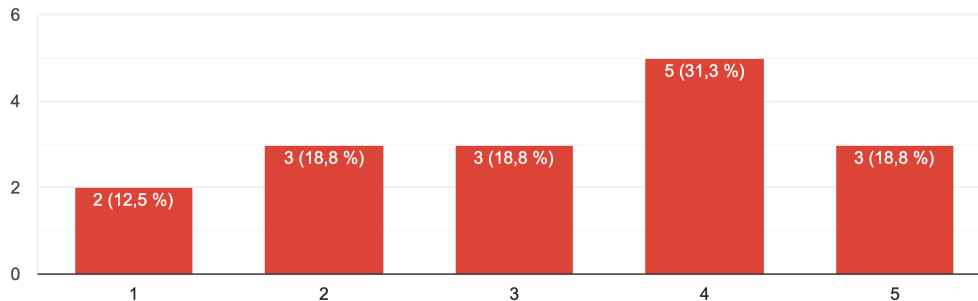16 Antworten

Figure 8: Answers from question 10 in German

Question number 10 showed mixed results. The experts both showed interest as well as opposite interests. However, more than 50 percent stated that a credit system in online learning would be interesting or very interesting.

- 3 out of 16: very interesting
- 5 out of 16: interesting
- 3 out of 16: moderately interesting
- 3 out of 16: not so interesting
- 2 out of 16: not interesting at all

Question 11: Would a cross-organizational learning platform for emergency services be relevant to you? (Regardless of organizational affiliation). For example: international course formats and algorithms, standards, and guidelines - independent of individual organization doctrinal opinions.

Wäre eine organisationsübergreifende Lernplattform für den Rettungsdienst für Sie relevant? (Unabhängig von der Organisationszugehörigkeit). ... von individuellen Lehrmeinungen der Organisation
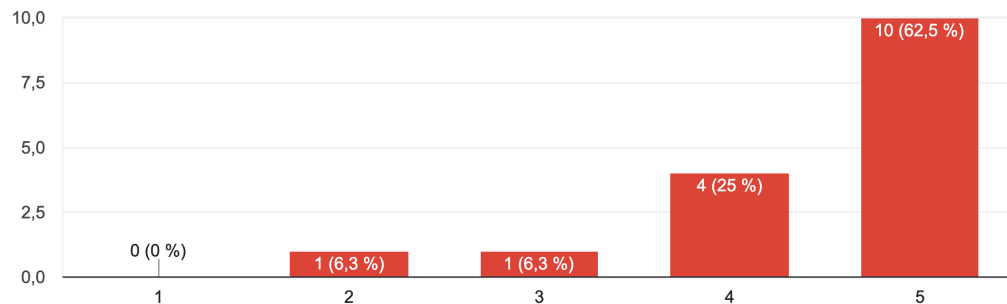16 Antworten

Figure 9: Answers from question 11 in German

Question number 11 aims to show how relevant a cross-organizational learning platform is for the rescue service. The experts predominantly concluded that such a platform is very relevant.

- 10 out of 16: Very relevant
- 4 out of 16: relevant
- 1 out of 16: moderately relevant
- 1 out of 16: not so relevant

Question 12: Please briefly justify your decision on the previous question. (cross-organizational learning platform)

- There is a desire to visit content from other organizations regardless of their respective "doctrines" and to be more aligned with international guidelines.
- Current challenge: Being involved with multiple organizations that have different doctrinal opinions leads to inconsistent ways of working.
- A uniform doctrinal opinion could allow standardized procedures for a specific area, such as all of Vienna in emergency medical services, and promote the use of international standards.
- The possibility of 1:1 credit for courses from other organizations would standardize knowledge and allow learning from other perspectives.
- A focus on current evidence-based knowledge and sharing knowledge across organizations would be desirable.
- Although not everyone is interested in the idea, a unified body of doctrine could help incorporate current standards and improve outreach.

- The difficulty is to stay "up-to-date" as there are many different standards from different organizations, for example from the ERC and AHA.
- An organized platform for higher-level, organization-independent knowledge would be a useful way for everyone to access it.
- The introduction of a cross-organizational doctrinal standard would enable better collaboration in the field and promote the exchange of experiences.
- Uniform guidelines in the ambulance service are desirable in order to work according to prevailing science and not according to the individual preferences of the respective chief physicians.

Question 13: How important is personalized training and feedback to you?

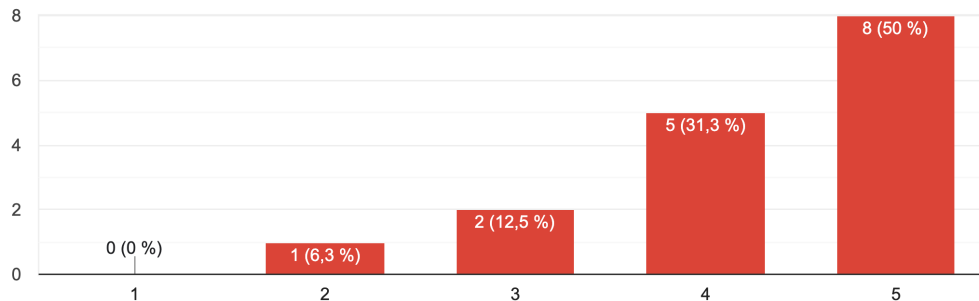Wie wichtig ist Ihnen personalisiertes Training und Feedback?
16 Antworten

Figure 10: Answers from question 13 in German

Personalized feedback and training were stated to be "very important" for 8 out of 16 experts.

- 5 out of 16: important
- 2 out of 16: moderately important
- 1 out of 16: not so important

Question 14: How important is it to you to be able to track your progress as well as your performance on e-learning content?

Wie wichtig ist es Ihnen, Ihre Fortschritte sowie Ihre Leistung bei E-Learning Inhalten verfolgen zu können?
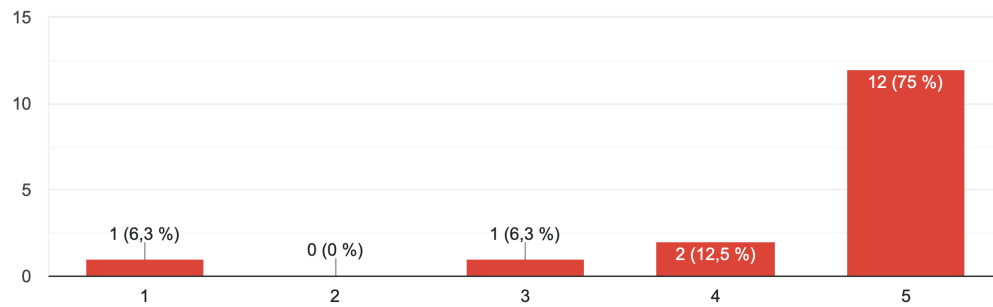16 Antworten

Figure 11: Answers from question 14 in German

Most of the participants (12 out of 16) stated, that the ability to track the learning progress is very important.

- 12 out of 16: important
- 1 out of 16: moderately important
- 1 out of 16: not important

Question 15: How important is it to you to be able to visit course content on mobile devices?

Wie wichtig ist es Ihnen, die Kursinhalte auch auf Mobilgeräten besuchen zu können?
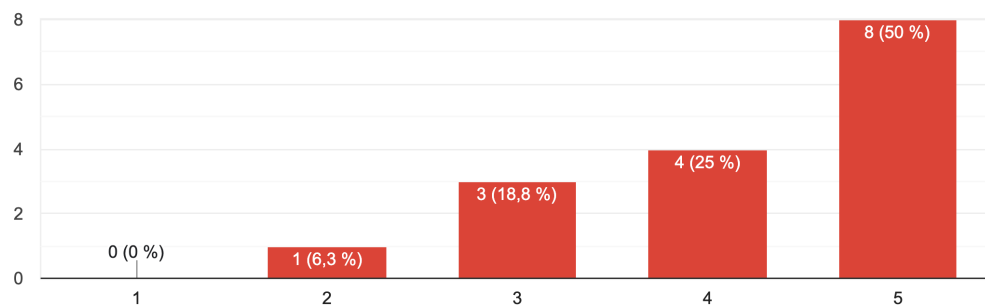16 Antworten

Figure 12: Answers from question 15 in German

The possibility of also being able to visit the course content properly on a mobile device was stated to be "very important" for 8 out of 16 experts.

- 4 out of 16: important
- 3 out of 16: moderately important
- 1 out of 16: not so important

The results indicate, that for most expert participants, a good mobile user experience is either important or very important.

Question 16: Are there innovations you would like to see from online learning platforms for emergency services?

- Ability to make course content available offline, either through an offline mode or an app that allows access to content without an Internet connection.
- Incorporating augmented reality to create interactive and immersive learning simulations.
- Use of source references to scientific findings instead of doctrinal statements to create a sound knowledge base.
- Flexibility in acquiring knowledge means that the platform should offer a variety of learning options and formats.
- A mobile app that is networked with the learning platform and allows users to access content on the go.
- Establish a standardized paramedic training platform in Austria.
- Interactive simulations and learning games that allow users to simulate practical situations and test their decisions.
- Expansion of the range of continuing education courses.
- Integration of interactive sequences to wrap the teaching content in stories and make learning more exciting.
- Providing short, informative content for mobile devices that can be accessed quickly (similar to One-Minute Wonders).
- Emphasizing practical relevance to ensure that the learning platform supports classic course formats and provides hands-on learning experiences.

Question 17: What features should an e-learning platform offer from the instructor's perspective?

- Administrative functions: Ability to create courses, manage participants, and create certificates.

- Targeted interaction: the option to create your own "group" to interact with assigned trainees in a targeted manner and conduct knowledge checks.
- Multimedia options: Integration of multimedia elements to prepare courses in multimedia and enhance the learning experience.
- Knowledge checks: Ability to conduct quizzes and other knowledge checks, as well as the creation of a dedicated exchange forum for instructors.
- Communication: A chat function to communicate with participants, as well as an overview to monitor the progress of participants.
- Exchange: The ability to exchange with learners to create an interactive learning environment.
- Ease of use: A user-friendly interface to quickly and easily answer questions or make adjustments to courses.
- Clear tools: Clearly structured overview of teaching aids, such as documents, handouts, and examples of practical exercises.
- Appropriate implementation: Features should not be overloaded or provided in an inflationary manner to improve the user experience.
- Accessibility to feedback: Easy access to the feedback facility so that teachers can continuously improve their courses.
- Customized feedback: Ability to provide customized feedback and quick and easy customizability of courses to meet learning needs.

4 Development of the EMS Learning and Tutoring Platform

This chapter will provide an overview of the development process of the EMS Learning and Tutoring Platform. It will discuss the key features and functionalities of the platform, the design process, and the technologies employed to create a user-friendly and effective learning experience. Additionally, this chapter will examine the challenges faced during the development process and how they were overcome.

The goal is to develop the platform according to the expert interview survey results. The expert interview showed that e-learning platforms **offer numerous advantages and disadvantages.** The goal in development is to implement as many advantages as possible, such as interactive course formats or interactions between course participants. Participants indicated that multimedia content, interactive courses, webinars, case studies, and quizzes and tests were of particular interest. The development will try to implement exemplary course content as well as find a plug-in with features that meet these requirements. The advantages of the existing course platforms (kurse.roteskreuz.at) should be implemented and carried over while trying to eliminate the disadvantages.

Hence many of the experts also stated that a smooth visit to the platform on mobile devices is important, and attention is also paid to **optimizing the user experience on smartphones and tablets**. In addition, an attempt is made to take up the innovations and wishes of the experts and to implement them if possible. If the implementation of various features is not successful, these will be used for **future development stages**.

Since the **main goal is cross-organizational accessibility**, an attempt is made to implement a registration process that is as simple as possible. Furthermore, the course content should be designed according to standardized guidelines, independent of organization-specific regulations.

To enhance the user experience, a logo for the prototypical online learning platform has been created using Adobe Illustrator. To evaluate the tool in a meaningful way, a sample video has been created as the first course content.

4.1 Background Requirements and Planning

This chapter discusses the background requirements and planning for the development of the online learning platform. The first section provides an overview of the software development life cycle (SDLC), which is a framework for planning, developing, testing, and deploying software. The second section presents a user role flowchart diagram that illustrates the different roles of users in the platform. The third section lists the functional requirements for the platform, which are the features that the platform must have in order to meet the needs of its users. The fourth section provides a wireframe design for the platform, which is a visual representation of the user interface. The fifth section provides background information on WordPress, which is the platform that will be used to develop the online learning platform.

4.1.1 Software Development Life Cycle

The Software Development Life Cycle (SDLC) is a structured process used by software development teams to design, develop, test, and deploy software applications or systems. It provides a systematic approach to building software, ensuring that it meets the specified requirements and quality standards while being completed within budget and time constraints (*SDLC - Software Development Life Cycle - Javatpoint*, n.d.).

For the online learning platform, the **requirements analysis** was conducted using the expert interview survey. The **design-process** will be conducted using a simple wireframe-apporach to outline the key building blocks of the prototype website, as well as the logo design. In the **development-process**, the backend as well as the front end of the website were set up inside the hosting- and WordPress environment. **Testing** will be conducted using a standardized usability test (UEQ), to gather information on how to further improve the software to a state of market maturity. A graphical representation of the SDLC can be found in Figure 13 below.
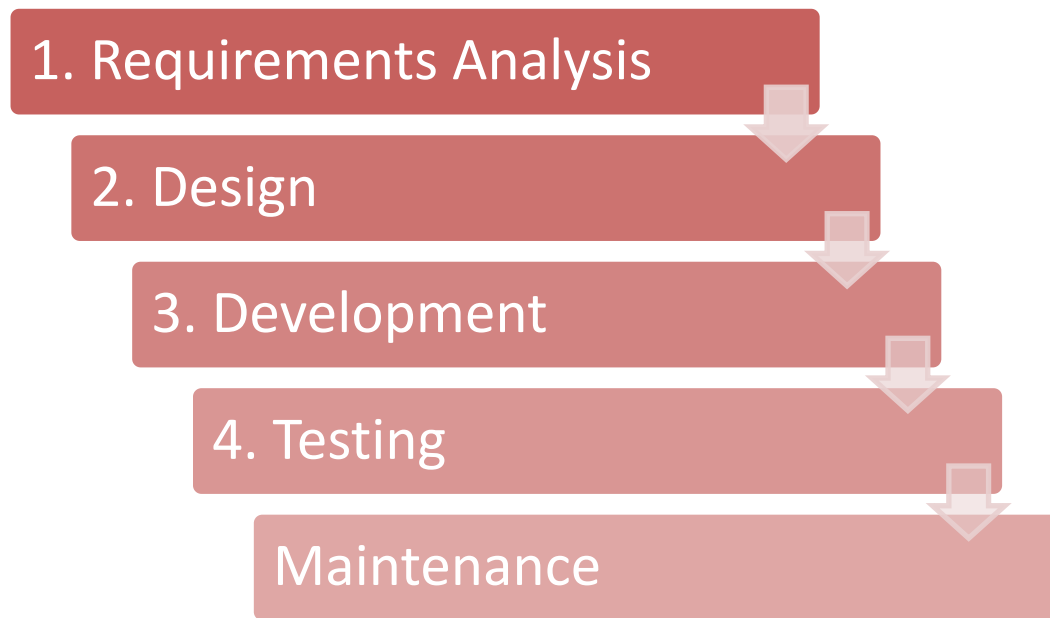
Figure 13: Software Development Life Cycle

4.1.2 User Role Flowchart Diagram

The user role flowchart diagram outlines the registration and login process for two distinct user groups (students and teachers) on a website. The flowchart diagram visible in Figure 14 visually depicts the steps and interactions involved in accessing the website's features. The flowchart underscores the distinct paths for students and teachers in both the registration and login processes. It captures the logical sequence of actions and decisions that guide users through these interactions, enhancing the website's user experience by ensuring seamless access for both user groups.

