Enhancing e-learning experiences in higher education: Implementation of QR Codes in a gamified environment

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Abstract

Gamification is an educational trend that orientates on the needs of today's learners and people with a high affinity towards gaming. It aims at creating a motivational and interactive learning environment. For this purpose, the gamified project "The Legend of Zyren" has been initiated in 2013 turning a course for undergraduate students into an exciting adventure. Since then, due to the evaluation results of the project, several improvements have been made. One remaining goal is to enhance interrelationships between offline and online contents and thus students and digital technology. The solution that is presented in this article is the use of Quick Response (QR) codes. Thereby, the physical world can be connected with digital tasks and actions. Several forms of QR codes have been implemented in order to address different types of game elements. To verify the benefits, an evaluation with the participants of the project has been conducted. The results show that most students (83%) could use the QR codes without any problems and evaluated them as a diversified alternative to conventional tasks (70%). For the tutors of the course the integration of QR codes results in some important advantages, inter alia, an ease of work and an enhanced insight into the students learning progress.

Keywords: Gamification, E-Learning, QR codes, Game Elements, Higher Education.

Introduction

Education in the digital age requires new forms of learning techniques and environments in order to cover the needs of today's learners. The so-called "google-generation" is shaped by changing information literary skills (Gunter, Rowlands, & Nicholas 2010) and the use of smartphones in daily life is of particular importance (Falaki et al. 2010). The habitude of accessing information anytime and from everywhere results from student's high affinity towards information and communication technology (Orszullok, Knautz, & Soubusta 2013a). Providing an interactive and stimulating learning environment facilitates the enhancement of information literacy skills and maintains motivational aspects of learning (Wintermeyer & Knautz 2015). Different forms of e-learning have been considered in order to attain such conditions. Today, especially the application of game elements is seen as an ideal realization of a motivational environment that turns learning into more than a monotonous duty (Lee & Hammer 2011). The use of game mechanics in contexts without game-based background is defined as gamification (Deterding et al. 2011).

A lot of gamified projects have been launched in business and education. The project this article will rely on is "The Legend of Zyren", which has been successfully implemented and developed in 2013 in order to turn a course on knowledge representation for information science students into an exciting adventure (Hanraths, Wintermeyer, & Knautz 2016, Knautz 2013, Knautz, Göretz, & Wintermeyer 2014, Knautz, Orszullok, & Soubusta 2013, Knautz, Soubusta, & Orszullok 2013, Knautz, Wintermeyer, & Göretz 2014, Orszullok & Knautz 2014, Orszullok, Knautz, & Soubusta 2013b, 2013a, Wintermeyer, & Knautz 2015). The project consists of a text-based adventure embedded in a platform on which every student has to solve so-called quests in order to pass the course. In addition, during a real-life practical course the participants form groups and face up to further tasks, also augmented by story elements and

additional game mechanics. During the past years the project was improved based on evaluation results and experiences during the realization. In 2016, the concept for the gamified lecture was revised for the fourth time. One remaining goal is to enhance the integration of the platform and the practical session and thus the relation between the group and technology. Other projects use Quick Response (QR) codes to combine the physical environment with digital elements (Fitz-Walter et al. 2012; Rouillard & Laroussi 2008). Thus multiple media can be approached. In the case of Zyren these QR codes are integrated to increase the immersion of the students with their online character. Students can further resolve the online assignments independently without the help of a tutor as the system automatically verifies the answers. After having implemented the QR codes in the existing system, a questionnaire was created and answered by the participating students. The evaluation is intended to enhance the e-learning experience.

The project: The Legend of Zyren

Before the project has been launched, the course on knowledge representation consisted of a traditional lecture, a practical seminar and assignments which the students had to solve in order to pass the course. The contents of the course are primary theoretical and the failure rate of 44% in the final exam was not satisfactory. In order to provide a better learning environment for the students, parts of the course were redesigned completely. While the lecture itself remained untouched, the practical course was revised and an online platform replaced the former homework assignments. The platform was realized via a self-developed metasystem called "Questlab" which is freely available online[32] and provides access via mobile devices due to a responsive design (Hanraths et al. 2016). The structure of Questlab allows to create several gamified courses with the help of a modular system. Based on one's own need, game elements like a story, avatars, quests, experience points (XP), levels, achievements and leaderboards can be constructed. In the following, these game elements will be explained shortly.

