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Project Heb@AR: Exploring handheld Augmented Reality training to supplement academic midwifery education

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Abstract: Augmented Reality (AR) promises great potential for training applications as it allows to provide the trainee with instructions and feedback that is contextualized. In recent years, AR reached a state of technical feasibility that not only allows for larger, long term evaluations, but also for explorations of its application to specific training use cases. In the BMBF funded project Heb@AR, the utilization of handheld AR as a supplementary tool for the practical training in academic midwifery education is explored. Specifically, how and where AR can be used most effectively in this context, how acceptability and accessibility for tutors and trainees can be ensured and how well emergency situations can be simulated using the technology. In this paper an overview of the Heb@AR project is provided, the goals of the project are stated and the project's research questions are discussed from a technical perspective. Furthermore, insights into the current state and the development process of the first AR training prototype are provided: The preparation of a tocolytic injection.

Keywords: Augmented Reality; Training; Midwifery; Education

1 Introduction

Augmented Reality (AR) promises great potential for training applications, as it allows to provide the trainee with instructions and feedback that is contextualized. Hereby, information is not elicited the conventional way, where a cognitive transfer process is necessary to contextualize the provided information into the current training situation, but the information is directly displayed into the physical context where and when it is needed. While it is generally well known that this can improve trainees' motivation and learning outcomes [Le12], current literature on utilizing AR for medical training specifically shows promise but often lacks the supporting evidence [BGS16]. This is at least partially explained by the limitation that AR hardware suffered from in its infancy: often technical implementations were the main challenge of projects and elaborate evaluations with technically stable prototypes have been difficult. In recent years, AR reached a state of technical feasibility that not only allows for larger, long term evaluations but also for the

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exploration of the technology in those specific training use cases, e.g. in the medical context. Now the focus of projects shift from the technical feasibility to identifying and exploring needs of specific contexts, evaluating developed prototypes with larger sample sizes and starting the process of exploring long term implementations and acceptances of AR applications in existing training structures. Increasingly, AR based training can be explored as an extension of computer- & web-based trainings, that are already successfully used for decades, to extend them with the utility of contextualizing information that can be provided by AR based training applications (see Fig. 1).

In the BMBF funded project Heb@AR, the utilization of handheld AR as a supplementary tool for the practical training in the academic midwifery education is explored, which is not yet covered by the literature. Specifically of interest is how and where can AR be used effectively in this context, how can acceptability and accessibility for tutors and trainees be ensured and how well can emergency situations be simulated using the technology.

Fig. 1: AR-based training is the logical extension of computer-based & web-based training

2 Project Overview

The German midwifery education is currently transitioning towards a full academization. Based on a recent law, from 2022 onwards, midwives will be exclusively qualified at universities, rather than by vocational training through the dual education system, which is still the standard today [HG20]. While this is an important step towards increasing the status of midwives in the medical context, it also leads to new challenges. The practical component of the training still has a high priority with exemplary bachelor’s consisting of 4380 hours of theoretical and 2200 hours of practical training. This naturally leads to bottlenecks regarding available practical tutors, training space and scheduling restrictions for trainees in the long run. Furthermore, with the full academization of the midwifery education, the heterogeneity of students magnifies, only increasing the impact of those restrictions due to potential needs for more individual support. Despite those new challenges, the general goals remain: Students have to reach a theoretical and technical expertise and especially the transfer from theory to practice has to succeed. Furthermore, students also have to be prepared for important emergency situations that cannot be trained reliably in practice. In general, the academic education is moving towards problem-based learning approaches to enable students more self-regulated learning, often in collaborative settings [Zu12]. This is partially done in laboratory training sessions and with the utilization of learning-management systems. The development of problem-based learning approaches for midwifery students in particular hereby faces special challenges and is largely unexplored but could have huge potential based on the high percentage of practical training.

Starting in November 2019, forces have joined with interdisciplinary researchers from midwifery science, medical-didactics and computer science for a duration of three years to implement and evaluate AR-based training as a supplementary tool for problem-based learning approaches in midwifery education. In short, the project will consist of the development of 3 exemplary AR training scenarios from the field of emergency management for handheld AR devices that are iteratively evaluated and improved, the implementation of those AR scenarios into existing structures (e.g. learning-management systems) and ultimately the exploration of methods to enable tutors themselves to create new AR trainings. Within the project several interesting research questions arise for each project partner. The ones with a technical primary focus are highlighted in the following.

