David Unbehaun, Konstantin Aal, Viktoria Richert, Volker Wulf (2021): CareFox: An Interactive Learning Application for Care-Students. 8th International Conference on Infrastructures in Healthcare. DOI: 10.18420/ihc2021_003

CareFox: An Interactive Learning Application for Care-Students

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Abstract. Demographic transformation and medical-technical progress are generating new demands for standards and quality in professional caregiving. The job profile and especially the nature of care apprenticeships is changing significantly and use of digital media is becoming an increasingly ubiquitous and important aspect of the work. In this paper, we present a design case study that focuses on the development and evaluation of a multimedia learning application for and with care students. Adopting a user-centered design approach, we collected design requirements for the application in workshops and interviews with 23 care-students. The results show that it is important to create a structured approach to providing information and that social aspects such as chat allow for higher motivation and collaboration in learning. The findings also suggest that, by using game mechanisms such as a quizzes and difficulty levels, care-students can be further motivated to become more engaged with learning content.

Introduction

Demographic change, medical-technical progress and increasing quality requirements are changing the nature of professional caregiving and care apprenticeships (Komendziński et al., 2016; ten Haken et al., 2018). While the need for professional and institutional care is increasing, the number of qualified professional caregivers is declining (Rothgang et al., 2012). In line with broader developments, digitalization in the healthcare sector is progressing exponentially (Bhavnani et al., 2016). This is having a growing impact upon the complexity of care, be it in the documentation of information, assistive systems, videogame-based interventions or robotics (Aloulou et al., 2013; Carros et al., 2020, 2020;

Fasola & Mataric, 2012; Müller et al., 2015; Unbehaun, Aal, et al., 2020; Unbehaun et al., 2018; Unbehaun, Taugerbeck, et al., 2020). Not only are mobile technologies evolving (Brown & Mbati, 2015; Ertl et al., 2019), but also forms of (digital) teaching and learning (Aal et al., 2018, 2014, 2015; Ertl et al., 2019, 2021; Fletcher, 1989; Weibert et al., 2017; Yerousis et al., 2015). There is increasing scope for digital applications to help care-students, in their apprenticeship to become a health-care professional, to acquire new knowledge and to verify the applicability of this knowledge in practice (Brown Wilson et al., 2020; Hofmeyer et al., 2018). Digital systems in care-education can create new opportunities for both formal and informal teaching and learning in care and health occupations. It can initiate and enable students to learn in the absence of teachers and learning groups and help them to acquire new knowledge and competences independently, without being bound to specific temporal and spatial constraints. With this comes a higher degree of autonomy and need for self-organization, not only with regard to the spatiotemporal aspects of learning, but also, with regard to goals, content, methods and evaluation (Dubs, 2000). Apart from potential changing how learning is organized, digital learning and interactive media can also have an impact upon the quality of learning (Kerres & Nattland, 2007). Several studies illustrate that substantial advancements have been made toward the development of novel technologies and identification of therapeutic areas as well as mobile devices and apps for health care professionals in medical practice (Aungst & Patel, 2020; Ventola, 2014). Inspection of the literature concerning digital applications to help care-students reveals that there is currently a lack of studies that design applications for and with care-students and examine the individual and collaborative effects of technology and provide recommendations regarding the design of appropriate functionalities and design related aspects for care-students. We therefore present here results from a design case study (Wulf et al., 2011) that describes how the process was pursued across the various steps of exploring, evaluating and designing a multimedia-based learning application for care-students. In this article, we present a prototype learning application that was designed for and evaluated with care-students. Workshops, semi-structured interviews, usability tests and observations in different care-schools provided the necessary information about the attitudes and practices of the target group. Care students played an active part in designing paper-based mock-ups and the development of the final interactive prototype. Individual interactions with the prototype, its impact on individual and social learning and the character of its appropriation was then investigated with care-students over the course of an 8-month user-centered design case study. The aim of this study was to address the research question: *"How should a learning application for care-students be designed in order to promote learning?"* Over the course of this work, we developed a learning application for the education of health care professionals, where individual and cooperative learning spaces can be