A story is the common theme throughout a gamified course. To facilitate the identification between a player and the story (Martin 2005) a personal avatar can be used. Quests are tasks which contain the actual learning content and can be embedded in the narrative elements. Quests are supposed to motivate the player to achieve certain goals (Zichermann & Cunningham 2011). By solving these tasks, a player can earn experience points. Points are important to give an overview of the player's status and rank (Kapp 2012). A certain amount of XP causes a character to reach a higher level. Achievements are visual badges, which the players earn by fulfilling specific actions. Examples are reaching a certain level or solving a particular quest within the first attempt. Achievements serve as a reward to support the feeling of ego enhancement and status (Antin & Churchill 2011). Leaderboards sort users by different variables such as XP. They have a competitive and motivational effect due to the transparent demonstration of the player's success in comparison to others (Costa et al. 2013). In the case of "The Legend of Zyren" all available game elements and features of Questlab have been adapted to the purpose of the course. In Figure 1 an overview of the implemented course is displayed.

The setting of the story is Zyren, a realm of fantasy. Suitable for the fantasy environment, the avatars consist of the races humans, elves, orcs and goblins from which each student can choose a personal favourite. Simultaneously the participant has to apply his knowledge on the contents of the lecture on knowledge representation via the embedded quests. For a detailed description of all realized game mechanics see (Knautz 2013, Knautz, Göretz, & Wintermeyer 2014, Knautz, Orszullok, & Soubusta

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[32] http://questlab.hhu.de

2013, Knautz, Soubusta, & Orszullok 2013, Knautz, Wintermeyer, & Göretz 2014, Orszullok & Knautz 2014, Orszullok, Knautz, & Soubusta 2013b, 2013a, Wintermeyer & Knautz 2015).
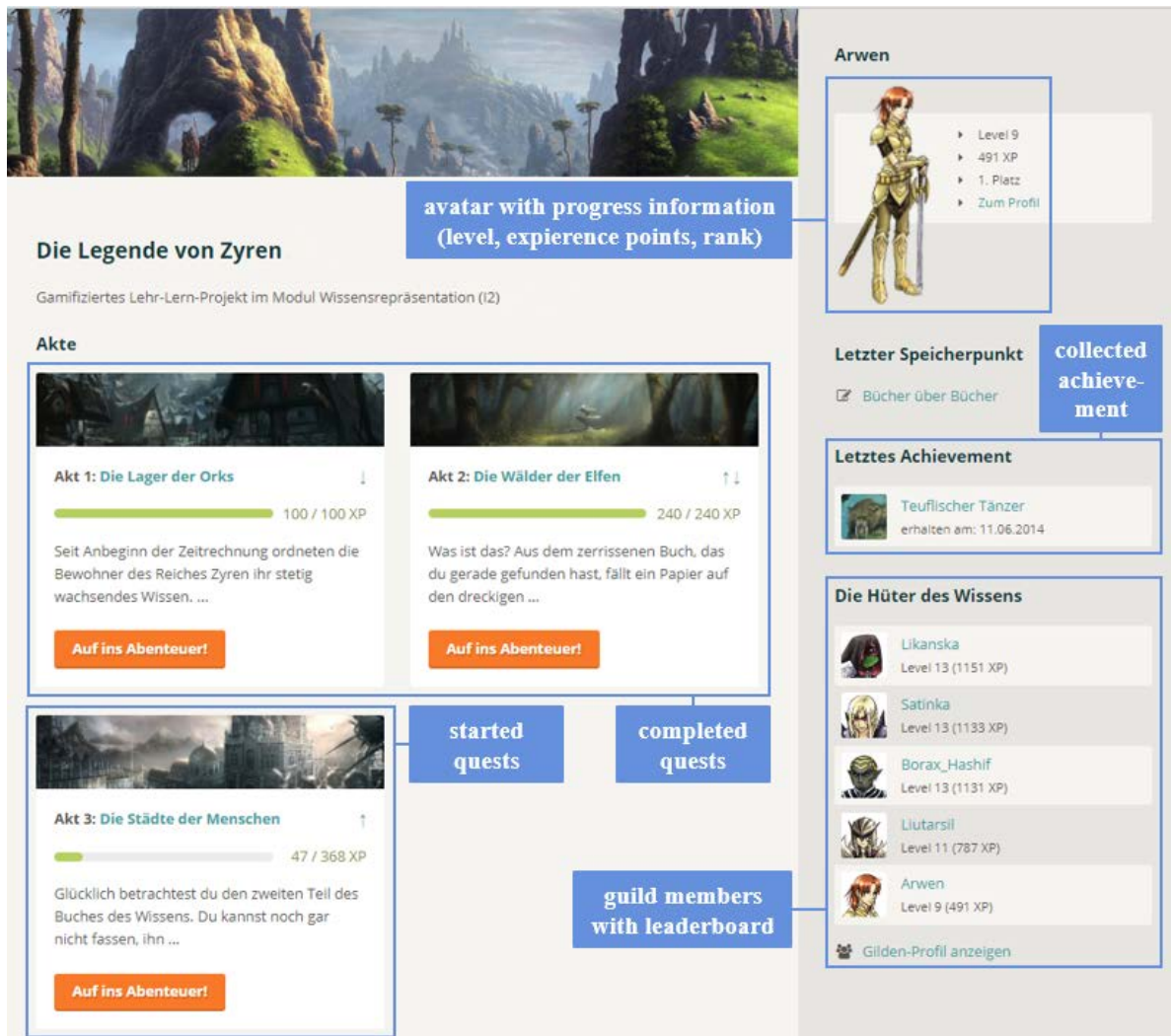