Registration:

- The process begins with the user visiting the website and clicking on the "Register" button.
- The user is directed to the registration form where they input their personal information such as name, email, and password.
- After submitting the form, the system validates the entered data and checks for any errors or missing fields.
- If the data is valid, the system creates a new student account, stores the provided information, and generates a unique student ID.
- The student is then redirected to a confirmation page notifying them of successful registration.

Login:

- A registered user who wishes to log in clicks on the "Login" button.
- The user is prompted to enter their registered email and password.
- Upon submission, the system verifies the credentials against the stored database.
- The two-factor authentication must be fulfilled.
- If the credentials match, the system grants access to the student's *or* teacher's dashboard, allowing them to interact with their profile and available features.
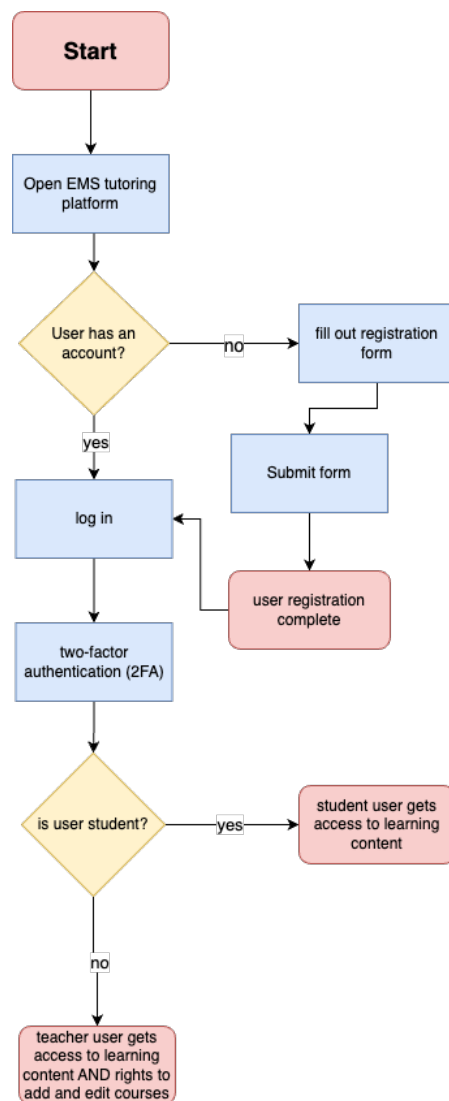

Figure 14: User role flowchart diagram

4.1.3 Functional Requirements

The functional requirements were derived from the expert interviews. The most crucial or frequently cited desired features of the experts were prioritised. The aim is to integrate these into the prototype. Due to possible technical limitations (WordPress, plugin), it may not be possible to implement all desired features. The functional requirement "usability (ease of use)" will be evaluated through the UEQ usability test in the evaluation section of this thesis. Furthermore, weaknesses in the usability of the existing course platform of the Red Cross were already revealed in the expert interview.

- Good usability (ease of use)
- Possibility to use several image formats (image, video)
- Define user roles (Admin, Teacher/Tutor, Student)
- Creation of exams
- Feature to exchange between student/student as well as student/teacher and teacher/teacher.

4.1.4 Wireframe Design

To plan and execute the visual layout of the prototypical website more efficiently, a simple wireframe mock-up design was created. The sections (numbered with red lettering from 1 to 5 in Figure 15) should contain the following content:

- Section 1: Logo / Site Identity
- Section 2: Main navigation, Search bar, and link to user profile
- Section 3: Navigation for main sections (for example general content, content for EMTs, content for paramedics)
- Section 4: Categories (for example anatomy, pharmacology…)
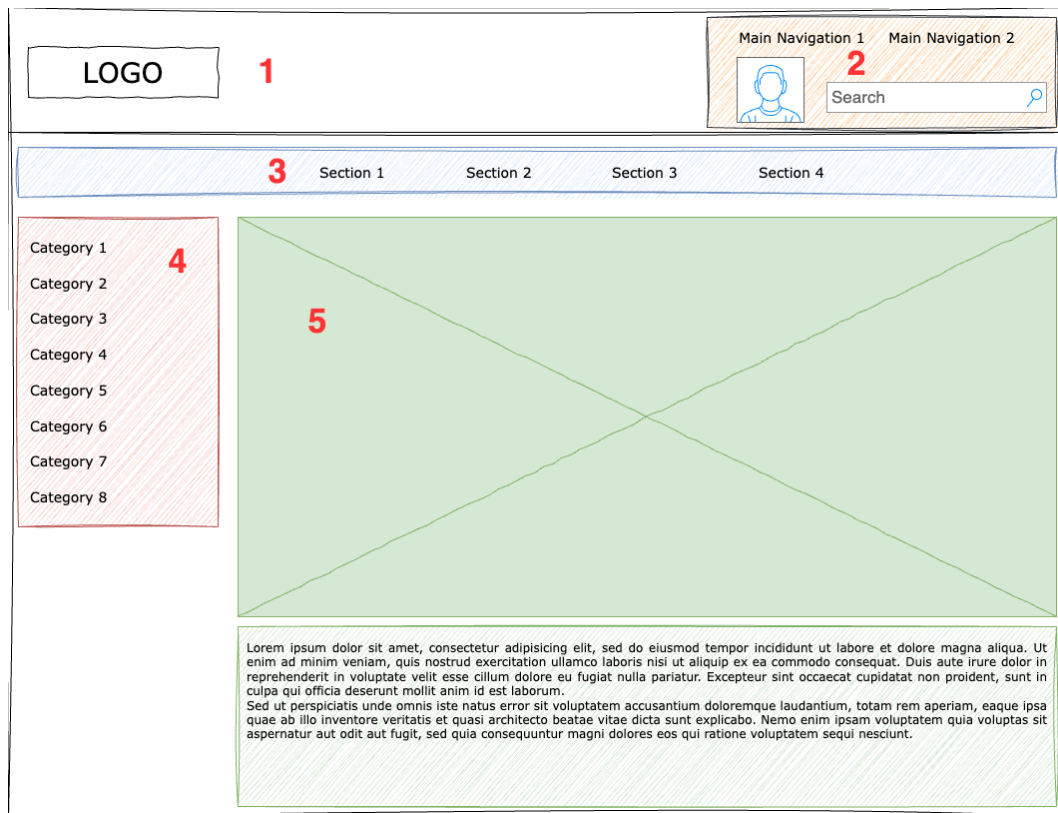- Section 5: Content introduction with image and short description

Figure 15: Website wireframe mockup

4.1.5 WordPress

Using WordPress as the platform for prototypical development in a master's thesis project offers several compelling advantages. One of the primary reasons for its selection is the user-friendly interface that characterises WordPress. This ease of use enables both technical and non-technical individuals to efficiently create and modify content, features, and layouts, expediting the development process in the initial stages of the project. The fast-prototyping capabilities of WordPress reinforce its suitability for such actions. With a variety of pre-designed themes, plugins, and templates available, researchers and developers can quickly create and test different ideas and concepts. This speeds up the iterative process of improving and finalizing the prototype. (Toonen, 2022)
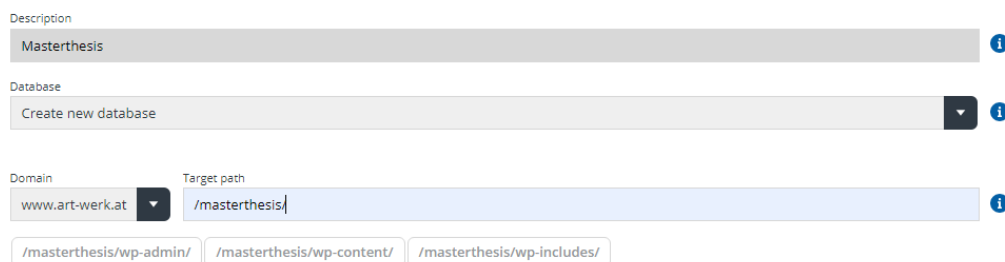
Customisability is another crucial factor that contributes to the popularity of WordPress for prototyping. While the platform offers ready-made components, it also enables significant customisation. This adaptability is especially beneficial for projects with unique specifications or features, since it allows developers to modify the WordPress environment to match project objectives flawlessly. (Toonen, 2022)

While the immediate scalability might not be a primary concern during prototyping, it's worth acknowledging WordPress's ability to accommodate projects of varying sizes. Thus, if the master thesis prototype evolves into a more extensive project, WordPress can serve as a foundation for further development.

4.2 Platform Development

4.2.1 Hosting and Backend Environment

To host the WordPress environment as well as the accompanying plug-ins, a webserver is needed. All files (databases, images, stylesheets, …) are stored on the webserver. In Figure 16, the initial setup-process is highlighted: A new database is automatically created, and a file path must be selected.

Figure 16: Installation of the WordPress-CMS system via an online dashboard

Different web applications require different server parameters to run properly.
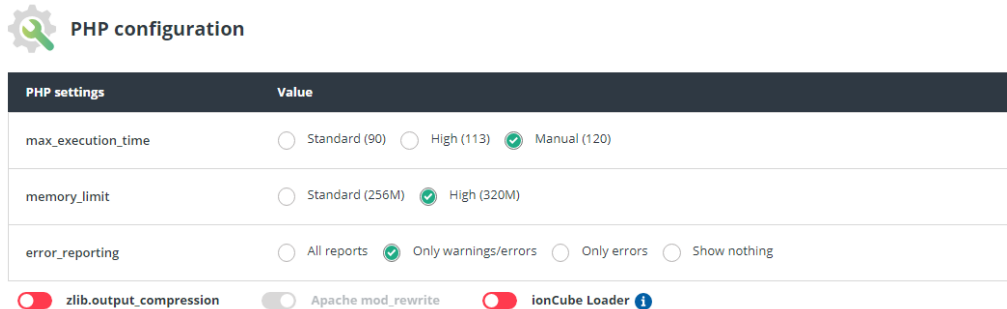
The PHP 'max_execution_time' specifies the maximum time in seconds before a script is stopped. This setting helps to prevent faulty scripts from affecting the performance of the server ('PHP max_execution_time', n.d.).

The PHP 'memory_limit' reserves part of the server's system memory to dump and execute scripts. Basic WordPress installations do not require a high memory limit whereas demanding applications (like online-learning platforms) can benefit from a higher memory limit (*Was Ist Das PHP Memory Limit Und Wie Lässt Es Sich Verändern?*, n.d.).

Inside the PHP configuration of the server, the parameters 'max_execution_time' and 'memory_limit' were adjusted. To adjust the parameters, the hosting provider's online interface as seen in Figure 17 can be used. Alternatively, the file 'wp-config.php' can be edited to alter the parameters more precisely:

```
set_time_limit(120);
define('WP_MEMORY_LIMIT', '320M');
```


Figure 17: Configuration of PHP-parameters using the online interface.

4.2.2   WordPress Environment

WordPress was installed on the webserver via an online interface. Before installing the plugins required for the online learning platform (see chapter 4.2.3), some settings were adjusted in the backend WordPress-environment. Furthermore, several essential plugins were installed.

The following settings were altered:

- Test user account added for visualizing the user experience from the perspective of a student.
- Change permalink-structure
- Disable auto-update to avoid website malfunction due to an update.

The following plugins were installed:

- Updraft Plus – for incremental, automatic backups
- Elementor – page builder required for the learning platform.
- Jetpack and W3 Total Cache – for performance improvements
- Disable XML-RPC Pingback – to avoid DDoS Pingback attacks.
- User switching – for easy switching between admin/developer and test student user

4.2.3   E-Learning Plugin

To implement the E-Learning tool, a versatile and well-functioning plugin had to be selected. Several plugins exist which offer a similar feature set. Two plugins

available on the market were assessed and analysed to choose the one that suits the need of a platform for emergency medical services the best.

Both plugins (TutorLMS and MasterStudy LMS) [1] provide identical fundamental features, as they are both well-suited for constructing e-learning platforms. Table 3 presents the necessary features and integrations, as well as the corresponding prices of the plug-ins. The comparison furthermore aids in the application of the decision matrix.

Both plugins offer a free version, with limited functionality. For the purpose of this thesis, the free version was used to build the prototype, though not all desired features could be implemented.

Table 3: Feature comparison of WordPress plugins

	Tutor LMS version: 2.2.4	MasterStudy LMS version: 4.8.12
Price	**$ 499** (1-time payment)	**$ 199** (1-time payment)
Mobile app support	No	Yes
Live chat	No	Yes
Personalized dashboard	Partially	Yes

A **decision matrix** (see Table 4) was used to systematically evaluate and compare different options or alternatives based on a set of criteria. This approach helps in making well-informed decisions by providing a structured way to assess each option's strengths and weaknesses across various dimensions. By assigning weights to the criteria and scoring each option accordingly, the decision matrix allowed to objectively quantify and compare the options, ultimately helping to choose the one that aligns best with the requirements. The plug-in with a higher score will be used for the prototypical development.