created. With the help of these learning spaces, training and work-related qualification needs were met while seeking to increase the quality of care and patient safety. The presented work therefore addressed central requirements arising from practical and theoretical needs from care-students and the mediation of complex nursing and medical learning content. We found in particular that the system supported individual and social learning, motivated users through a gamification approach and improved the learning experience in general. As a consequence, our study provides a new body of insights for the currently rather under-developed domain of learning applications for care-students. Researchers and developers may benefit from our results and reflections by drawing upon the proposed implications when addressing future improvements in the design of learning and teaching technologies across a variety of domains.

Related Work: Mobile Learning, Gamification, and User Interface Design

It can provide personalized and contextual learning experiences and make a significant contribution to distance learning (Brown & Mbati, 2015, p. 129). Research has focused on how learners' mobility, complemented by personal and public technologies, can contribute to the process of acquiring new knowledge, skills and experiences (Sharples et al., 2009, p. 3). A major advantage of mobile technologies is their ability to facilitate collaboration between an individual and a group, as well as across organizations. However, collaboration is also possible between those undertaking theoretical and practical training. Mobile technologies, especially in the field of distance learning, open up new possibilities for users to collaborate with others anywhere (Arrigo et al., 2005). The technology can thus become a constant companion and guide for learning (Sharples et al., 2009, p. 4). Mobile apps offer a large number of learning options and can feature in educational formats such as serious games, flashcards, etc. (De Waard, n.d., p. 119). For students, mobile technologies play a particularly important role, as they often prefer mobile devices to desktop computers. According to (Deterding et al., 2011), gamification can be defined as the use of game elements in non-playful contexts. Zichermann and Cunningham (Zichermann & Cunningham, 2011) describe it as incorporating a process of game thinking and mechanics. Both views see it as involving users in the process and being about solving specific problems. Kapp (Kapp, 2012) extends the definition by adding aesthetic components and sees it as a way to motivate people to act and to promote learning. The idea of using game mechanisms in non-playful contexts initially gained importance in digital marketing, where it was seen as a way of increasing motivation, user activity, and user loyalty. At heart it is about influencing behavior (Stieglitz, 2017) by motivating people to perform tasks for which they

would otherwise have little enthusiasm. This strategy brings people into a process that can help them master different aspects of life (Stampfl, 2012). Motivation is a broader concept and encompasses the totality of factors that determine the updating of targeted behavior or actions (Nitsch & Allmer, 1976). It can thus be understood as the justification of behavior in a person-environment relationship. This relationship is fundamental for the motivation process. Motivation also deals with the motives that drive people, move them and cause them to behave in a certain way. Research, here, is concerned with behavioral determinants such as age, culture, or situation that can change a person's behavior (Graumann, 1969). The demand for products with good usability has increased as users have become resistant to the frustrations caused by complicated and incomprehensible user interfaces. The user interface is the part of a computer with which people can directly interact. It consists of two components: the input, which captures the wishes and needs of the users; and the output, which represents how the computer is responding to those wishes and needs (Galitz, 2007). Therefore, the first impression when using an application is important and determines the success of the interface. It is important that users find that certain components meet their expectations, such as information selection, content quality, availability, timeliness and comprehensibility.