Figure 1. Implementation of "The Legend of Zyren" in Questlab

Beside a personal profile of a character in Zyren, a team area has been embedded on the platform. During the practical course the students unite as special forms of teams, so-called guilds. Guilds originate from Massively Multiplayer Online Role-Playing Games (MMORPGs) and are an "association of players who chose to come together to achieve a common goal" (Riegle & Matejka 2006, p. 1). These common goals are the guild quests held during the practical lessons which are rewarded with XP similar to the quests on the platform. There are different types of guild quests. Some remind of common parlor games or game shows like "Jeopardy!", others are self-developed concepts or campus quests, which are conducted in the style of scavenger hunts. A recurring element in the guild quests are narrative components which give an impulse to fulfil certain tasks. Thus, the practical sessions do not only serve to transmit theoretical knowledge on the course's contents but also contain game elements and support the social component by forming groups. Moreover, the practical lessons are not completely detached from the platform because on the one hand every session is embedded in the fantasy story and on the other hand XP received during the guild quests are added to the avatars on the platform as well. The guild area provides an overview of all groups, a ranking and a summary of every passed guild quest.

Before integrating QR codes, the guild area was edited manually e.g. by adding XP, which have been earned during the practical sessions.

Beside the narrative elements and these points, the connection of platform and real life course can be further strengthened. Addressing today's importance of smartphones, QR codes are an appropriate possibility to link the digital and physical parts of Zyren and to provide students with adaptive information (Rouillard & Laroussi 2008). With the introduction of these QR codes additional game elements can be implemented aiming at a higher level of collaboration, which turned out to be an important dynamic to support the learning process (Knautz, Göretz, & Wintermeyer 2014). In the following section the concrete functions of QR codes and contexts in which they already exist will be explained.

QR codes

QR codes are forms of barcodes that can be read by smartphones. Developed by Denso-Wave, which is a subsidiary of Toyota, these codes already exist since 1994. They were initially used to track inventory in vehicle parts' manufacturing (Ashford 2010). Unlike traditional barcodes the stored information in QR codes is much more extensive. Beside conventional text, URLs, phone numbers, SMS or electronic business cards (V-cards) can be deposited. QR codes can be created easily and free of charge or with only marginal costs. The benefit of QR codes has also been recognized in different learning environments. The projects "Secret SLQ" (Fitz-Walter et al. 2012) as well as "PerZoovasive" (Rouillard & Laroussi, 2008) serve as an example. "Secret SLQ" by Fitz-Walter et al. (2012) is a form of scavenger hunt with additional gameplay elements like challenges, points and leader boards. It was designed to facilitate the access to the State Library of Queensland for children at the age of 8-14. All elements are embedded within a story about being trapped in the library. To escape, the player must find hints and solve challenges all over the library. Beside his own knowledge and skills, the player is accompanied by a cock-roach named Lester. QR codes are hidden all over the building and "provide a historic viewpoint of the library, contextual background of artifacts, clues to challenges, and challenges themselves that initiate a quiz for children to complete" (Fitz-Walter et al. 2012).

In contrast, "PerZoovasive" (Rouillard & Laroussi 2008) is not driven by a story but instead uses QR codes to convey information. The project is located in a zoo and makes use of contextual QR codes. With these codes context-sensitive information can be transferred. Consequently, the corresponding language, state of knowledge and possible tasks can be adapted to a particular user. In addition, e.g. information about an animal race (species, food, etc.), a specific animal (name, age, etc.) or a quiz can be retrieved. Some comparisons between Zyren and the aforementioned projects can be drawn. Similar to "Secret SLQ" an underlying story is of main importance. "PerZoovasive" on the other hand primary uses QR codes to provide its users with adaptive information, which is also the goal of the implementation regarding "The Legend of Zyren". The concrete methods for the realization are depicted in the following section.