The maximum point value that can be awarded is 2. If a plugin meets the requirement in its entirety, the plugin receives 2 points for the criteria. If the feature

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[1] https://stylemixthemes.com/wordpress-lms-plugin/
https://www.themeum.com/product/tutor-lms/

is only partially present, 2 points are given. If the plug-in does not have the required feature at all, 0 points are awarded. As MasterStudy LMS is the cheaper plugin, it was awarded 2 points for the criterion "price".

The scores are based on testing them in the WordPress environments and furthermore on several online articles which review the plug-ins in depth. [2]

Criteria used were price, the availability of a mobile app, a live chat, the feature set of the personalized dashboard (plus integrations) as well as the feature set of the gradebook / points system.

An application for mobile devices offers two viable benefits over the mobile website view in the browser.

- Offline mode to view course content without an internet connection.
- Push notifications (for example new courses, grades, messages)

Live chat is a feature that was thought to be useful considering the expert interview results (interaction between users). Furthermore, upon independent testing and comparison of the plugins, it was discovered that a customisable dashboard could enhance the user experience. These potential modifications could prove useful for rescue service corporations (for example Red Cross), allowing for the adaptation of the platform to implement their corporate identity.

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[2] https://saas-guru.info/masterstudy-lms-vs-tutor-lms/
https://vocal.media/geeks/tutor-lms-vs-masterstudy-lms-what-you-need-to-know

Table 4: WordPress Plug-In comparison using a decision matrix

Criteria	Weight	Tutor LMS version: 2.2.4		MasterStudy LMS version: 4.8.12	
		Points	Weighted points	Points	Weighted points
Price	0,1	1	0,10	2	0,20
Mobile App	0,3	0	0,00	1	0,30
Live Chat	0,2	0	0,00	1	0,20
Personalized Dashboard	0,2	1	0,20	2	0,40
Sum			0,3		1,1

MasterStudy LMS scores 1,1 while Tutor LMS scores 0,3 due to the price and feature difference.

4.2.4 Creating Courses and Sample Content

The first course content for the UEQ-participants to evaluate was created using the online dashboard. Critical course information such as the course name, the category, the level (Beginner, EMT, Paramedic), and an image must be provided as seen in Figure 18.

Figure 18: Course creation

After creating demo courses, the courses appear in the dashboard. On the left side of this dashboard, the courses can be filtered for categories (for example diagnostics, anatomy, and guidelines). Furthermore, the level (Beginner, EMT, Paramedic) can be filtered so the student can view courses that fit their skill level appropriately. The following Figure 19 shows the dashboard with the filter.

All courses depending on your selection
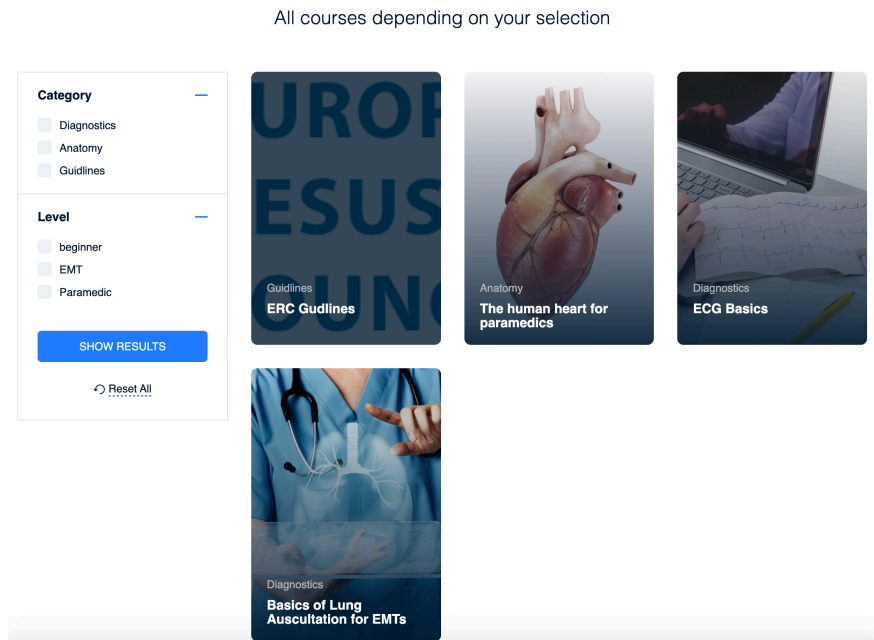

Figure 19: Course overview / dashboard

In the student's dashboard, all enrolled courses show up (see Figure 20). As stated by the participants of the **expert interview in question 14**, tracking the course progress is a vital feature that was implemented by altering the course's properties.
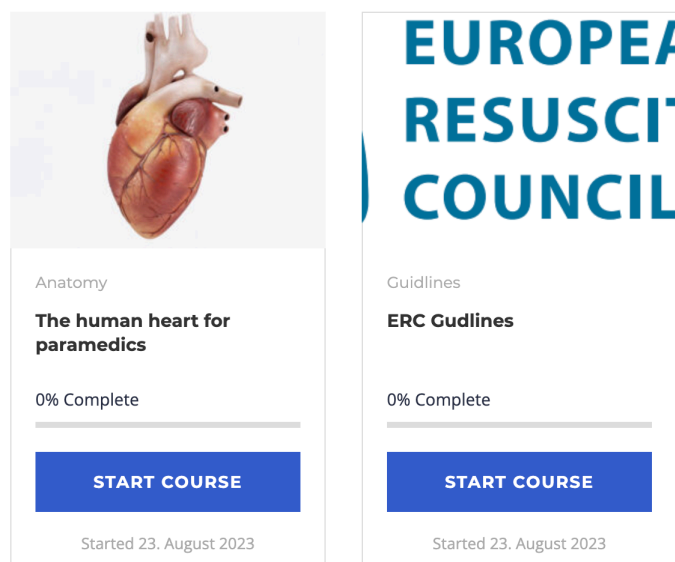
Figure 20: Detailed course information inside the dashboard with completion rate

Inside the course itself, detailed information is provided to the student, as seen in Figure 21. Important information such as the number of enrolled students as well as the duration of the course and the duration of the multimedia video content can be viewed at one glance at the right sidebar.

When clicking on the "Curriculum" tab, the individual course chapters are presented to the student as seen in Figure 22.
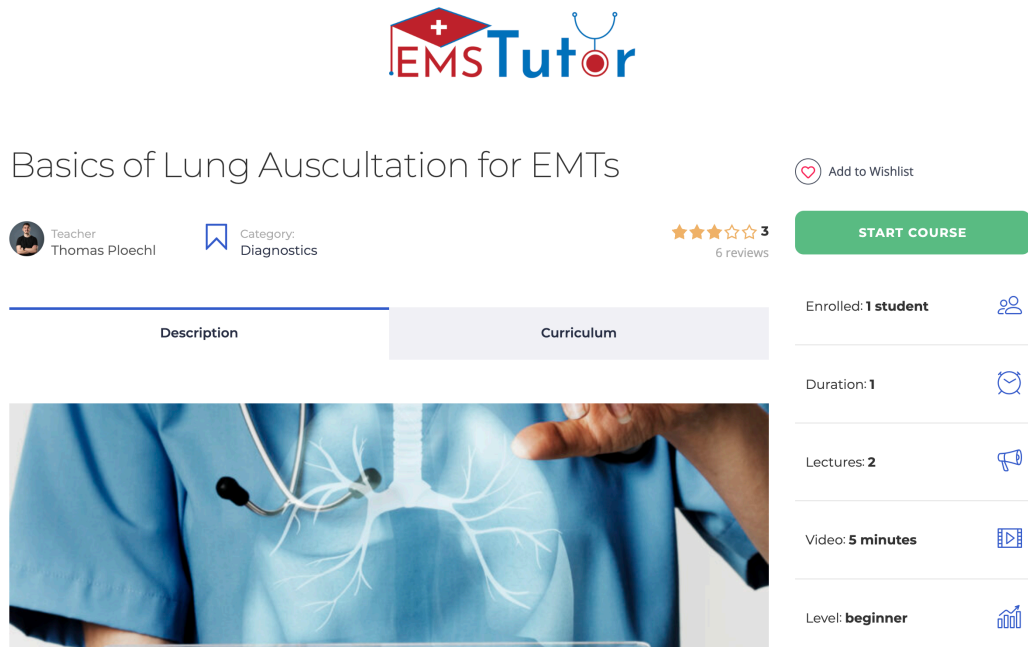
Figure 21: Inside a course

Figure 22: Individual course chapters

The Austrian Red Cross platform has some issues regarding the mobile responsive design. The prototype was designed with a mobile-first strategy. All users on mobile devices can visit the platform properly without any visual issues as seen in Figure 23.
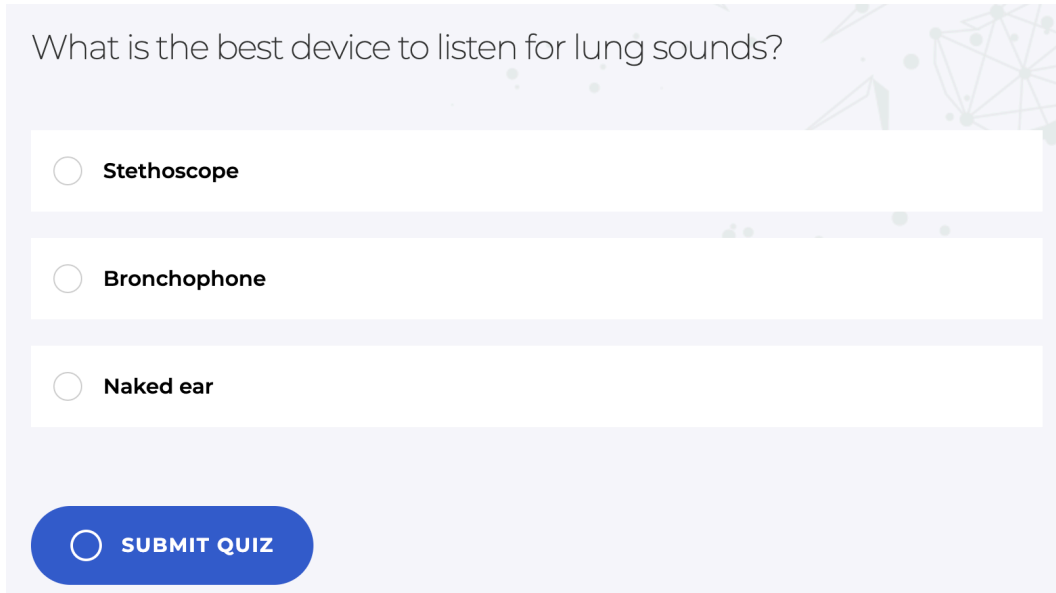
Figure 23: Mobile responsive design

Due to the reason that many expert interview participants (12 out of 16 / 75 %) found that quizzes and tests are interesting, this feature was activated inside the course properties. Figure 24 shows an example quiz.
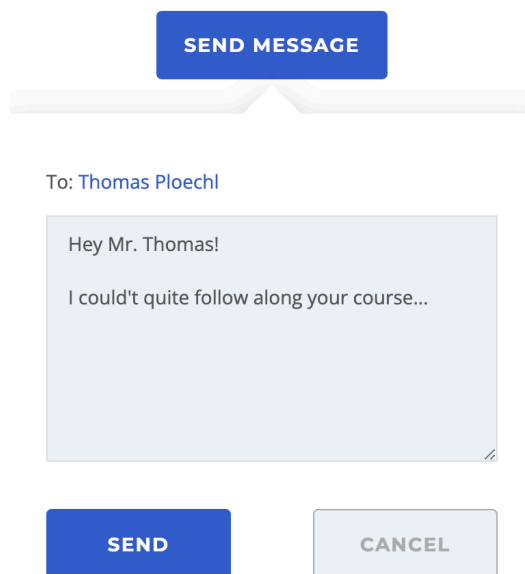
Figure 24: Example course quiz

Due to the demand for social interaction in question number 9 from the expert interview questionnaire, a suitable plugin that provides this feature was chosen. After configuring the chat function, the student can interact with the teacher using a simple online form (see Figure 25)

Figure 25: Interaction between users using the chat function.

When enrolling in a course, the user is prompted to either log-in with an existing account or create a new one. After entering the user credentials, access is provided to the course. Figure 26 shows the log-in interface.

Figure 26: Log-in / Sign-up process

After registration, every user is assigned the user role of "student". A request to become an instructor can be sent out using a short form depicted in Figure 27. After submitting the form, the request can be accepted or declined within the administrator's dashboard.
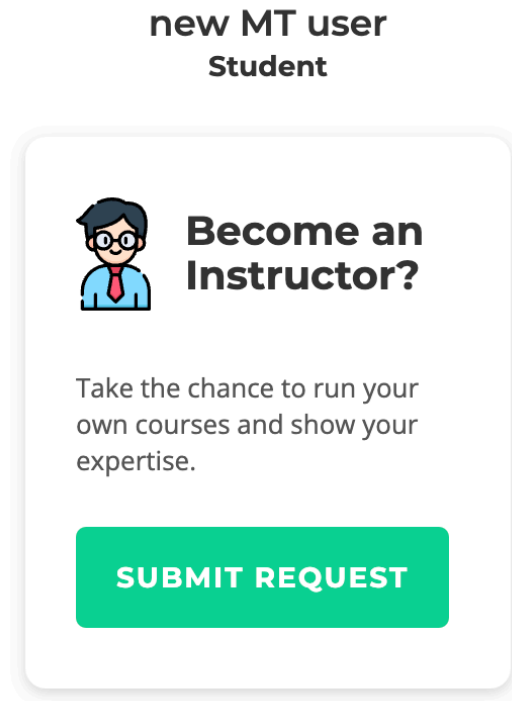
Figure 27: Instructor request

4.2.5 Performance Optimization

This chapter delves into the details of website performance optimization, exploring techniques to enhance loading times, responsiveness, and overall improving the user experience.

Website performance testing

Google PageSpeed Insights is a web-based tool provided by Google that helps website owners and developers analyse the performance of their web pages. It provides insights and recommendations on how to improve the loading speed and overall user experience of a website. PageSpeed Insights evaluates both mobile and desktop versions of a website and provides a performance score along with detailed suggestions for optimization. (*Informationen zur PageSpeed Insights API*, n.d.)