Methods

Our study was framed around the concept of design case studies, as originally articulated by Wulf et al. (Wulf et al., 2015, 2011). This approach consists of three phases: (1) a pre-study consisting of empirical analysis of existing individual and social practices in the specific field; (2) design of innovative ICT-based artefacts related to the findings from the pre-study; and (3) investigation of interaction with and appropriation of the designed technical artefact over a longer period of time. In the **pre-study** we studied the existing practices, the organizational and social perspectives, and the individual and social needs and challenges confronting care-students. We initially conducted 10 semi-structured interviews in three different care-schools to gain meaningful insights into the everyday life of care-students. This approach enabled an open collaboration amongst a variety of actors, reflecting their different levels of knowledge, interests, and expectations with regard to a mobile learning application. In the **second iterative step**, concepts were developed on the basis of user journeys, which underpinned the creation of wireframes and click dummies. We designed and developed a paper prototype based on the findings from the pre-study. As part of the design case study process, we repeatedly re-designed and extended the paper-based prototype and developed an interactive prototype with Axure that was formally evaluated with care-students in the third stage. To facilitate a practical and needs-oriented solution, we applied a user-centered approach and involved

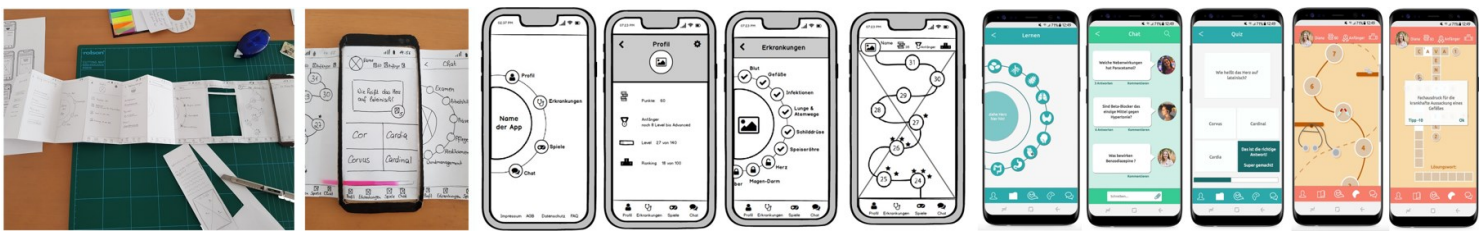
care-students as co-developers in different usability tests. This enabled us to draw upon their different bodies of knowledge, interests, and aspirations in the research and design process. Throughout the **third step**, the different designs, starting with the mock-ups, then the paper prototype, followed by the interactive prototype, were evaluated with the future users of the application. The participants in the interactive evaluation came from two different nursing schools and were in the first and second year of their apprenticeships. A total of 13 care-students participated in the tests. Usability tests were undertaken in the evaluation phase because we wanted to get a detailed understanding of how our participants experienced and understood the prototype. The participants were given specific tasks in order to obtain clear results. The tasks were embedded in scenarios that were realistic descriptions oriented towards the participant's goals. Overall, 23 people took part in the study, across the various phases. The target group consists of 16 to 23-year-old trainees in the health and nursing professions. A total of ten trainees were interviewed during the pre-study and the prototype was created with and evaluated by a total of 13 trainees. Over the course of the design case study, we conducted workshops with usability tests, observations and semi-structured interviews with the participants to understand their existing practices and to uncover the relevant technological, organizational and social perspectives that would need to be taken into consideration. The qualitative data consisted of audio recordings and field notes gathered over the course of the interviews and observations. This was analyzed using a thematic analysis approach. Based on the transcripts, coders performed an inductive analysis of the data and generated main categories. Coding discrepancies were discussed and eliminated by adding, editing or deleting codes, according to the outcome of the discussion.

TECHNICAL OVERVIEW AND DEVELOPMENT OF THE PROTOTYPES

A low fidelity paper prototype was created after the first interviews. For the paper prototype, the central functionalities and interaction possibilities were incorporated according to the findings from the pre-study (interviews and workshops). At this point, only rough functionalities were proposed. To be able to simulate the interactions of the app, interactional elements such as the keyboard, input fields, warning messages, etc. were cut out individually. The final device was made of cardboard in order to be able to run through the individual paper screens. The wireframes show only the first drafts of the functions and the layout. The first image is the start page with different menu items: *Profile, Diseases, Games* and *Chat*. If the user selects the *Profile* menu item, he or she has the option of making profile settings via the *Settings* icon. In addition, the user is informed of previously obtained points, the status, the reached level and their

current ranking. In the profile settings, the user can change his or her image, username and password. The main disease topics can be found under the menu item *Diseases*. In the learning units, illnesses, anatomy, physiology and aspects of patient care are illustrated.