Research and Methodology

Subsequently, a possibility to integrate QR codes into an existing gamified learning environment will be discussed. For the evaluation, a questionnaire was developed and handed to the participating students. The evaluation models and methods will be presented in the subsequent section.

Implementation

In the case of "The Legend of Zyren" QR codes were used that provide a link to the e-learning platform Questlab, respectively one of its subpages. During the practical course the QR codes have been made accessible to the students either on the presentation slides or printed on paper distributed on the campus. When a student scans the code via smartphone or tablet, a web browser opens and the e-learning platform appears. After scanning the QR code, different events can occur due to the type of link (Figure 2). Three different types were implemented which are all related to a specific game element. Character titles and guild achievements were newly realized via QR codes whereas guild quests existed before, but not in a digital form.
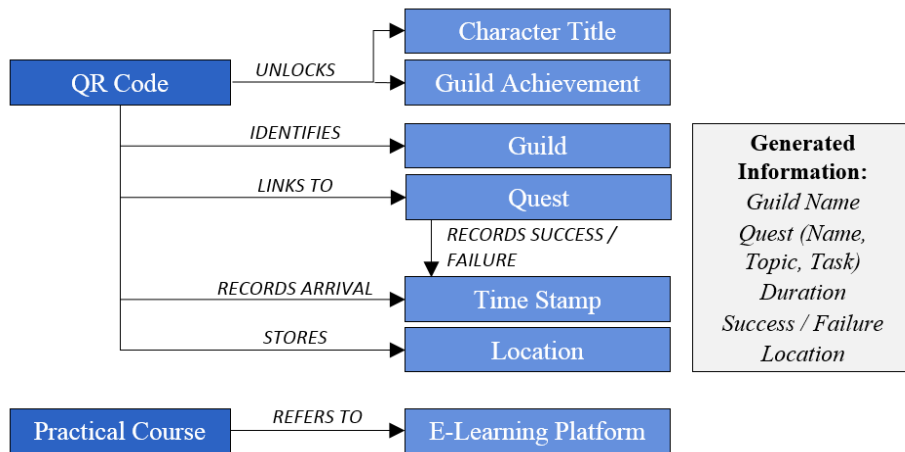

Figure 2. Implementation model for QR codes

Guild Quests. The most complex form of QR codes is the realization of quests which include the actual learning content. Every meeting of the practical course consists either of a classroom session or a campus quest. The three campus quests in the form of a scavenger hunt put a greater focus on the implementation of QR codes. In former realizations, participants had to visit several stations on the campus where they solved tasks assigned by tutors. A direct connection between the campus quest and Questlab was not given. By the use of QR codes this connection is generated as some of the tutor stations are now replaced by a QR code.

The resulting mixture of human and QR code based challenges provides a diversified combination of tasks. Now every campus quest has its own page in the course area on Questlab where all information is accessible for the students. In addition to a story related to the sessions topic (e.g. Pokémon, "Gotta Catch 'Em All!"), the page provides a scalable map with all stops of the recent campus quest (Figure 3).
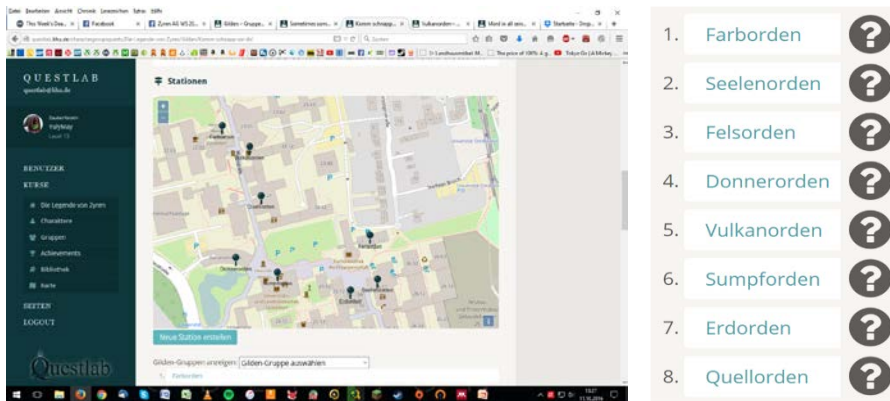
Figure 3. Left: Map with all stops of the campus quest "GottaCatch 'Em All!"; Right: Overview of all stations including their covered icons