To benchmark the performance of the prototype website, a Google PageSpeed test was performed before and after the optimisation.

Performance results before optimization

The benchmark results before the optimisation depicted in Figure 28 show a variety of areas for improvement. Especially performance (speed) with 73% can be improved.

Specific areas of improvement are:

- Text compression
- Resources that block rendering
- Removing used CSS and JavaScript files
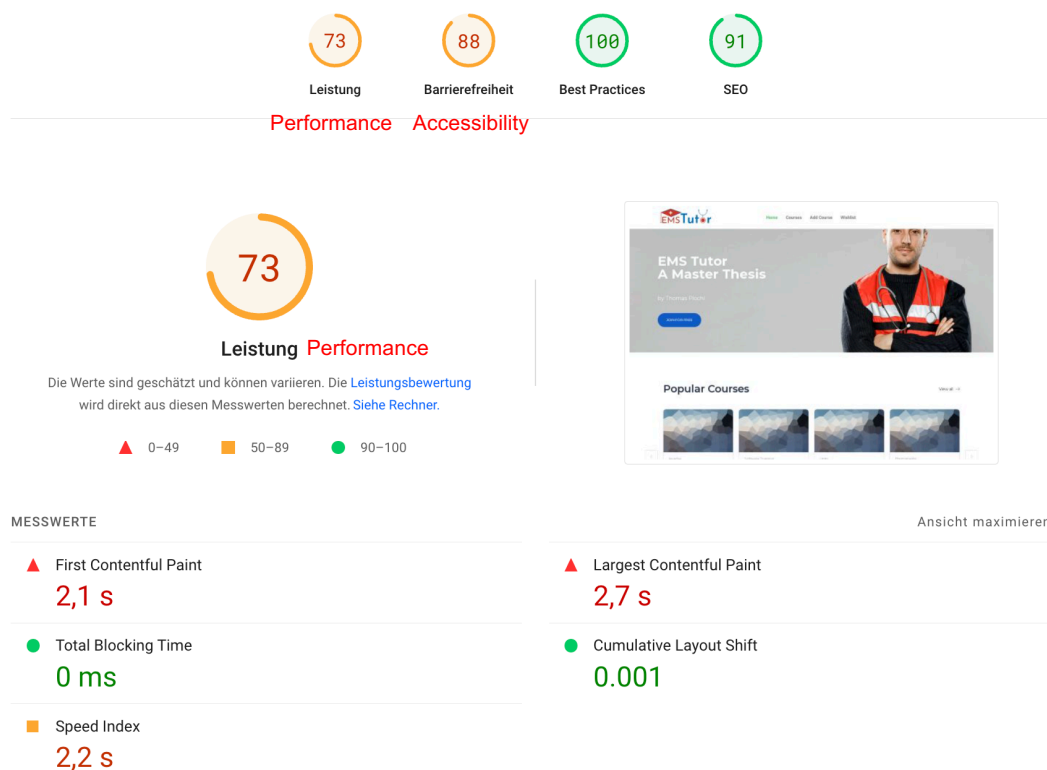
Figure 28: Google PageSpeed result before optimisation. (English translation in red lettering)

Caching

Website caching is the process of storing and reusing frequently accessed web page elements, like images, scripts, and content, to improve loading speed and reduce server load. It enhances the user experience by delivering faster and more efficient web pages. (*What Is Caching?*, n.d.)

To implement caching on the prototypical website, the plugin WordPress plugin "Jetpack" was used.

GZIP compression

GZIP compression is a method used to reduce the size of files, such as web page resources, before they are sent over the internet. It works by compressing the data using the GZIP algorithm, which eliminates redundant or repetitive information, resulting in smaller file sizes. This reduces the amount of data that needs to be transferred between a web server and a user's browser, leading to faster page loading times and improved website performance (*GZIP Komprimierung*, n.d.).

The compression can be performed using plugins on WordPress or manually adjusted inside the .htaccess file on the webserver using the following code (in this case specifically compressing **JavaScript, fonts, CSS, HTML, and text elements**):

```
<IfModule mod_deflate.c>
  AddOutputFilterByType DEFLATE application/javascript
  AddOutputFilterByType DEFLATE application/x-font
  AddOutputFilterByType DEFLATE text/css
  AddOutputFilterByType DEFLATE text/html
  AddOutputFilterByType DEFLATE text/javascript
  AddOutputFilterByType DEFLATE text/plain
  AddOutputFilterByType DEFLATE text/xml
</IfModule>
```

A manual optimisation allows a more precise adjustment, on which file formats should be compressed.

Optimizing media and fonts

Lazy loading is a technique to improve page loading performance by deferring the loading of non-essential or off-screen content until it's needed. This is particularly useful for web pages that contain a large number of images, videos, or other media files. The traditional way of loading content on a web page involves fetching all resources at once, which can result in slower initial loading times, especially when dealing with large or numerous media files. Lazy loading, on the other hand, delays the loading of certain elements until they come into the user's view, or when they are about to be interacted with (*Lazy Loading - Web Performance | MDN*, 2023).

To implement lazy loading, the WordPress Plugin "W3 Total Cache" was used.

Content delivery network

To further improve the website's performance, a CDN (Content Delivery Network) was used. A content delivery network can be implemented via WordPress plugins or configured manually within the webhost settings. For a manual configuration, the DNS (Domain Name System) parameters need to be directed to the servers of the CDN. For this thesis, "Cloudflare" was used as a CDN.

Webservers before CDN utilisation:

```
ns2.world4you.at
ns1.world4you.at
```

Webservers after CDN utilisation:

```
art.ns.cloudflare.com
lady.ns.cloudflare.com
```

A CDN, or Content Delivery Network, is a network of geographically distributed servers designed to deliver web content and assets to users more efficiently. The main purpose of a CDN is to optimize the delivery of web pages, images, videos, scripts, and other resources by reducing the physical distance between the user's device and the server that hosts the content.

Performance results after optimization

Due to the optimisation processes, the PageSpeed score could be **increased from 73% to 92%** as seen in Figure 29. The speed index as well as the time to draw the first content on screen increased.
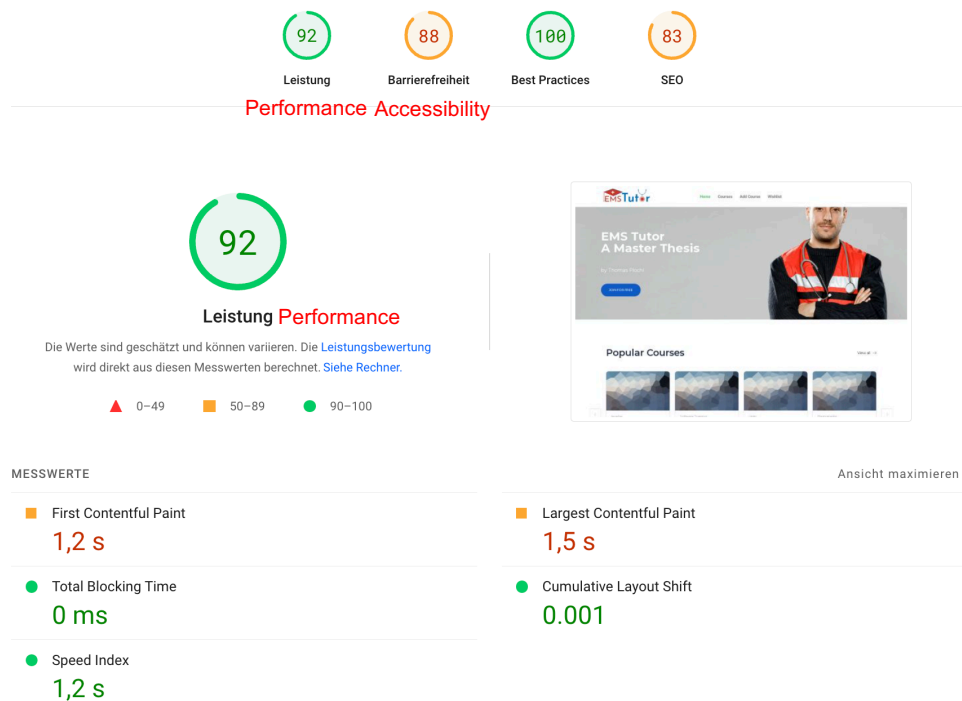
Figure 29: Google PageSpeed result after optimisation. (English translation in red lettering)

4.2.6 Improving Security

SSL encryption

To improve the website's security, an SSL (Secure Sockets Layer) certificate was installed on the webserver.

An SSL certificate, which stands for Secure Sockets Layer certificate, is a digital certificate that helps secure the communication between a user's web browser and a web server. It ensures that data transmitted between the browser and server is encrypted and protected from unauthorized access, providing a secure connection for sensitive information such as login credentials, credit card details, and personal data (*What Is SSL (Secure Sockets Layer)?*, n.d.).

For this website, a Basic-Wildcard certificate was installed through the host's web interface in foresight of possible future subdomains. The basic functionality is shown in Figure 30.

A Wildcard SSL certificate is a type of SSL certificate that allows users to secure a main domain and all its subdomains with a single certificate (*Types of SSL Certificates | SSL Certificate Types Explained*, n.d.).
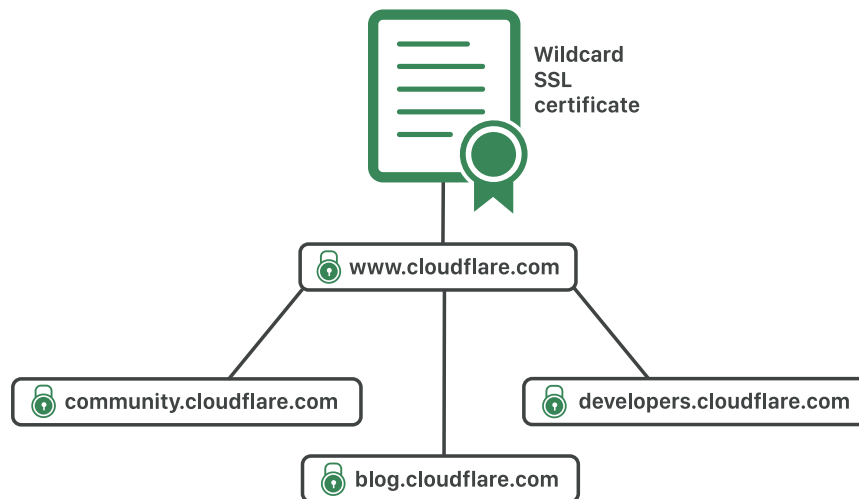
Figure 30: Wildcard SSL certificate (subdomain encryption) (*Types of SSL Certificates | SSL Certificate Types Explained*, n.d.)

2-factor authentication

Two-factor authentication (2FA) is **an additional layer of security** used to protect user accounts from unauthorized access. It requires users to provide two different types of identification factors when logging into an account, making it much more difficult for attackers to gain access, even if they have the user's password (*What Is Two-Factor Authentication (2FA) and How Does It Work?*, n.d.).

The two factors that are used in 2FA can typically be divided into three categories:

Knowledge factor: This is usually a password or PIN that the user knows. It's the first factor and is the most common form of authentication.

Possession factor: This is a physical device or token that the user possesses, such as a smartphone, hardware token, or smart card.

Biometric factor: This involves biometric characteristics of the user, such as fingerprint, facial recognition, or iris scan.

For this prototype, a two-factor authentication using a **possession factor.** The user trying to log in to the website needs to confirm the login-request on a secondary device (smartphone). To implement the 2-factor authentication, the PlugIn "miniOrane" in conjunction with the Google Authenticator was used. After the setup-process, the user trying to log in needs to verify the login on their mobile device, as seen in Figure 31 and Figure 32.
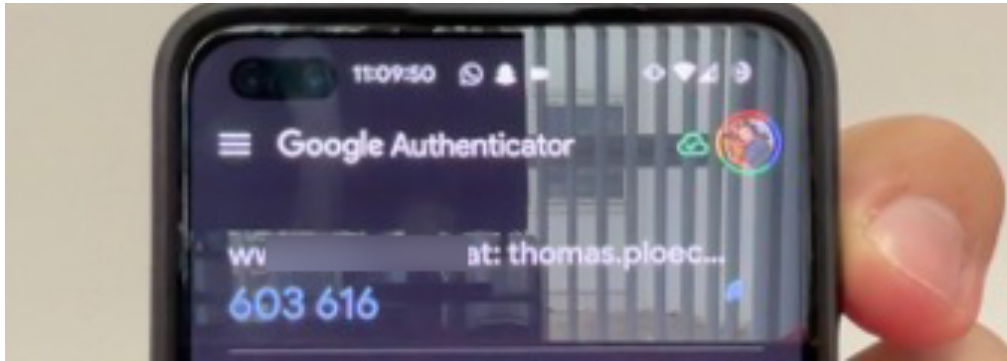
Figure 31: Code inside the Google Authenticator app

Figure 32: Prompt to input the authentication code from the Google Authenticator app.

4.3 Graphic and Logo Design

To create a more attractive appearance for the potential end-users as well as the participants of the User Experience Questionnaire (UEQ), a draft logo was created. The logo implementation should also increase user experience and therefore increase the UEQ-score.

Adobe Illustrator was the tool of choice for designing a logo for the online learning platform due to the ability to design and export image files in a vector file format. Compared to standard rasterized images which are built out of blocks of colour (pixels), vector files are images that have been created using mathematical formulas that define the points on a grid. This process allows the images to be up and downscaled infinitely without losing the image quality. Rasterized images with pixels can only be scaled up to a certain point without losing image fidelity (*What Is a Vector File & How to Use & Create Them | Adobe*, n.d.).

Another advantage of vector files is, that they offer a smaller file size in comparison to rasterized images (*Vector Files*, n.d.). As depicted in Figure 33, the scaling properties are visualized.
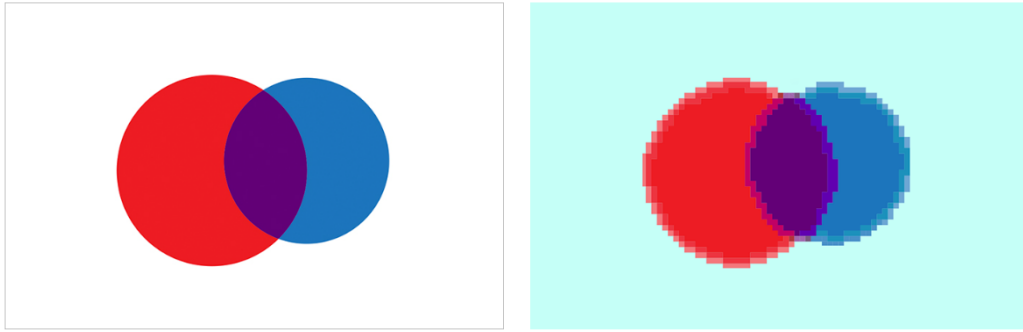
Figure 33: Vector image (left) versus rasterized image (right) (*What Is a Vector File & How to Use & Create Them | Adobe*, n.d.)

