

From Know That to Know How – Providing New Learning Strategies for Information Literacy Instruction

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Abstract. Gameful design has become a popular trend to create more engagement in the area of education and learning environments. Using games mechanics and game principles from both digital and non-digital games can also be incorporated into information literacy instruction. Therefore the project “The Legend of Zyren” was initiated to gamify a course on information literacy and provide a new educational environment with a focus on new technologies and dynamic learning structures. This paper focuses on evaluation of the online platform and parts of the practical session, and the ability to impart information literacy with regard to perceived quality (e.g. user-friendliness, usefulness, security/trust and fun) of content, implementation and the general concept of gameful design. The results of the evaluation confirm the positive effect of the gamified learning environment on motivation and content mastery among students regarding the acquisition of information literacy. The students were more engaged in the learning content and able to apply the acquired knowledge to solve arising problems.

Keywords: Information literacy instruction, knowledge representation, gamification, gameful design, higher education.

1 Gamified Learning in Information Literacy Instruction

Humans love to play. From the day we are born, we play [1]. As we grow older, playing becomes a smaller part of our life, but the desire to play never really leaves us. Video games in particular are becoming even more popular among today’s digital natives – people who have grown up in and around the digital world [2]. Gamers expend countless hours playing and mastering techniques and tactics, improving their skills and overcoming difficult challenges, often reaching the “flow state,” a temporary state of mind in which users are so fully immersed in their work that it seems to be an effortless process [3]. Gamification aims to utilize peoples’ desire to play and aims to evoke a similar degree of motivation and dedication by using game mechanics to make otherwise mundane or difficult tasks more appealing. Besides addressing a general desire to play, the various game mechanics also satisfy a broad range of human (core) desires like reward and status, achievement and self-expression or competition and

altruism [4]. Furthermore, Sebastian Kelle [5] defines two important game design principles that contribute to learning success. Incorporating collaboration and competition into a gamified framework aims to achieve a balance between knowledge acquisition through teamwork and engagement through competition, so that “learners should be motivated and “drawn” into the game, but not overly distracted from the learning goal” [5, p. 14]. Besides this, the natural structure of a game serves as a catalyst for content mastery. The content is bound to an interactive context in which the students have to apply the disciplinary content meaningfully [6, p. 520]. The knowledge which is acquired at one level of the game has to be applied and intensified to accomplish the next one, which is supported by feedback loops [7, p. 12] and visual manifestations of the learning progress in the form of leaderboards, levels and rankings [8]. This cyclic implementation and the constant upward movement of the difficulty levels of a game create a cycle of expertise and support content mastery and consolidation [9].

In recent years, gamification has become increasingly popular with implementations ranging from simple point systems on websites to tools like jogging apps, in which users have to run through a zombie apocalypse [10]. At the same time teamwork, competitiveness, and especially information literacy, have become key skills in today’s society. However, as the new generation of learners demands a more interactive and motivating learning environment, gamification seems to be a promising approach to mediate these skills [11]. “Games and game-like elements have begun to invade the real world” [11, p. 1] and researchers are starting to recognize the worth of games for education and other purposes. Games mechanics and game principles from both digital and non-digital games can also be incorporated into information literacy instruction [12-13].

Inspired by other successful gamification projects in education like *The Multiplayer Classroom* [14] or the *Khan Academy* [15], we decided to gamify one of our obligatory second semester courses on Knowledge Representation by turning it into a fantasy role-playing game. By applying various game mechanics like experience points, levels and leader boards and combining them with an adventurous story, we wanted to create an interactive environment that increases students’ motivation and engagement. The project is divided into a classical lecture with focus on information literacy, an online platform where a text-based adventure is set and students solve quests, and a practical session, where the content is intensified and students can solve tasks in groups (guild quests) and demonstrate how information literate they are [16]. Partial aspects of the project have been presented in [16-18], but this paper represents a first comprehensive overview of the whole project.

2 Gamified Framework – Student Centered Design

We did not want to use just one or two gimmicks to make the course more interesting; more likely, our aim was to turn the whole course into an actual game and make the experience as immersing and motivating as possible. A lot of our ideas came from fantasy role-playing (video) games (RPGs) like *Skyrim* and *World of Warcraft*. Just

as in RPGs, the student can choose between different races, like elves, goblins, humans and orcs. The chosen avatar then travels through the fantasy world of Zyren, fighting monsters and bad guys, helping people out, finding treasures and saving the world.