After scanning a code at one of the QR code stations without tutors the participants gain access to a small online task on Questlab. These assignments are designed as factual questions (multiple choice and text input) to enable a short processing time on the smartphone which has a limited screen size. After solving the quest, the guild receives a direct feedback through a jingle and a story element (Figure 4). QR codes are also used at tutor stations. Instead of a short task only a text input field is displayed. Here the guild has to enter the password which they earn by solving the tutor's task correctly.
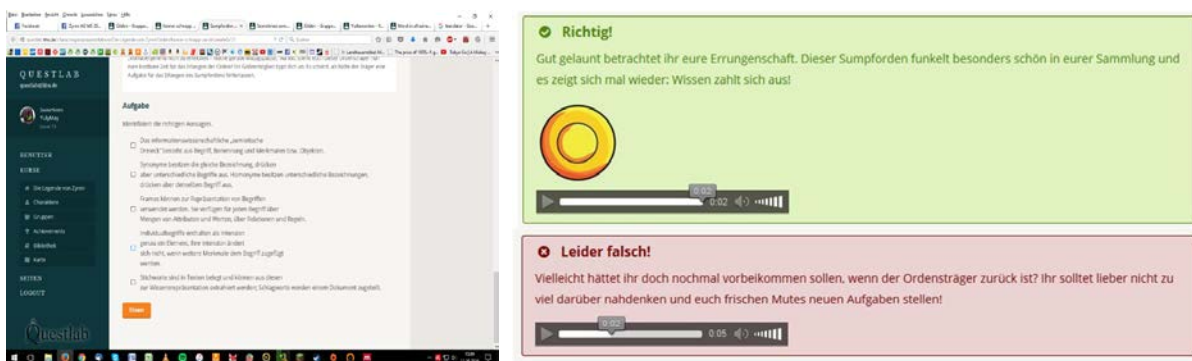

Figure 4. Left: Multiple Choice task, Right: Feedback of a correct (green) and incorrect (red)

Character Titles. During each session, the QR codes with link to a character title were placed in the presentation slides or printed on paper hidden on the campus. The titles facilitate an individualization of the personal avatar on the platform. A total of 13 titles, like "Throne Guardian" or "King of Villains", can be collected. In order to retain the narrative tension, the correspondent name of the title is not displayed before the QR code has been scanned. Afterwards, the title is stored at the individual's profile. **Guild Achievements.** As an equivalent to the achievements for individual players, achievements for guilds (e.g. "The winner takes it all" or "The Fearless") were introduced. The guilds can earn these by fulfilling different tasks or finding the hidden QR codes as part of the campus quests. During the classroom sessions on the contrary only guilds that reach a certain goal (e.g. to catch the highest amount of XP) during the guild quest are provided with a particular achievement.

Beside the mere QR codes, additional information can be stored during the scanning process which are useful in order to evaluate the students' progress in a guild quest and to improve further implementations

of the course. Thus, time stamps and success respectively failure information of a quest are stored each time a guild scans a code and completes a task. Success rates can then be calculated in order to estimate the guild's performance in a particular quest. As an important goal of the project is to enhance the e-learning experience of the participating students, it is also essential to estimate the added value for this group, which is presented in the following subsection.

Evaluation Model

In order to evaluate the implemented QR codes and their effects, the evaluation model that has been used for former evaluations of the course (Knautz, Göretz, & Wintermeyer 2014) has been expanded. The underlying model is based upon three core concepts of gamification that have been identified by Hamari, Koivisto and Sarsa (2014): motivational affordances, psychological outcomes, and behavioral outcomes. Different aspects of gamification were fixed and structured in eight facets. The individual items, called foci, can be combined with each other in order to form questions for the evaluation survey which increases the expressional power of the model. As this article focuses on the evaluation of the implemented QR codes, this item was added to the evaluation model, specifically to the facet System Features (SF) which belongs to the dimension motivational affordances. To figure out if the newly implemented items further strengthen the gamified concept of the course, the former questionnaire was accordingly supplemented by 13 questions concerning this focus. Ten further questions were developed addressing the guild achievements and character titles as these elements were also made available via QR codes. The resulting paper-based survey was handed to all of the 179 students that took part in the revised course during the summer term of 2016. Each question can be answered based on a Likert-like scale from 1="strongly disagree" to 6="strongly agree". A neutral option is missing on purpose in order to force a tendency from those students that are not sure about their answer. An additional free text field was added in order to catch any supplementary ideas of the students.