Inside Adobe Illustrator, a new file was created using the dimensions 2000 by 1300 pixels. The exact dimensions no not matter hence the file is exported as a vector file (.svg file format). The dimensions chosen are important for the image aspect ratio to create a file that is about twice the height compared to the width of the image. The letters "EMS Tutor" were created using the text tool, whereas the additional design elements were created using the path tool to draw the rhombus and the rectangle tool to draw the white cross as well as the cord hanging down. In the third step, the letter 'o' was replaced with a stylized o which resembles a stethoscope.

The following figures (Figure 34, Figure 35, Figure 36, Figure 37) depict the design iterations.

Figure 34: Step 1 - Creating the text element.
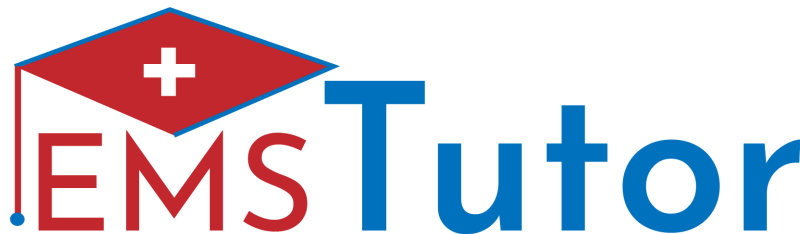
Figure 35: Step 2 - Creating additional design elements using the path tool.
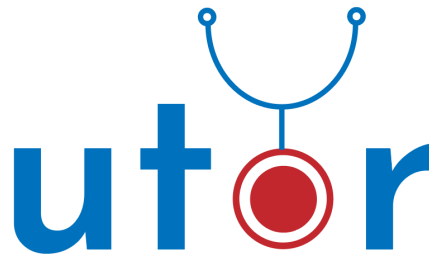
Figure 36: Replacing the letter 'o' with a stethoscope.
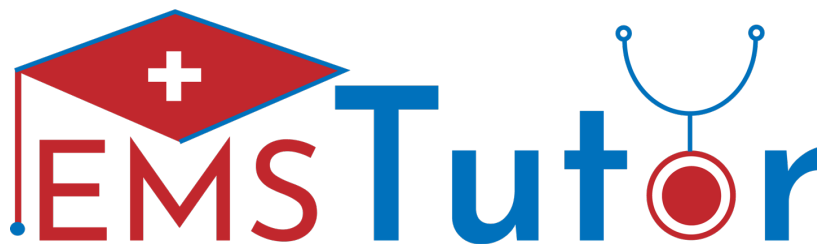
Figure 37: Final EMS Tutor Logo

4.4 Sample Video Production

To evaluate the online learning platform, a first sample video was created. The video is intended to convey certain learning contents both theoretically and practically in an online course. This section will highlight the steps involved in creating a video that demonstrates how a patient's lung is auscultated. The goal is to show the key aspects of lung auscultation in a short videoclip using audio-visual effects.

4.4.1 Video Production

To convey the learning content in the best possible way and maintain a professional appearance, the video needed to be produced using high-quality camera equipment. The video was recorded in a resolution of 3840 pixels horizontally by 2160 vertically. This high resolution allows more flexibility in the post-production workflow to crop into the image to highlight certain key aspects of lung auscultation. To create a steady and smooth image, an electronic gimbal was used to stabilize the camera. The lens used offers a large focal range to capture wide angle as well as close-up shots without the need to change the lens. All video files are captured with a colour depth of 10 bit with a 4:2:2 chroma subsampling.

Recording options

- Resolution: 3840 x 2160
- Colour depth: 10 bit, 4:2:2 chroma subsampling
- Framerate: 50 frames per second

At 8-bit, each channel can capture 256 shades of a given colour, so the final image can represent a total of 16.7 million colours. A 10-bit file contains 1,024 shades per channel, giving a total of more than one billion colours. This allows for more flexibility in the post-production and colour grading workflow.

4:2:0 subsampling provides for the smallest files, but with reduced colour information, there is less flexibility during post-production editing. In contrast, 4:2:2 results in more colour information. This allows for greater flexibility during editing and maintains high image quality even after colour grading (*Videography FAQ*, n.d.). As Figure 38 depicts, with 4:2:0 some colour information is lost.

Figure 38: Chroma subsampling 4:2:2 vs 4:2:0 (Moore, 2023)

All footage is captured in 50 frames per second. The final project will be exported in 25 frames per second. This allows for the footage to be slowed down by 50%. This could be useful to visualize certain steps more precisely.

Video equipment

- Camera: Sony A7s III
- Lens: Tamron 28-75mm f 2.8
- Gimbal: DJI Ronin RS2 (see Figure 39)

Figure 39: Ronin RS2 gimbal with mounted camera

Storyboard

To plan and execute the video production more efficiently, a simple storyboard was drawn by hand (see Figure 40)

- Scene 1/1: Teacher and topic introduction
- Scene 1/2: Teacher and topic introduction (close-up)
- Scene 2/1: Teacher auscultating patient with a stethoscope (wide)
- Scene 2/2: Teacher auscultation patient with a stethoscope (close-up)
- Scene 2/3: Teacher auscultating patient with a stethoscope (wide)
- Scene 3/1: Useful tips and tricks, closing thoughts.
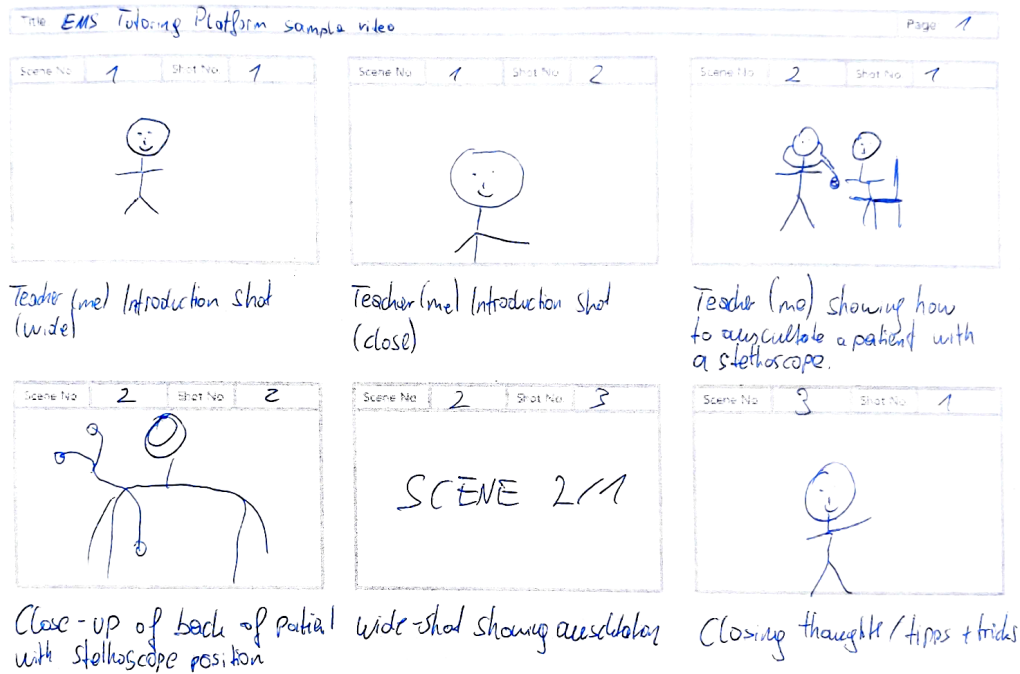
Figure 40: Storyboard

4.4.2 Video Post-Production

After the video shoot was finished, all video files were imported into Adobe Premiere Pro. Adobe Premiere Pro is a non-linear video production software that was used to cut the recorded clips, apply certain effects (colour-grading, slow-motion, text-inserts…), and export the project as a video file after the editing process was complete. To add special effects like camera tracking, Adobe After Effects was used alongside Adobe Premiere Pro.

As video production is not in the main scope of this thesis, the general steps of video cutting, colour grading, exporting, and text-inserts as well as screengrabs of the remaining scenes according to the storyboard are not presented in detail.

After importing the footage into Adobe Premiere Pro, the individual clips were replaced by an Adobe After Effects composition to apply the 3D Camera-Tracker. The 3D Camera-Tracker was used to virtually place any object (in this case an image of a lung) inside the scene in 3D-space. This translates to the object staying in the same position even if the camera itself was moved while shooting the clip – it moves alongside the camera's movement. Figure 41 shows the automatically generated tracking points and the red target circle, which represents a plane in 3D-space where the desired object is going to be placed.

Figure 41: 3D Camera-Tracking points with a red target circle

A graphic of a lung was placed in the scene. Using rotoscoping, a technique to trace moving footage frame by frame, the arm was masked out to make the lung disappear behind the arm. The results are depicted in the following Figure 42.
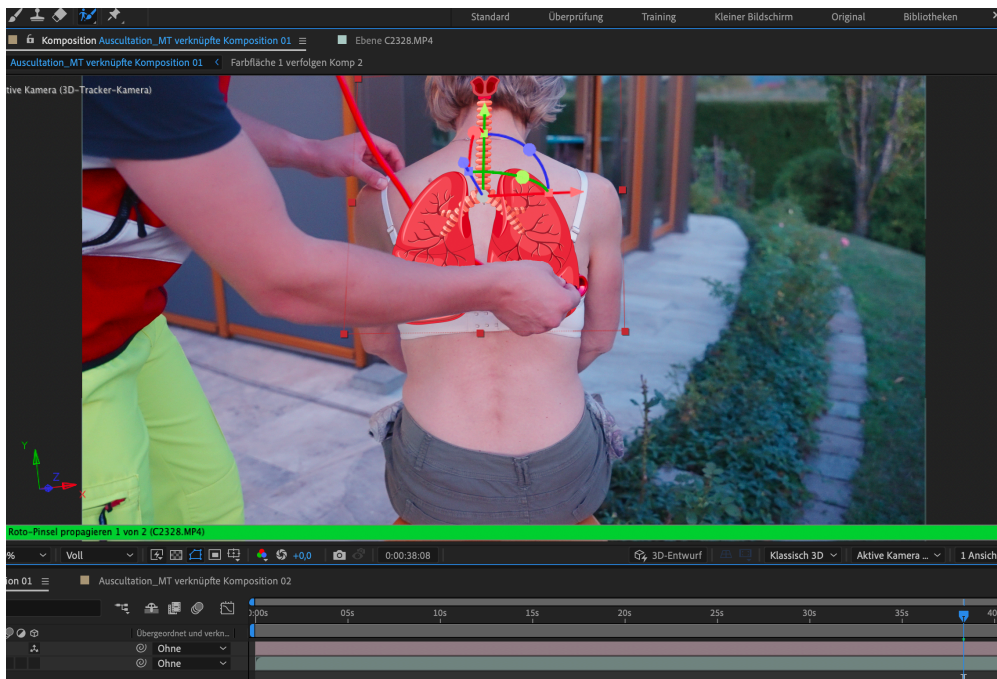
Figure 42: Rotoscoping the arm to place the lung behind it

The lung model in 3D-space should assist students' comprehension of auscultation points on the patient's back. For the purpose of this thesis, the position, and size of the lung is not fully anatomically correct.
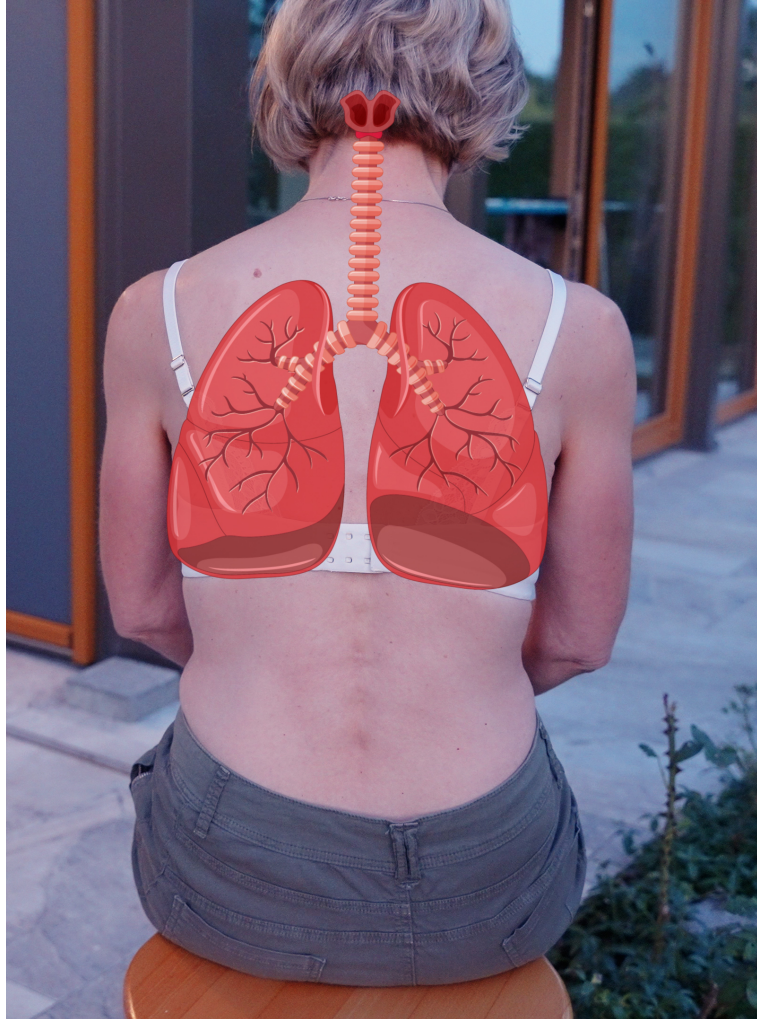
Figure 43: Lung model in 3D-space inside the scene (final image)

Figure 43 shows the final image.