After preparing the paper-based prototype the participants were invited to navigate and execute typical user scenarios and the completion of possible tasks in usability tests. This served to identify problems during use and task completion or the paper-based prototype central screens, functionalities and interaction possibilities were constructed. The tests, here, only explored rough functionalities and individual paper screens were traversed by the cardboard device. The individual screens were displayed in a meaningful sequence, making it easier to draw them through the device. The usability tasks consisted of *logging in*, *viewing their own status, completing a learning unit* and *a level*, and *writing a chat message on the subject of medication*. Issues were identified and changes were then implemented in the interactive prototype before re-evaluation. This iterative process was pursued to encourage the users to be co-designers and to create, learn, make changes based on new knowledge, and re-design it together with us in a participatory fashion, so that a continuous improvement of the prototype was guaranteed (Barnum, 2011). The menu item *Learning* contains 16 further submenu items. These are the main individual learning topics. If one of the main topics is selected, the user will be taken to the next screen with specific menu items for the main topic. If one of these items is selected, the learning session begins. Information on each session is displayed both verbally and visually. The presentation of the learning units is based on the principles of Mayer's theory of cognitive multimedia learning (Mayer, 1997). Thus, they contain spoken or written texts combined with static or dynamic graphics, depending on which principle of multimedia learning makes sense. In the interviews, the participants were asked which multimedia presentation they would like to see on which topic. Anatomical and physiological aspects of the learning units are therefore represented with 3D models and animations. The topics of the learning units are not divided into anatomy, physiology, pathology and nursing, as is often the case in other applications (Richert, 2018). Instead, to ensure that these topics are linked, users will find, for example, that if diseases are the main topic and a disease is selected, there is not only a description of the disease, but also information about how a patient is to be cared for. In a similar fashion, physiological aspects can be found under anatomy. The texts of the learning units are written in simple language so that they are easily understood and the most



Figures 1,2 and 3 Paper-based Prototype (left); Wireframes (middle) and Figure Interactive Prototype (right)

important things are marked in bold. This requirement also arose during the interviews. As noted above, gamification involves the use of game elements in non-game contexts (Deterding et al., 2011). Learning is just such a context and it can be gamified by incorporating elements such as points, levels, progress bars, badges, and challenges. The goal is to become a top-ranked user by the end of the course. However, this can only be achieved if a user successfully completes all levels. Users are free to choose the order in which they tackle the 16 main topics. It emerged during the interviews that care-schools discuss the learning material in different apprenticeship years. If a subject area is selected, the players can complete a certain number of levels relating to that particular subject. By way of example, in the game world, if the *Heart* theme is selected, the player will be taken to the next screen showing the different levels. As it is not only factual knowledge tasks, but also transfer tasks that are set, each of the four specific topics in the heart area has two levels, which can be played in a random order. So, in total, there are eight levels that can be played. For each main theme, a competition level is also offered in which a match takes place against another random player. Challenges are provided by a mixture of time pressure and the nature of the tasks, so as to deliver cognitive stimulation (Blohm & Leimeister, 2013). In these ways, the game world can be seen to rely on a combination of intrinsic and extrinsic motivation, with competition, such as matches, leading to intrinsic motivation. The chat function is based on constructivist learning approaches, where learning is seen to depend on collaboration and cooperation (Colley & Stead, 2005). It draws inspiration from the concepts of situated learning and communities of practice. Communities of practice are self-organizing systems of informal learning (Gray, 2004). The app's chat function aims to enable such an online community of practice encompassing trainees, teachers, and experts. Here, the care students can solve problems partly through social exchange with each other.