Results

In total, 84 students (n=84) fully completed the questionnaire. The results regarding the newly introduced elements (QR codes, character titles and guild achievements) can be retraced in Figure 5. Regarding the unproblematic use of the QR codes with a smartphone, 83% reported on a positive tendency with even 39 (46%) ratings for the best possible option. The mean value amounts to 4.8 (SD = 1.4). Nevertheless, the answers in the free text fields showed that some students with older smartphones or a slow internet connection sometimes had problems with the scanning process. Concerning the usefulness of QR codes most students (70%) agreed that a combination of quests with QR codes is a diversified alternative to conventional tasks. Similarly, 59 students (70%) hold that the use of QR codes to loosen up the guild quests is useful although in this case only 17 students (20%) strongly agree. The question if the use of QR codes enhances the connection between guild quests and platform was answered positively by 56 (66%) of the participants. Beside the QR codes in general, the evaluation of character titles and guild achievements shows that the latter score better than the former. Both elements were examined with regard to the question if they are fun for the participants. Referring to this, character titles were rated positively by 60% of the students. The fun aspect of guild achievements on the contrary reaches a positive value of 70%.

The question if collecting achievements with the guild strengthened the team spirit was answered positively by 67% whereof 23% strongly agree. A mean value of 4.0 (SD = 1.6) also shows that most of the students agree with this statement. This positive outcome of the guild elements is also reflected in evaluation questions about guild collaboration (Figure 6). For example, the question "I enjoyed working

on the teaching contents together with my guild" was answered positively by 74 students (88%) from which 30 participants (36%) strongly agree with the statement. This results in a mean value of 4.8 (*SD* = 1.2). Likewise, again 74 students (86%) tend to agree to "I enjoyed working in a guild" with even 32 students (38%) fully agreeing and again a mean value of 4.8 (*SD* = 1.3).

Scanning the codes provides the tutors with important information. Through a time-stamp and a note whether a guild solved a task or failed at it, it is possible to draw conclusions on the difficulty of the tasks. For the guild quest "Gotta Catch 'Em All!" e.g. some relevant findings could be gathered. Solving a task at a QR Code station took between one and three minutes. Further, the multiple choice station "Volcano Badge" was solved correctly by 33.24% of the guilds, which indicates a problem of comprehension in this quest on metadata. On the other hand, the task "Cascade Badge" on the calculation of semantic similarity was solved correctly by 88.46% which is evidence to suggest that students cope well with this topic.
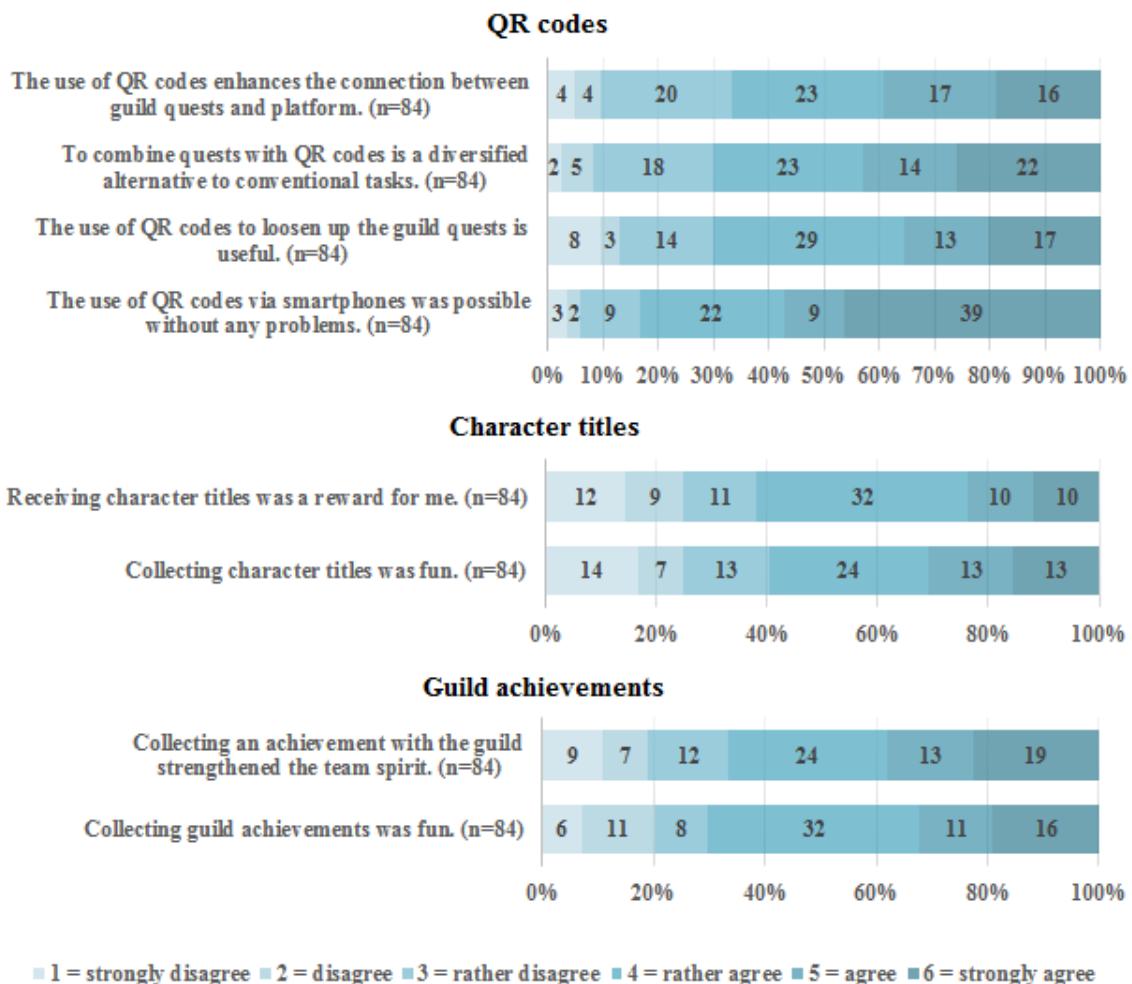