After editing the footage inside Adobe After Effects, the final steps of producing the video were made in Adobe Premiere Pro:

- Colour correction
- Text inserts
- Slow-motion effects
- Exporting

5 Testing and Evaluation Results

In this part of the master thesis, the results of the UEQ usability test are discussed, and conclusions are drawn from them to answer the research question. This chapter will provide an overview of the testing and evaluation results for the EMS Learning and Tutoring Platform. It will discuss the methods used to gather feedback and the key findings from the testing and evaluation process. Additionally, this chapter will examine the implications of these findings for the design and development of online learning platforms for EMS personnel.

Testing and evaluating the usability of the EMS Learning and Tutoring Platform is critical to ensure that the platform is meeting the needs of EMS personnel and providing an effective learning experience. Testing and evaluation of the platform involved gathering feedback from EMS personnel to assess the platform's usability, effectiveness, and potential impact on learning outcomes.

5.1 Evaluation (UEQ)

To evaluate the usability of the developed platform, the **user experience questionnaire (UEQ)** was used. The usability of the developed prototype was compared to an existing platform developed by the Austrian Red Cross (Moodle based). All participants of the UEQ have full access to both e-learning platforms to fully test the usability. The UEQ was filled out online using a Google Forms survey depicted in the following Figure 44.

Figure 44: Google Forms UEQ survey

The UEQ Usability Test is a quick and easy way to measure the user experience (UX) of a product. It is a self-reported questionnaire that consists of 26 items, grouped into six scales. The detailed items associated with each group can be found in Figure 45, courtesy of the official UEQ-handbook.

- Attractiveness (ATT): How appealing is the product to the user?
- Perspicuity (PER): How easy is it to understand how the product works?
- Efficiency (EFF): How easy is it to use the product to achieve its goals?
- Dependability (DEP): Does the user feel in control of the interaction?
- Stimulation (STI): Does the product provide a stimulating and engaging experience?
- Novelty (NOV): How new and innovative is the product?
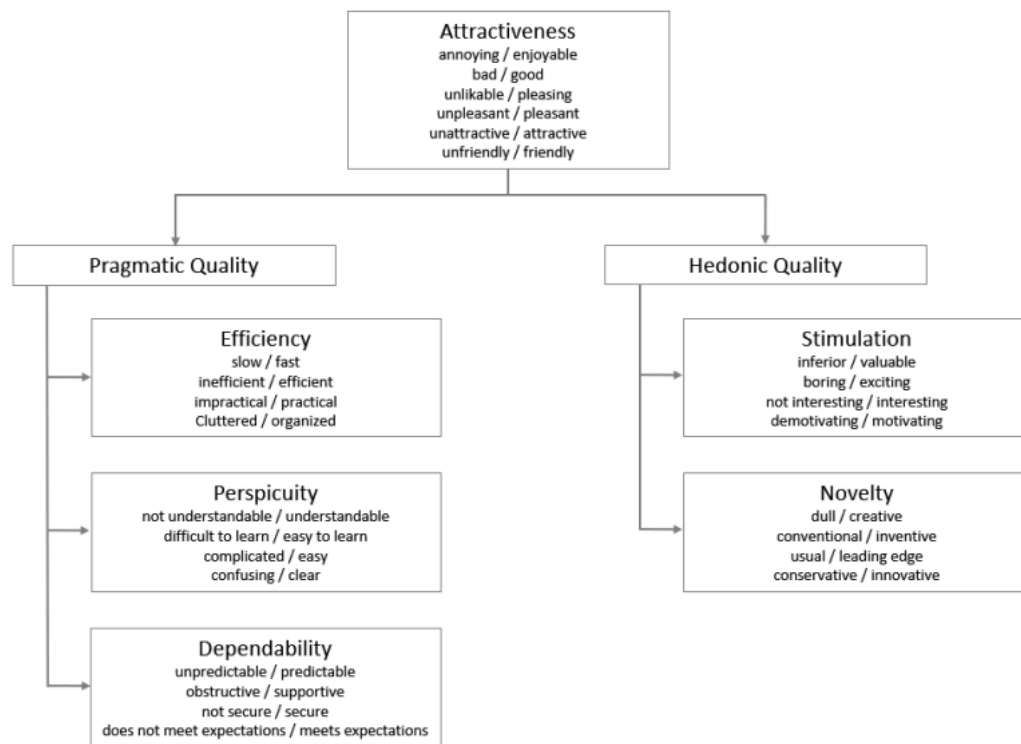
Figure 45: Assumed scale structure of the UEQ (UEQ Team, 2023)

The UEQ is designed to be completed by users after they have had a short amount of time to interact with the product. It can be administered online or in person. The results of the UEQ can be used to identify areas where the UX of the product can be improved. (UEQ Team, 2023)

The questionnaire was sent out via an online form. Firstly, the prototype was evaluated, and afterwards the existing Austrian Red Cross platform was evaluated.

1. The user is given a brief overview of the product.
2. The user is then asked to complete the 26-item questionnaire.
3. The items are rated on a scale of -3 to +3. Accordingly, a rating of -3 indicates the most negative response, a rating of 0 denotes a neutral response, and a rating of +3 represents the most positive response.
4. The results of the questionnaire are then analysed to identify the strengths and weaknesses of the product's UX.

After gathering all the results in a spreadsheet, the data was analysed using the **UEQ-comparison spreadsheet.** All datasets from the Google Forms survey have been transferred and evaluated.

As seen in Table 5 the raw data from the survey was transferred to the first spreadsheet "MT Prototype".

Table 5: Raw data input (UEQ-comparison spreadsheet)

Description of data set 1:	MT Prototype

Items																									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
6	5	2	2	2	4	6	5	2	2	4	3	6	5	4	5	1	2	3	6	2	6	2	3	1	5
5	6	4	1	3	5	5	7	2	5	5	3	6	5	2	5	4	4	2	5	3	5	3	5	3	3
6	5	1	2	2	5	6	5	1	2	4	2	5	5	5	6	3	3	2	5	3	5	2	2	2	6
4	5	4	3	2	4	6	6	1	5	3	3	3	6	4	5	2	3	2	5	2	7	3	3	2	5
6	6	4	2	1	5	7	6	2	3	6	1	6	5	6	6	2	1	1	6	2	7	1	3	3	6
3	5	4	4	3	5	5	4	3	3	4	4	4	5	5	5	2	3	4	5	3	6	4	3	3	4
5	3	2	3	4	4	4	4	2	3	5	4	4	5	5	5	2	4	4	5	2	5	6	2	2	5

The questionnaire randomizes the order in which positive and negative terms are presented for each item. Within each dimension, half of the items are presented with the positive term first and the other half with the negative term first. As presented in Table 6, the values are transformed. The +3 represents the most positive and the -3 the most negative value.

Table 6: Transformed data (UEQ-comparison spreadsheet)

Items																									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
2	1	2	2	2	0	2	1	2	2	0	1	2	1	0	1	3	2	1	2	2	2	2	1	3	1
1	2	0	3	1	1	1	3	2	-1	1	1	2	1	-2	1	0	0	2	1	1	1	1	-1	1	-1
2	1	3	2	2	1	2	1	3	2	0	2	1	1	1	2	1	1	2	1	1	1	2	2	2	2
0	1	0	1	2	0	2	2	3	-1	-1	1	-1	2	0	1	2	1	2	1	2	3	1	1	2	1
2	2	0	2	3	1	3	2	2	1	2	3	2	1	2	2	2	3	3	2	2	3	3	1	1	2
-1	1	0	0	1	1	1	0	1	1	0	0	0	1	1	1	2	1	0	1	1	2	0	1	1	0
1	-1	2	1	0	0	0	0	2	1	1	0	0	1	1	1	2	0	0	1	2	1	-2	2	2	1

The transformed data was then applied to the individual categories as seen in Table 7.

Table 7: Transformed data applied to categories.

Skale means per person (first evaluation)					
Attractiveness	Perspicuity	Efficiency	Dependability	Stimulation	Novelty
1,50	1,75	2,00	1,25	1,50	1,25
0,67	2,00	1,25	1,50	0,75	-1,00
1,83	1,25	1,75	1,00	1,50	2,00
1,17	0,75	2,00	1,25	1,25	0,00
1,67	2,00	2,50	2,25	2,50	1,25
0,50	0,50	1,00	0,50	1,00	0,50
1,17	0,50	0,50	0,75	0,00	1,25

The same data input and transformation process was performed using the second dataset from the evaluation of the other EMS tutoring platform.

After this step, the data was compared using scale means. The results are presented in chapter 5.2. The next subchapter will provide a short overview of how to interpret the results according to the official UEQ-handbook.

5.1.1   Interpretation Guidelines of the Results

According to the official UEQ-handbook, the results can be interpreted in the following way:

> "The standard deviation of a scale mean can be interpreted as a measure for the level of agreement of the participants concerning the UX quality aspect measured by a scale. The lower the standard deviation is, the more do different participants agree in their evaluation. A recommendation to interpret the standard deviations of UEQ scales was derived from the analysis of a large sample of UEQ studies." (UEQ Team, 2023)

Three thresholds were defined:

- High agreement: Standard deviation of scale below 0.83.
- Medium agreement: Standard deviation of scale between 0.83 and 1.01.
- Low agreement: Standard deviation of scale above 1.01.

5.2 Results (UEQ)

Seven participants carried out the UEQ usability test. This chapter presents a detailed analysis of the UEQ survey data. All UEQ data can be found in the appendix in section B.

The results of the UEQ usability test indicate that the prototype outperforms the current Red Cross platform in the categories of "Attractiveness", "Perspicuity", "Efficiency", "Simulation", and "Novelty". In the category of "Dependability", the current platform of the Red Cross shows superior performance.

Table 8 shows the detailed results of the scale means comparison.

Table 8: Comparison of scale means (Table view)

| Scale | MT Prototype | | | | | | kurse.roteskreuz.at | | | | |
	Mean	STD	N	Confidence	Confidence Interval		Mean	STD	N	Confidence	Confidence Interval
Attractiveness	1,21	0,50	7	0,37	0,85	1,58	0,76	0,99	7	0,73	0,03	1,49
Perspicuity	1,25	0,68	7	0,50	0,75	1,75	0,82	1,04	7	0,77	0,05	1,59
Efficiency	1,57	0,69	7	0,51	1,06	2,08	0,68	1,10	7	0,81	-0,13	1,49
Dependability	1,21	0,57	7	0,42	0,79	1,63	1,29	0,93	7	0,69	0,60	1,97
Stimulation	1,21	0,77	7	0,57	0,64	1,78	0,64	1,00	7	0,74	-0,10	1,38
Novelty	0,75	1,00	7	0,74	0,01	1,49	-0,25	1,55	7	1,15	-1,40	0,90

This diagram in Figure 46 shows a visual representation of the UEQ usability test results. The average values of the prototype platform are represented by the blue bars, whereas the red bars indicate the average values of the kurse.roteskreuz.at platform. Table 9 illustrates a more thorough analysis.

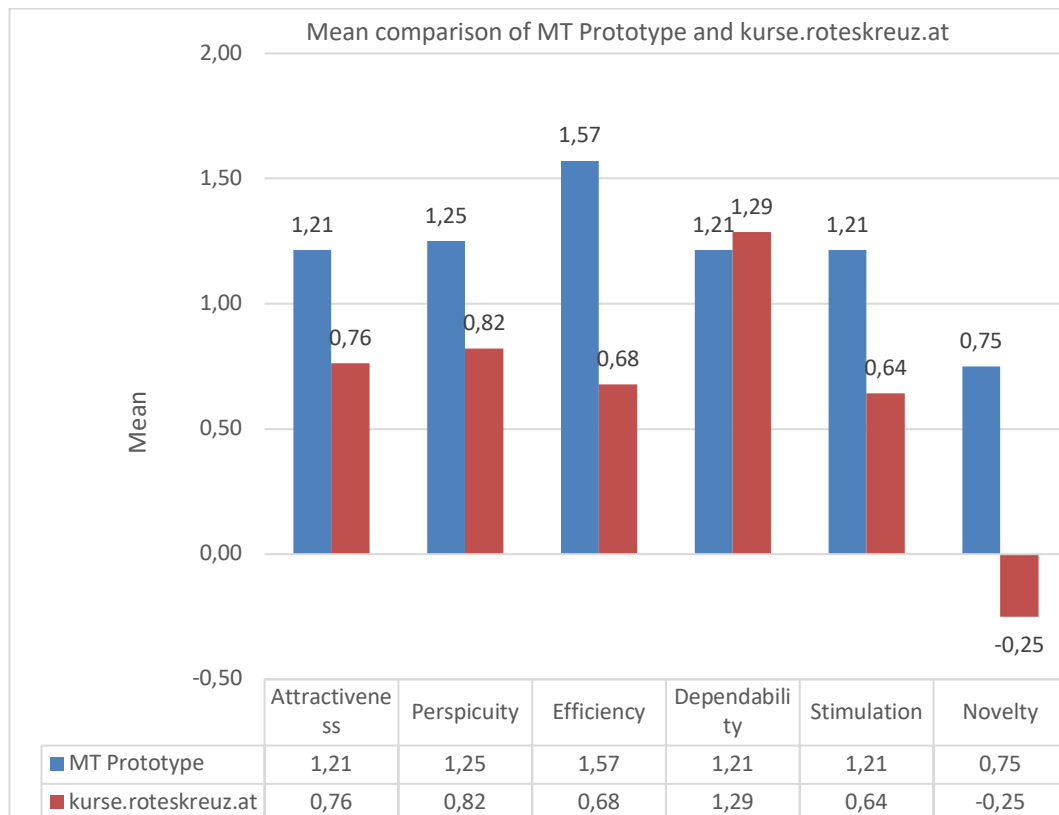|	Attractiveness	Perspicuity	Efficiency	Dependability	Stimulation	Novelty
MT Prototype	1,21	1,25	1,57	1,21	1,21	0,75
kurse.roteskreuz.at	0,76	0,82	0,68	1,29	0,64	-0,25

Figure 46: Comparison of scale means (Diagram view)

Table 9: Detailed analysis (Delta and % Difference)

Category	Mean Prototype	Mean kurse.roteskreuz.at	Δ	% Difference
Attractiveness	1,21	0,76	0,45	159%
Perspicuity	1,25	0,82	0,43	152%
Efficiency	1,57	0,68	0,89	231%
Dependability	1,21	1,29	-0,08	94%
Stimulation	1,21	0,64	0,57	189%
Novelty	0,75	-0,25	1	-300%
Average	1,20	0,66	0,54	88%

On average, the prototype scored a mean of 1,2 and the <u>kurse.roteskreuz.at</u> platform a mean of 0,66 across all the categories. Delta value average is 0,54 which translates to an average percentual difference of 88%. The prototype platform scores 88% higher on average in terms of mean values.