Findings from the evaluations

The registration process and logging in, as well as viewing the status achieved so far, posed no problems for the participants. The term *Diseases* led to the most frequent instances of incorrect use, because it was used in the prototype as a synonym for the individual learning units. However, this was the only point of confusion. The term was chosen because the menu navigation in the learning units depends on the diseases. Most participants were confused by the request to undertake the course unit regarding anatomy of the heart, because they did not understand whether the course unit was actually under the menu item 'disease' or under 'games'. As the participants knew from the earlier interviews that knowledge checks would take the form of mini-games, it seems likely that the confusion stemmed from this. Regarding the games in the game world, it was

noted that the levels should become progressively more difficult. Two participants also suggested that the points earned should only be visible on the start page at the end of the game and not after each question as was the case in the paper prototype. In addition, one participant asked if she could buy something with the points she had earned. So far, this option had not been considered, but we felt it might be useful if the user could buy tips with the points. With regard to the chat function, some of the participants felt that under posed questions, not only a speech bubble should be used to display the comment function and the number of comments, but also a button that could be clicked to reveal the answers. A further proposition was that it be possible to indicate the number of questions or answers in a circle or to create a sub-item for them in the *Chat* function, so that they could be sorted accordingly. Here, it was necessary to consider whether it would make sense to display new questions, as a user would probably not have the time to view every question. Hundreds of new questions can be asked within a short period of time. As with the paper prototype, the registration process and viewing one's status did not pose any problems when the interactive prototype was evaluated. However, one respondent commented on the possible need for a help field. Other suggestions were made to improve the game world. Three participants wanted the game to be explained in advance. This could be done by clicking on a question mark button. Alternatively, a small video or explanation could be displayed at the beginning of the game (this could then be skipped if not needed). During our observations, it was also noted that one respondent was not aware that the number in the crossword puzzle had to be clicked to get the puzzle. The same respondent also said that the solution to the puzzle should be displayed immediately after the puzzle had been completed. However, the other five participants enjoyed sorting the order of the letters and uncovering the solution, so it is not clear that this added functionality is necessary.

Discussion, Implications and Conclusion

Early involvement of users in the design process has positive effects on user satisfaction, improves usability and ensures optimal adaptation to user needs (Sarodnick & Brau, 2011). As the goal of a user-centered design process is to design a product (or application) that has a high usability (Semler, 2016), the evaluations made it possible to determine how the multimedia learning application should be designed so that the users can achieve their goals effectively, efficiently and satisfactorily. Some of the advantages of a well-implemented mobile learning platforms are promotion of individual reflection processes (Yang, 2009) and the development of cognitive and emotional skills (Pimmer et al., 2014). A clear set of principles with regard to health and care practice learning is necessary for these advantages to be achieved in an effective pedagogical process (Lea & Callaghan, 2011). The principles of usable design

have a particular impact on an application's usability, as they ensure that user expectations are taken into account during the interaction with the product (Gralak & Stark, 2015). The need for training and support as well as one's own device preferences are also considered within this kind of design process (Taylor et al., 2010). The visual design of an interface plays a significant role in improving usability. There is a focus here upon creating order, increasing readability and making effective use of things like color contrasts. The user experience is also of critical importance (Mose, 2012). With the help of an appropriately aesthetic design, users can be addressed emotionally to generate positive feelings, such as joy and fun, when using an application (Jacobsen & Meyer, 2017). Beyond any personal or group motivational effects, we have also noted here that implementing design elements such as badge systems can help third parties such as moderators monitor a community and identify opportunities and problems. Improving the usability and acceptance of an application involves paying attention to one's choice of methods and the careful selection of design elements. The user-centered design process is particularly suitable for tailoring applications to the needs of users and active evaluation helps to identify problems before and during use. The evaluations provided by care-staff and students provided helpful feedback as the learning application developed. More than this, the participants offered up new ideas and potential improvements, actively playing a part in the design. Mobile learning refers to educational offers provided mainly on handheld computational devices. The advantages of mobile learning via a smartphone are spontaneity, portability and the provision of learning content in more easily digested bits and pieces (Traxler, 2005). We observed that, by incorporating aspects of gamification, chat functions to support collaboration and quiz games that initiate social interaction and collaboration, the app can serve as a gateway from individual and isolated learning towards mobile-based social learning and collaboration. Additionally, the level of difficulty and the possibility of adjusting the games and learning content to different interests, with access at different times and in different settings, was perceived to be both valuable and motivating. Our usability studies and evaluations confirmed that a well thought-out application, developed together with its future users can help to map the requirements of today's care apprentices to their needs and can enrich their daily apprenticeship. Over the course of our development of CareFox, a number of implications for the design of learning applications for care-students were uncovered. Our general recommendations would be that such applications should be available on smartphones because of the potential user-base it supports and, depending on the learning unit, that headphones be available when students watch a video with spoken text. This helps to avoid disturbing other people in their environment and aids comprehension. The aim is to use the app to repeat learning content and prepare for exams through playful exercises. As a smartphone is a private object, the student should use the app on their own and track their own successes. Apart