1. **Acceptability:** How can handheld AR be utilized effectively and implemented in a way that it is intuitively usable and perceived as useful by the students?
2. **Scalability:** Which scenarios are suitable to be trained through handheld AR? Do AR scenarios scale better with the increasing number of students compared to on-site trainings? Could AR even be used to realize novel exam formats?
3. **Viability & Longevity:** How can tutors/lecturers be enabled to create their own scenarios using authoring tools, which was identified as a crucial factor for successful longer-term AR implementations in previous work [BRP19]? How can handheld AR be integrated seamlessly into existing technical (e.g. learning-management systems) but also social teaching and training structures and contexts?
4. **Self-regulation & Collaboration:** In which ways can handheld AR support self-regulated and collaborative learning at home and in training facilities?

Beyond that, the researchers from midwifery science are especially, but not comprehensively, interested in the transferability of acquired knowledge and the aspect of interdisciplinary cooperation. Therefore, how can knowledge and skills acquired in AR based training be applied in practice? How effective can this transfer of knowledge be elicited? Can AR improve interdisciplinary cooperation in obstetric emergencies? In obstetric emergencies, at least two professional groups are usually involved in the care. Interprofessional communication and action are important. The medical-didactic researchers additionally interest the identification of factors regarding an interprofessional and interdisciplinary transferability of the AR formats.

3 Development of the first prototype

In Summer 2020, the first prototype for one of the three scenarios is developed: The preparation of a tocolytic injection, which is currently being evaluated. Here, a syringe with a carrier solution and a drug is prepared and stored for emergency situations.

While the project follows a design-based research approach in accordance with [RG05], the procedure that was used for bootstrapping the first prototype differs slightly, as additional challenges emerged due to the exploratory nature: It had to be ensured that the action sequence that will be implemented is correct and that didactic considerations are integrated while still retaining good overall usability of the application. Therefore, a more linear approach for this exploration was chosen. Further improvements to the prototype will be made iteratively based on feedback.

First, the action sequence that was supposed to be implemented was observed in detail and each step analyzed to ensure correctness. The action sequence was then furthermore recorded on video and shared with the didactic and technical implementation team. Based on the observed and recorded action sequence, a task process analysis [JHT89] was created, formalizing the action sequence.

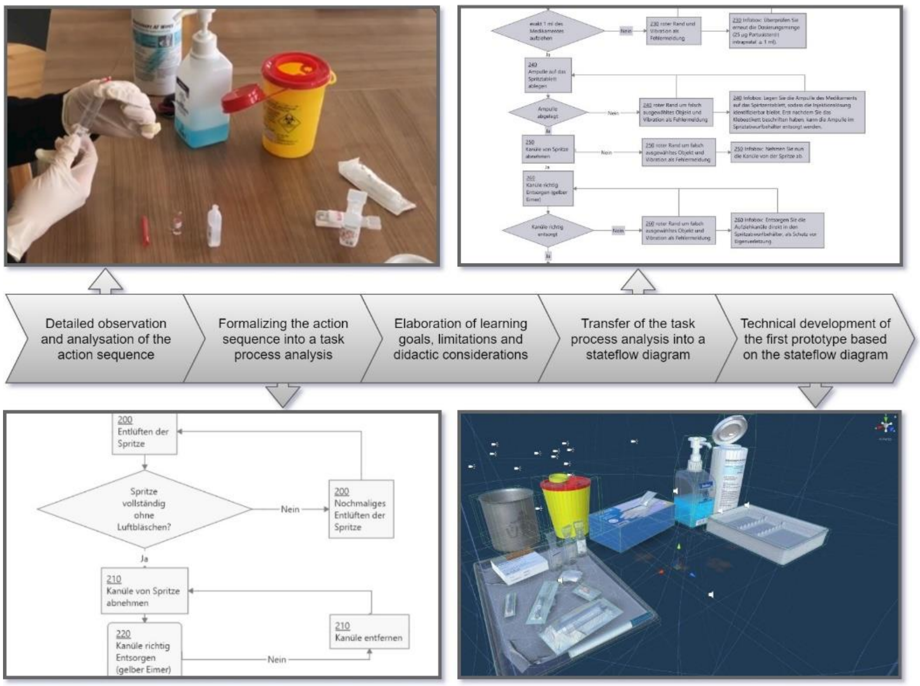

Fig. 2: The development process of our first AR prototype for the AR training scenario of preparing a tocolytic injection.