Attractiveness: The "Attractiveness" category shows that the "Mean Prototype" score is 1.21, while the "Mean kurse.roteskreuz.at" score is lower at 0.76. This represents a significant positive difference of 0.45 (159% difference), indicating that the prototype data rates the category of attractiveness higher than the data from kurse.roteskreuz.at.

Perspicuity: In the "Perspicuity" category, the "Mean Prototype" score is 1.25, which is higher than the "Mean kurse.roteskreuz.at" score of 0.82. This indicates a positive difference of 0.43 (152% difference), suggesting that the prototype data rates perspicuity higher than the kurse.roteskreuz.at data.

Efficiency: The "Efficiency" category demonstrates the most substantial difference. The "Mean Prototype" score is 1.57, significantly higher than the "Mean kurse.roteskreuz.at" score of 0.68. This results in a considerable positive difference of 0.89 (231% difference), indicating that efficiency is rated much higher in the prototype data compared to kurse.roteskreuz.at.

Dependability: In the "Dependability" category, the "Mean Prototype" score is 1.21, while the "Mean kurse.roteskreuz.at" score is slightly higher at 1.29. This leads to a negative difference of -0.08 (94% difference), suggesting that dependability is rated slightly higher in the kurse.roteskreuz.at data.

Stimulation: The "Stimulation" category shows a notable difference. The "Mean Prototype" score is 1.21, whereas the "Mean kurse.roteskreuz.at" score is 0.64.

This results in a substantial positive difference of 0.57 (189% difference), indicating that stimulation is rated much higher in the prototype data.

Novelty: In the "Novelty" category, the "Mean Prototype" score is 0.75, while the "Mean kurse.roteskreuz.at" score is much lower at -0.25. This leads to a significant negative difference of -1 (300% difference), suggesting that the prototype data rates novelty significantly higher than the kurse.roteskreuz.at data.

In summary, the table data demonstrates differences in the ratings of various categories between the "Mean Prototype" and "Mean kurse.roteskreuz.at" data sources. The magnitude and direction of these differences vary across categories, with some aspects being rated much higher in one source compared to the other. These differences can provide insights into how the two data sources perceive and assess these categories.

To find out if there is any significant difference between the two evaluated platforms, a two sample T-Test assuming unequal variances was used (see Table 10). **With an alpha level of 0,05, no significant difference between the two EMS-tutoring platforms was found:**

Table 10: T-Test

Alpha level:	0,05	
Attractiveness	0,3068	No Significant Difference
Perspicuity	0,3811	No Significant Difference
Efficiency	0,0977	No Significant Difference
Dependability	0,8656	No Significant Difference
Stimulation	0,2550	No Significant Difference
Novelty	0,1821	No Significant Difference

6 Discussion

The research has shown that online learning platforms have both advantages and disadvantages. The advantages include convenience, flexibility, interactive learning experiences, and social interactions. The disadvantages include the need for high-quality and accurate content, user-friendly design, and continuous professional development for teachers and educators. The results of the expert interviews suggest that e-learning platforms are a valuable tool for continuing education in the emergency services. However, there are some areas where the platforms can be improved to better meet the needs of learners. These areas include usability on mobile devices, presentation of course content, and tracking of learning progress.

The functional and technical requirements for a prototypical internet-based learning and tutoring platform for emergency medical services have been outlined. The platform should have an appealing and user-friendly UX/UI design, be able to deliver educational content, facilitate collaboration and communication, and incorporate assessment tools. The platform should also be developed using web development tools and hosted on a dedicated web server.

The usability test results showed that the prototype platform outperforms the current Red Cross platform in terms of attractiveness, perspicuity, efficiency, dependability, simulation, and novelty. The prototype platform scored an average of 1.2, while the Red Cross platform scored an average of 0.66. This means that the prototype platform scores 88% higher on average across all the categories compared to the platform distributed by the Austrian Red Cross.

Overall, this master's thesis holds practical promise for enhancing EMS education through online learning platforms. Its combination of WordPress development, expert insights, and usability testing offers a robust framework for further refinement and expansion. Future research should consider addressing the identified limitations and exploring pedagogical approaches and user engagement strategies to maximize the platform's effectiveness in training future EMS professionals. Overall, the research has shown that online learning platforms have the potential to be a valuable tool for continuing education in the emergency services. However, some challenges need to be addressed in order to make these platforms more effective.

6.1 Implications

The master's thesis focused on the prototypical development of an online learning platform for Emergency Medical Services (EMS) using WordPress, with a comprehensive approach that included online expert interviews and a usability test using the UEQ (User Experience Questionnaire). This research effort carries several practical and theoretical implications that can benefit both the field of EMS education and the broader realm of online learning platforms.

Expert Interviews: Expert interviews conducted during the research offer practical recommendations and insights from experienced professionals in EMS education. These recommendations can be implemented to enhance the platform's effectiveness, content, and usability.

Model for Future Development: The prototypical development approach used in this research can serve as a model for future developers and educators looking to create customized online learning platforms for specialized fields. The choice of WordPress as a development tool can provide a practical foundation for others to build upon.

Enhanced EMS Training: The development of an online learning platform tailored to the specific needs of EMS education holds the potential to significantly enhance the training process for EMS professionals. This practical implication is crucial, as it can contribute to improved preparedness and performance in real-life emergency situations. Online platforms can offer cost-effective training solutions, reducing the need for physical facilities and printed materials. This can be especially valuable for organizations with limited budgets, making high-quality EMS education more accessible. The use of WordPress allows for scalability and ease of content management, enabling institutions to expand their EMS training programs as needed. Moreover, online platforms can be accessed remotely, facilitating learning for individuals in different geographical locations.

6.2 Limitations

While the master thesis focused on an important and relevant topic, it is crucial to recognize and discuss its limitations. These limitations include the choice of WordPress as the development platform, participant bias, and a small sample size in online expert interviews and the UEQ usability test. Acknowledging these limitations is the first step in improving future research and development efforts in the field of online EMS learning platforms.

Technological Limitations: Depending solely on WordPress for the development of the platform might have introduced technological limitations. For instance, the scalability of the platform, especially as the number of users and content grows, may be challenging to manage effectively within the WordPress framework. For example, the functional requirement "interaction between students" could not be implemented.

Generalizability: The research may not consider the unique requirements and contexts of different EMS programs, regions, or countries. What works in one context may not necessarily work in another, and this could limit the generalizability of the prototype and its findings.

Time Constraints: Master's theses often have tight time constraints, which can limit the depth and breadth of research and development efforts. This limitation may have influenced the thoroughness of the prototype and the comprehensiveness of the expert interviews.

Small Sample Size: The master thesis might have suffered from a small number of expert participants. A low number of participants can limit the generalizability of the findings and the comprehensiveness of the insights gained. It may not adequately represent the diverse range of opinions and expertise within the EMS field.

Participant Bias: The expert interviews conducted online could introduce bias into the research findings. The research study or data collection process focused on gathering information related to participants' subjective perceptions. This means that the data being collected is based on individuals' personal feelings, beliefs, opinions, or experiences rather than objective, quantifiable measurements. External factors refer to elements or conditions that are not directly related to the research study but have the potential to impact the participants' responses or perceptions. (For example: time constraints, noise, and other outside influences) These factors are external in the sense that they are not controlled by the researchers and can introduce variability or bias into the data.

7 Conclusion

This chapter presents the conclusions of this master thesis, which investigated the strengths and weaknesses of online learning platforms in general and further for emergency medical services (EMS), how these systems can be improved, and the functional and technical requirements for building a prototypical internet-based learning and tutoring platform for EMS. The findings of this thesis suggest that online learning platforms can be a valuable tool for EMS training and education. However, some challenges need to be addressed, such as ensuring the quality of the content, providing opportunities for learner interaction, and ensuring that the platforms are accessible to all learners.

Research Question 1: What are the strengths and weaknesses of online learning platforms for emergency medical services, and how can systems be improved?

Online learning platforms for EMS have both advantages and disadvantages. One of the benefits is the convenience and flexibility they provide. These platforms enable paramedics and emergency medical technicians (EMTs) to acquire training materials and courses at their own pace and from any place with an internet connection. This flexibility is particularly useful for people who have busy schedules or work unpredictable hours. Another advantage of online learning platforms is their capability to provide interactive and captivating learning experiences. These platforms can integrate multimedia items, including videos, interactive quizzes, and simulations, that can augment the learning process and create an engaging standpoint for learners. Furthermore, online platforms can enable social interactions and collaborations among learners through features such as discussion forums and virtual learning groups.

However, online learning platforms for EMS need to address several weaknesses. One of the primary challenges is guaranteeing high-quality and precise content. It is crucial to ensure that the information provided on these platforms is up-to-date, grounded in evidence, and aligned with the latest guidelines and best practices in EMS. Additionally, the platforms ought to be user-friendly and instinctive, with unambiguous navigation and instructions, to guarantee that learners can effortlessly get to and move through the content.

To enhance online learning platforms for EMS, several actions can be taken. Firstly, it is essential to implement continuous quality assurance processes to

periodically review and update the content. This can involve working together with subject matter experts and professionals in the field to ensure the accuracy and relevance of the material. Secondly, it is important to actively seek user feedback and integrate it into the design and functionality of the platform. This can assist in identifying areas for enhancement and resolving any usability concerns. Lastly, continuous professional development and training ought to be afforded to teachers and educators to ensure they possess the essential abilities and information to effectively provide online classes and aid learners in the virtual setting.

Research question #2: How do the respondents of the questionnaire and usability test assess (prototypical) learning and tutoring platforms for emergency medical services, and do they recognise their added value?

Expert Interview Assessment:

These results formed a basis for the development process as well as the current

The survey was conducted with 16 emergency service professionals to gather their opinions on e-learning platforms. The results showed that:

- Most participants (15 out of 16) are interested in e-learning platforms for continuing education.
- The most popular types of training for e-learning are maintain training (refresh knowledge), adaptation training (adapting the level of knowledge), and knowledge expansion training (expand qualification).
- The preferred digital learning materials are video, webinars, case studies, and access to digital guidelines and algorithms.
- Interactive simulations, videos, and virtual scenarios are highly important for e-learning platforms.
- The kurse.roteskreuz.at platform is generally well-liked, but there are some areas for improvement, such as usability on mobile devices and the presentation of course content.
- Social interaction and collaboration between participants and instructors are important, but the preferred methods vary.
- A credit system for online learning would be interesting to some participants.
- A cross-organizational learning platform for emergency services is very relevant to most participants.
- Personalized feedback and training are very important to most participants.
- The ability to track learning progress is very important to most participants.

- The ability to visit course content on mobile devices is important to most participants.
- Overall, the results of the survey suggest that e-learning platforms are a valuable tool for continuing education in the emergency services. However, there are some areas where the platforms can be improved to better meet the needs of learners.

Specific suggestions for improving e-learning platforms for emergency services:

- Improve usability on mobile devices.
- Make the presentation of course content more serious and avoid a childish presentation.
- Offer time-independent courses to allow more flexibility for participants.
- Better differentiate different types of courses, such as "advanced courses" and "advanced training," through filters and clear labelling.
- Introduce standardized learning tracking to make it easier to track personal successes and learning progress.
- Add more interactive elements to improve the user experience and make learning more engaging.
- Make it easier for learners to upload materials.
- Avoid unnecessary clicks and difficulties when completing training to ensure that learning content is delivered effectively.

Usability Test Assessment:

To evaluate the usability of the developed platform, the **user experience questionnaire (UEQ)** was used. The usability of the developed prototype was compared to an existing platform developed by the Austrian Red Cross.

The results of the UEQ usability test indicate that the prototype outperforms the current Red Cross platform.

On average, the prototype scored a mean of 1,2 and the kurse.roteskreuz.at platform a mean of 0,66 across all the categories. Delta value average is 0,54 which translates to an average percentual difference of 88%. The prototype platform scores 88% higher on average in terms of mean values across the categories "Attractiveness", "Perspicuity", "Efficiency", "Dependability", "Simulation" and "Novelty".

Research question #3: What are the functional and technical requirements towards building a prototypical internet-based learning and tutoring platform for emergency medical services?

Functional Requirements:

The online learning platform should have an appealing and user-friendly UX/UI design. It should be easy to use for all users, regardless of their technical skills. The platform should allow users to upload and use multiple image formats, such as images and videos. It should also define different user roles, such as admin, teacher/tutor, and student. The platform should allow teachers to create exams and students to take exams. It should also have a feature for students and teachers to exchange messages with each other. It should also allow teachers to grade exams and provide feedback to students.

Content Delivery: The platform must have the capability to deliver educational content related to emergency medical services. This involves granting learners access to educational resources, including videos, documents, and interactive modules, in an organized and easily navigable format.

The platform must include user management capabilities to enable the registration and authentication of both learners and tutors. Learners should be able to create accounts, monitor their progress, and access tailored learning materials. Tutors must possess the capability to oversee trainee accounts, evaluate their performance, and administer feedback.

Collaboration and Communication: The online platform ought to facilitate collaboration and communication among trainees and tutors. This can be accomplished via features such as discussion forums, chat functionality, and virtual classrooms. These tools allow trainees to engage with each other and with tutors, promoting a collaborative learning environment.

Assessment and Feedback: The platform ought to incorporate assessment tools for appraising the knowledge and competencies of trainees. This can be achieved through quizzes, exams, and practical appraisals. Tutors should be able to review and provide feedback on learners' performance, helping them to identify their areas for development.

Technical Requirements:

In addition to functional requirements, it is essential to include specific technical requirements to ensure the successful development and operation of the internet-based learning and tutoring platform for emergency medical services.

<u>Web Development Tools:</u> The platform will be developed using a range of web development tools including WordPress, CSS, JS, HTML, and PHP. Technical term abbreviations will be explained when first used. These tools offer the necessary frameworks and languages to create the platform's user interface, functionality, and backend processes.