Figure 5. Evaluation results of the newly introduced elements QR codes, character titles and guild achievements

Beside the information on the topical difficulties, the time stamp also helps to improve the locality of a scavenger hunt. For instance, the station "Soul Badge" was only visited by 19 out of 28 student groups. This probably indicates that the geographical position of this location was not ideal, which could be

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considered for the subsequent campus quest. Additionally, the tracking enabled to show the guild's path during the quest as every station was assigned to a position on the map of the campus. This shows whether the distances between the stations fit into the time frame of the practical course. Based on this information the locations can be improved if necessary. On the other hand, it is a good overview for the participants.
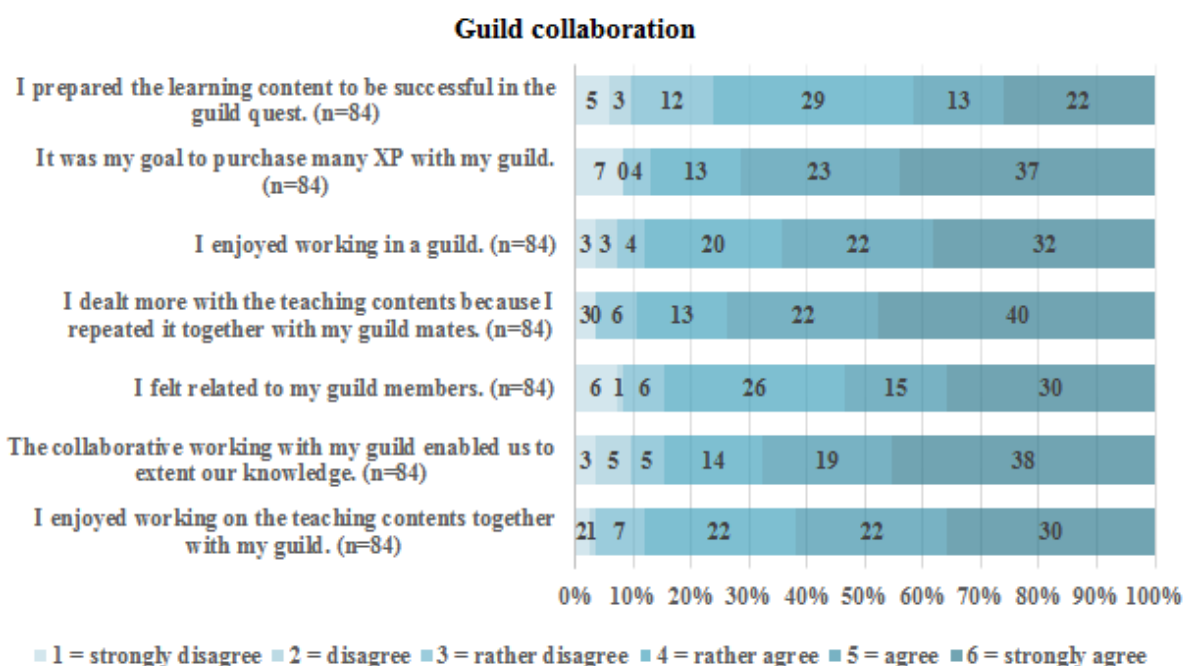