Based on the task process analysis, the learning goals, didactic considerations and technical limitations were discussed and formalized. Utilizing this, the process analysis was translated into a stateflow diagram, specifying the technical implementation more closely and was ultimately implemented to be the first prototype. Our development process is visualized with some exemplary visualizations in Fig. 2.

Simultaneously, during this process, possible interaction concepts mitigating the limitations for handheld AR (e.g. having one hand occupied) and the required 3D models were explored and prototyped on paper, with low-poly models and then realized as high-poly versions with complex interactions, physics, shadows and transparency effects (see Fig. 3).

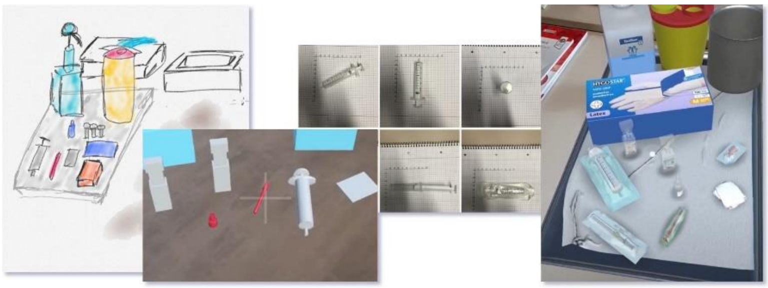

Fig. 3: Examples of the prototyping process of models and their interactions from paper prototyping, through low-poly models with simple interactions, to modeling the final versions.

The current state of the prototype is visualized in Fig. 4. It allows for location-independent preparation of the injection using only virtual objects that can be grabbed, combined and interacted with through movement of the smartphone and on-screen touch interactions. This first scenario in the project is also the onboarding scenario for our experimental group and is therefore relatively simple in its objective compared to the following scenarios.

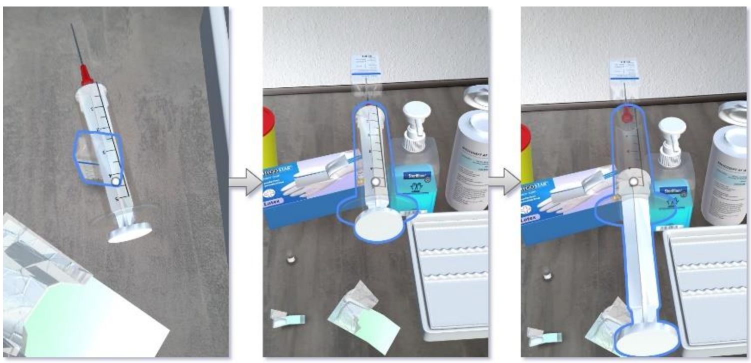

Fig. 4: The AR prototype guiding the virtual preparing of a tocolytic injection. Displayed is the step of drawing up the syringe with a carrier solution.

4 Conclusion & Outlook

In this paper the BMBF funded project Heb@AR was described, where the usage of handheld AR training to supplement the practical phases of academic midwifery education is explored. The project itself, the projects goals and the research questions were described on an abstract level. Furthermore, the current state and development process of the first prototype, the preparation of a tocolytic injection, was described.

In the future, it is planned to iteratively evaluate and improve the existing and upcoming prototypes for the AR trainings and to develop an authoring tool, enabling tutors to create their own AR trainings. Furthermore, the usability and reception of the interaction concept that was developed for the implementation of the procedural training tasks on handheld AR devices, which is only incidentally described in this paper, will be evaluated and published separately. In an ongoing usability study, the interaction concept and required extend and form of interaction onboarding is explored through a task-based, comparative, observational usability study with midwifery students that already completed the module the AR training is targeting to supplement. Here, the independent variables are the form and extend of interaction onboarding that is provided before using the AR training, which inherently also provides first insights into the usability of the interaction concept itself.

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