<u>Web Hosting:</u> The platform will be hosted on a dedicated web server. This will ensure that the platform has enough resources and stability to handle user traffic and data storage. The web server must be configured to fulfil the specific requirements of the platform and ensure optimal performance.

By considering the functional and technical requirements, it is possible to create a prototype internet-based platform for learning and tutoring in emergency medical services. This platform would offer effective learning experiences and provide support for the needs of trainees and tutors in this area.

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Appendix

A. Expert Interview Questionnaire (Questions and answer options)

Question 1 (multiple-choice)**:**

Please indicate your current position in the ambulance service.

Bitte geben Sie Ihre derzeitige Funktion im Rettungsdienst an.

- Emergency Medical Technician - EMT *(Rettungssanitäter:in)*
- Paramedic *(Notfallsanitäter:in)*
- Paramedic Instructor *(Lehrsanitäter:in)*
- Practical Tutor *(Praxisanleiter:in)*

Question 2:

Where do you see the advantages and disadvantages of an e-learning platform for emergency services?

Wo sehen Sie die Vor- und Nachteile einer E-Learning Plattform für den Rettungsdienst?

Question 3 (multiple-choice)**:**

What type of training is relevant or interesting to you?

Welche Art von Fortbildung ist für Sie relevant bzw. interessant?

- Maintain training (refresh knowledge) e.g.: ongoing training (BLS and trauma training). *(Erhaltungsfortbildung (Wissen auffrischen) z.B.: laufende Fortbildung (BLS- und Trauma-Trainings)*
- Adaptation training (adapting the level of knowledge) e.g: new doctrine *(Anpassungsfortbildung (Wissensstand anpassen) z.B: neue Lehrmeinung*
- Knowledge expansion training (expand qualification) e.g.: ECG advanced training *(Erweiterungsfortbildung (Qualifikation erweitern) z.B.: EKG-Fortbildung)*

- Advanced training (new Qualification) e.g.: emergency paramedic, further emergency competencies *(Aufstiegsfortbildung (neue Qualifikation) z.B.: NFS, Notfallkompetenzen)*

Question 4 (multiple-choice)**:**

Which of these types of training would you like to attend via e-learning?

Welche dieser Fortbildungsarten würden Sie gerne per E-Learning besuchen?

- Maintain training (refresh knowledge) e.g.: ongoing training (BLS and trauma training). *(Erhaltungsfortbildung (Wissen auffrischen) z.B.: laufende Fortbildung (BLS- und Trauma-Trainings)*
- Adaptation training (adapting the level of knowledge) e.g: new doctrine *(Anpassungsfortbildung (Wissensstand anpassen) z.B: neue Lehrmeinung*
- Knowledge epansion training (expand qualification) e.g.: ECG advanced training *(Erweiterungsfortbildung (Qualifikation erweitern) z.B.: EKG-Fortbildung)*
- Advanced training (new Qualification) e.g.: emergency paramedic, further emergency competencies *(Aufstiegsfortbildung (neue Qualifikation) z.B.: NFS, Notfallkompetenzen)*

Question 5 (multiple-choice)**:**

What kind of digital learning materials do you prefer?

Welche Art von digitalen Lernmaterialien bevorzugen Sie?
- Videos
- Interactive courses (*Interaktive Kurse*)
- Quizzes and Tests (*Quizzes und Tests*)
- Webinars *(Webinare)*
- Case studies (*Fallbeispiele*)
- Access to digital guidelines and algorithms *(Zugriff auf digiale Leitfäden, Algorithmen*

Question 6 (scale 1-5, single choice):

How important is it that the e-learning platform supports multimedia content such as videos, interactive simulations, or virtual scenarios?

Wie wichtig ist es, dass die E-Learning-Plattform multimediale Inhalte wie Videos, interaktive Simulationen oder virtuelle Szenarien unterstützt?

- 1 - Not important *(Nicht wichtig)*
- 2 - …
- 3 - …
- 4 - …
- 5 – Very important *(Sehr wichtig)*

Question 7 (free form text):

What approaches to improving the kurse.roteskreuz.at platform would you like to see?

Welche Ansätze zur Verbesserung der Plattform kurse.roteskreuz.at würden Sie sich wünschen?

Question 8 (free form text):

What aspects do you like about the kurse.roteskreuz.at platform?

Welche Aspekte gefallen Ihnen an der Plattform kurse.roteskreuz.at?

Question 9 (multiple-choice):

To what extent should the e-learning platform promote social interaction and collaboration among participants or between instructors and participants?

Inwiefern sollte die E-Learning-Plattform soziale Interaktion und Kollaboration zwischen den Teilnehmern bzw. zwischen Lehrenden und Teilnehmern fördern?

- Through forums and discussion groups *(Durch Foren und Diskussionsgruppen)*
- Through chat functions for real-time communication *(Durch Chatfunktionen für Echtzeitkommunikation)*
- Through virtual learning groups or Team projects *(Durch virtuelle Lerngruppen oder Teamprojekte)*
- Through peer reviews and Feedback *(Durch Peer-Bewertungen und Feedback)*

Question 10 (scale 1-5, single choice):

Learning and training while on duty: Would a system where you could earn "credits" on an ongoing basis be of interest? Example: Attend ongoing online training while on duty, earning credits - these credits could be used as an aspect of advancement from EMT to paramedic, for example.

Lernen und Fortbilden während der Dienstzeit: Wäre ein System, in dem Sie sich laufend "Credits" erarbeiten könnten, interessant? Beispiel: Im Dienst laufend Online-Fortbildungen besuchen, wodurch Credits gesammelt werden - diese Credits können z.B. als Teilaspekt für den Aufstieg von RS (Rettungssanitäter) auf NFS (Notfallsanitäter) verwendet werden.

- 1 - Not interesting *(Nicht interessant)*
- 2 - …
- 3 - …
- 4 - …
- 5 – Very interesting *(Sehr interessant)*

Question 11 (scale 1-5, single choice):

Would a cross-organizational learning platform for emergency services be relevant to you? (Regardless of organizational affiliation). For example: international course formats and algorithms, standards, guidelines - independent of individual organization doctrinal opinions.

Wäre eine organisationsübergreifende Lernplattform für den Rettungsdienst für Sie relevant? (Unabhängig von der Organisationszugehörigkeit). Zum Beispiel: internationale Kursformate- und Algorithmen, Standards, Leitlinien - unabhängig von individuellen Lehrmeinungen der Organisation

- 1 - Not relevant *(Nicht relevant)*
- 2 - …
- 3 - …
- 4 - …
- 5 – Very relevant *(Sehr relevant)*

Question 12 (free form text):

Please briefly justify your decision of the previous question. (cross-organizational learning platform)

Bitte begründen Sie Ihre Entscheidung der vorherigen Frage kurz. (organisationsübergreifende Lernplattform)

Question 13 (scale 1-5, single choice):

How important is personalized training and feedback to you?

Wie wichtig ist Ihnen personalisiertes Training und Feedback?

- 1 - Not important *(Nicht wichtig)*
- 2 - …
- 3 - …
- 4 - …
- 5 – Very important *(Sehr wichtig)*

Question 14 (scale 1-5, single choice):

How important is it to you to be able to track your progress as well as your performance on e-learning content?

Wie wichtig ist es Ihnen, Ihre Fortschritte sowie Ihre Leistung bei E-Learning Inhalten verfolgen zu können?

- 1 - Not important *(Nicht wichtig)*
- 2 - …
- 3 - …
- 4 - …
- 5 – Very important *(Sehr wichtig)*

Question 15 (scale 1-5, single choice):

How important is it to you to be able to track your progress as well as your performance on e-learning content?

Wie wichtig ist es Ihnen, die Kursinhalte auch auf Mobilgeräten besuchen zu können?

- 1 - Not important *(Nicht wichtig)*
- 2 - …
- 3 - …
- 4 - …
- 5 – Very important *(Sehr wichtig)*

Question 16 (free form text):

Are there innovations you would like to see from online learning platforms for emergency services?

Gibt es Innovationen, die Sie sich von Online-Lernplattformen für den Rettungsdienst wünschen?

Question 17 (free form text):

What features should an e-learning platform offer from the instructor's perspective?

Welche Features sollte eine E-Learning Plattform aus Sicht des Lehrenden bieten?

B. UEQ Results

Table 11: Data Set 1 - Prototype

| Description of data set 1: | MT Prototype |

Items																									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
6	5	2	2	2	4	6	5	2	2	4	3	6	5	4	5	1	2	3	6	2	6	2	3	1	5
5	6	4	1	3	5	5	7	2	5	5	3	6	5	2	5	4	4	2	5	3	5	3	5	3	3
6	5	1	2	2	5	6	5	1	2	4	2	5	5	5	6	3	3	2	5	3	5	2	2	2	6
4	5	4	3	2	4	6	6	1	5	3	3	3	6	4	5	2	3	2	5	2	7	3	3	2	5
6	6	4	2	1	5	7	6	2	3	6	1	6	5	6	6	2	1	1	6	2	7	1	3	3	6
3	5	4	4	3	5	5	4	3	3	4	4	4	5	5	5	2	3	4	5	3	6	4	3	3	4
5	3	2	3	4	4	4	4	2	3	5	4	4	5	5	5	2	4	4	5	2	5	6	2	2	5

Table 12: Dataset 1 - Transformed data

Items																									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
2	1	2	2	2	0	2	1	2	2	0	1	2	1	0	1	3	2	1	2	2	2	2	1	3	1
1	2	0	3	1	1	1	3	2	-1	1	1	2	1	-2	1	0	0	2	1	1	1	1	-1	1	-1
2	1	3	2	2	1	2	1	3	2	0	2	1	1	1	2	1	1	2	1	1	1	2	2	2	2
0	1	0	1	2	0	2	2	3	-1	-1	1	-1	2	0	1	2	1	2	1	2	3	1	1	2	1
2	2	0	2	3	1	3	2	2	1	2	3	2	1	2	2	2	3	3	2	2	3	3	1	1	2
-1	1	0	0	1	1	1	0	1	1	0	0	0	1	1	1	2	1	0	1	1	2	0	1	1	0
1	-1	2	1	0	0	0	0	2	1	1	0	0	1	1	1	2	0	0	1	2	1	-2	2	2	1

Table 13: Dataset 1 - Scale means per person

Skale means per person (first evaluation)					
Attractiveness	Perspicuity	Efficiency	Dependability	Stimulation	Novelty
1,50	1,75	2,00	1,25	1,50	1,25
0,67	2,00	1,25	1,50	0,75	-1,00
1,83	1,25	1,75	1,00	1,50	2,00
1,17	0,75	2,00	1,25	1,25	0,00
1,67	2,00	2,50	2,25	2,50	1,25
0,50	0,50	1,00	0,50	1,00	0,50
1,17	0,50	0,50	0,75	0,00	1,25

Table 14: Dataset 2 - kurse.roteskreuz.at

Description of data set 2:	kurse.roteskreuz.at

Items																									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
4	6	5	4	3	3	6	6	3	4	5	4	3	4	2	5	1	3	3	4	5	5	6	4	2	4
3	3	7	4	3	2	2	5	4	7	3	6	3	3	1	2	4	6	6	2	5	3	6	6	3	2
6	5	1	2	2	6	7	6	2	2	5	2	6	5	5	6	3	3	3	6	2	6	2	2	5	6
4	3	3	3	3	3	4	6	2	6	4	4	5	4	2	4	2	3	4	4	5	5	5	3	1	3
4	6	5	2	2	2	6	6	2	6	5	2	5	5	4	5	1	3	3	5	3	5	5	3	2	5
5	6	4	3	2	4	5	4	3	4	6	4	5	4	4	4	2	4	3	5	2	6	4	3	1	4
6	5	2	3	2	4	6	7	2	3	6	2	7	5	5	6	1	3	2	6	2	6	3	2	1	5

Table 15: Dataset 2 - Transformed data

Items																									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
0	2	-1	0	1	-1	2	2	1	0	1	0	-1	0	-2	1	3	1	1	0	-1	1	-2	0	2	0
-1	-1	-3	0	1	-2	-2	1	0	-3	-1	-2	-1	-1	-3	-2	0	-2	-2	-2	-1	-1	-2	-2	1	-2
2	1	3	2	2	2	3	2	2	2	1	2	2	1	1	2	1	1	1	2	2	2	2	2	-1	2
0	-1	1	1	1	-1	0	2	2	-2	0	0	1	0	-2	0	2	1	0	0	-1	1	-1	1	3	-1
0	2	-1	2	2	-2	2	2	2	-2	1	2	1	1	0	1	3	1	1	1	1	1	-1	1	2	1
1	2	0	1	2	0	1	0	1	0	2	0	1	0	0	0	2	0	1	1	2	2	0	1	3	0
2	1	2	1	2	0	2	3	2	1	2	2	3	1	1	2	3	1	2	2	2	1	2	3	1	1

Table 16: Dataset 2 - Scale means per person

Skale means per person (second evaluation)					
Attractiveness	Perspicuity	Efficiency	Dependability	Stimulation	Novelty
0,50	0,00	0,00	1,75	0,75	-0,75
-1,17	-0,75	-1,25	-0,50	-1,25	-2,75
1,33	1,75	2,00	1,25	2,00	2,00
0,67	0,00	0,50	1,00	0,25	-1,00
1,17	1,50	0,75	1,75	0,75	-0,50
0,83	1,50	1,00	1,25	0,75	0,00
2,00	1,75	1,75	2,50	1,25	1,25

Table 17: Comparison of scale means

Scale	MT Prototype						kurse.roteskreuz.at					
	Mean	STD	N	Confidence	Confidence Interval		Mean	STD	N	Confidence	Confidence Interval	
Attractiveness	1,21	0,50	7	0,37	0,85	1,58	0,76	0,99	7	0,73	0,03	1,49
Perspicuity	1,25	0,68	7	0,50	0,75	1,75	0,82	1,04	7	0,77	0,05	1,59
Efficiency	1,57	0,69	7	0,51	1,06	2,08	0,68	1,10	7	0,81	-0,13	1,49
Dependability	1,21	0,57	7	0,42	0,79	1,63	1,29	0,93	7	0,69	0,60	1,97
Stimulation	1,21	0,77	7	0,57	0,64	1,78	0,64	1,00	7	0,74	-0,10	1,38
Novelty	0,75	1,00	7	0,74	0,01	1,49	-0,25	1,55	7	1,15	-1,40	0,90