from this, we identified a number of specific design implications that would support better engagement: having an appropriate feedback mechanism; developing the competitive and collaborative aspects; providing a platform for exchange; offering rewards and making progress explicit; providing individual resources; ensuring the application is clear and well-structured; and delivering short rather than lengthy learning units. These implications may help to support designers working from a variety of perspectives, but most notably those seeking to design similar kinds of applications for care-students. **Feedback Mechanism**: There is an explicit desire on the part of users to get feedback on their own performance so as to be able to evaluate where there might be problems. This might include feedback on their results, their short-term and long-term progress, reminders, as well as motivational incentives. **Competitive and Collaborative Aspects**: Integrating competition-based and cooperative games should be considered in order to promote social interaction between the players around a topic. This helps to maintain long-term motivation. The implementation of a multi-player cooperative and/or competitive games may help students to become more involved and engaged. **Platform for Exchange**: A platform for exchange and problem solving should be available to the users, as problems often arise shortly before exams or in working life and interaction with others can help with finding a solution. This was a very important aspect and the users clearly wanted to solve their problems together with others, be they problems of understanding topics or problems in practice. Peer interaction is especially important here because students often do not dare to talk to their teachers about problems. **Rewards and Progression**: Rewards, or an achievement-based feedback system should be considered as we noticed there was both a sense of collaboration and competition between the participants. Building upon this, one possibility might be that care-students can obtain points that can be used more widely within their apprenticeship, i.e. for exam preparation, homework, etc.. In addition, the games should become more difficult as their knowledge increases and overtly foster competition. **Individual Resources**: As the app can serve as a way of repeating and reinforcing course content, the content should be limited to the essentials. Users want to have the most important information explained in a few sentences that draw upon their existing knowledge. They also want to be able to understand the texts right away, so that they do not have to search for explanations after a learning unit by trawling the Internet, etc. Having a **Clear and Well-structured Application**: A clear and well-structured presentation of the app's content and functionality is important, so that users can find their way around with ease. **Small Learning Units:** The learning content should be divided into small learning blocks, so that users can use the material during breaks or on the move and obtain rapid feedback. The work presented in this paper is based on a design case study for and with 23 care-students. It has illustrated that designing a learning-based application can practically enable care-students to access required

learning content in ways that are independent of place and time and that can be tailored to the individual needs of the apprentice. We observed that, by incorporating aspects of gamification, chat functions to support collaboration and quiz games that initiate social interaction and collaboration, the app can serve as a gateway from individual and isolated learning towards mobile-based social learning and collaboration. Additionally, the level of difficulty and the possibility of adjusting the games and learning content to different interests, with access at different times and in different settings, was perceived to be both valuable and motivating. Our usability studies and evaluations confirmed that a well thought-out application, developed together with its future users can help to map the requirements of today's care apprentices to their needs and can enrich their daily apprenticeship.

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