Figure 6. Evaluation results of guild collaboration

Overall, the embedment of the learning contents into the course worked well according to the evaluation results (Figure 7). Most students (94%) agree that they had to purposefully deal with a topic by solving a quest which results in a mean value of 5.0 ($SD = 1.2$) for this question. Even 96% of the students think that the application of knowledge helped to improve understanding the learning content, a mean value of 5.1 ($SD = 1.0$) confirms this positive outcome.
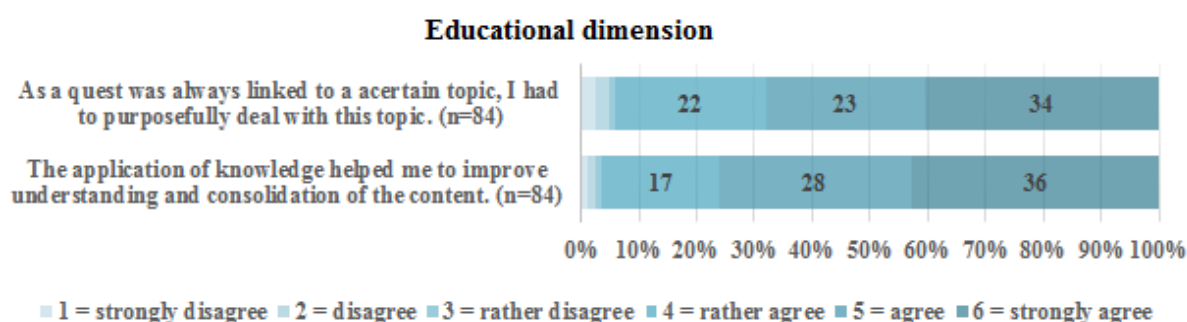

Figure 7. Evaluation results of the educational dimension

Conclusion

The presented platform for collaborative learning and teaching aims at addressing the need for new learning approaches, also in higher education. In the recent stage of the gamified project "The Legend of Zyren" QR codes were implemented to deepen the connection between the online platform Questlab

and the practical course. Based on the evaluation results, a positive trend of the use of the new elements and a strengthened connection between students and technology could be identified. The introduction of QR codes is a benefit especially for the tutors because of the information they obtain by tracking the codes. However, since this was the first attempt of such an implementation, there is also room for improvement. For example, there were some minor problems concerning the scanning process of the QR codes as well as the connection to the platform, which was due to a bad wireless signal or mobile internet access. Although this problem does not directly concern the implementation, attention should be drawn to a smooth process. A possible solution for the problem with the internet connection could be an extensive test at the potential locations. Only positions with stable wireless signal should be chosen.

In spite of a positive tendency, the results regarding the variety of the given tasks and the linking between guild quests and platform could come of better. To increase the variety of the QR code quests it is useful to extend the existing types of tasks, though the new types should not be too complex due to the display size of a smartphone. In order to emphasize the connection between platform and guild quest, existing features like the map could be used more intensely, thus serving as a basis for further mechanisms. Another possibility to strengthen the connection between both parts is to use QR code tasks in the non-campus guild quests more extensively. The same holds for the newly introduced character titles and guild achievements. Overall, both were perceived positively but also show potential for improvements. To design the obtaining of character titles more interesting it is possible to bind them to specific challenges like achievements. Moreover, the titles could be more present on the platform and also during the course so that they will be perceived more as a reward whereby the students can stand out from other participants. Regarding the guild achievements, a greater variation of challenges is conceivable.

The overall project has shown that gamification can be a useful solution to increase the motivation of students to learn and can offer them new possibilities to deal with the learning content. Especially the resulting collaborative aspects had a very positive influence on the motivation increase and the feeling of togetherness among the students. The e-learning platform also made it possible for each student to learn at his or her own pace and to focus even more intensively on information literacy. For this reason, the concept could also be applied to other seminars. Nevertheless, such an extensive gamification required a very high amount of time and personnel, which should not be underestimated when planning such a project. The use of game elements cannot be regarded as a valid solution for improving higher education in general, because the success depends strongly on the desired objective and the target group that is confronted with it.

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