As the main part of The Legend of Zyren is a text-based adventure, the story with its plot and narration is the core element of the game. The student embarks on a mission through the realm of Zyren to find the mysterious book of knowledge which was lost long ago. Since the book contains the collective knowledge of all inhabitants of Zyren, it is said to have an immeasurable power that allows its owner to gain control over the whole realm of Zyren. These missions, called quests, are challenges or riddles that the student has to face on his journey through Zyren. They can be regarded as exercises which test the student's knowledge of the lecture's contents and prepare him for the final exam. All in all there are 153 quests integrated in the main quest lines and side quest lines of the game that are of different types such as multiple choice items, text-box exercises, crossword puzzles or drag and drop graphics. These types of quests are automatically evaluated by the system and the student immediately gets to know whether his solution was correct or not. In case of a wrong submitted solution, the student has the possibility to restart the quest and try to solve it again. Besides this there are the so called "hand-in quests" which have to be submitted via email to the supervising tutors. These quests are more comprehensive than the automatically evaluated ones and are suitable for topics which have to be acquired in a more intense way.

Through solving quests the students earn experience points (XP), which are needed to rise to higher levels and directly reflect a student's progress [8], [11]. The level of progression is exponential, so as the plot proceeds, a student needs to earn more and more XP to reach the next level. Correspondingly, the amount of XP that can be earned through solving a quest also rises exponentially and a student will earn more points for solving later, more difficult tasks. Just like in real RPGs, there is no 'wrong' in the traditional sense. If a submitted solution is wrong, a student can simply try again until the right solution will be rewarded with the attached number of XP.

Most video games these days also feature an achievement system. Achievements can be regarded as additional status symbols that can be earned by accomplishing extra challenges or special attainments, which are linked to various requirements [19]. They address the desire for status and self-expression and motivate players to go above and beyond the necessary requirements of a game. Throughout, students can earn achievements for things like solving quests, reaching certain levels, making no mistakes or being present in the practical session.

Besides allowing students to work through the quests, the platform also serves to give students an overview of their progress. The main page displays the student's avatar, which evolves every time the student levels up, as well as the current level and the attached number of XP and the current quest. There are 15 possible levels and reaching level 11 is necessary in order to pass the course. Reaching higher levels gives the students a bonus on their final exams. From the main page the student can either continue where he left the adventure or access the quest overview, his achievements or a map of the realm of Zyren. The quest overview holds all quests arranged by quest lines and acts and separated into (obligatory) main quests and (optional) side quests.

Parallel to the online platform the students visit a weekly practical session, where they participate in so called "guild quests". At the beginning of the semester, students form guilds, with a guild name and a leader who is in charge of the groups. These guilds then compete against each other in gamified tasks ranging from Jeopardy-style quizzes to treasure hunts.

3 Implementation

The first prototype of the online platform was programmed in PHP using the CakePHP rapid development framework [20] and utilizing the Model-View-Controller software design pattern, which ensures strict division between the objects (models), the user interface (views) and the functionality (controllers). The platform is based on a MySQL database (Fig. 1).

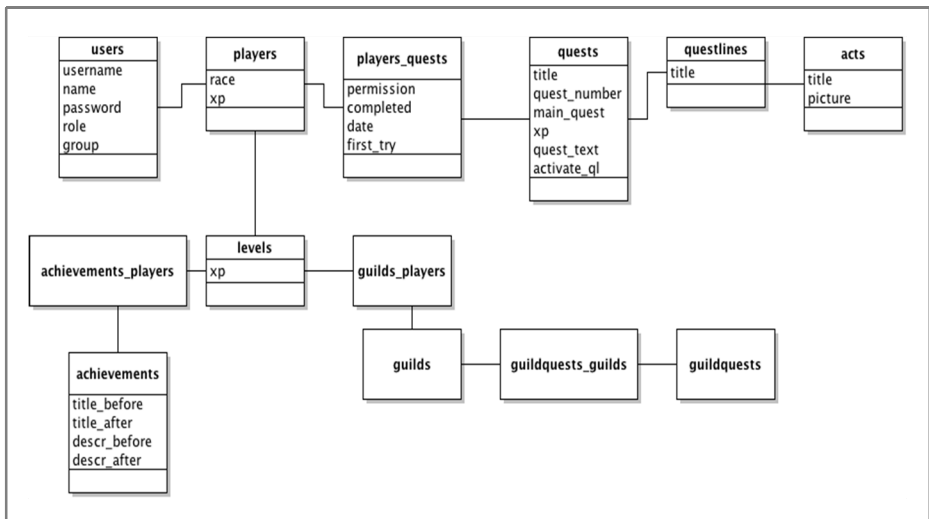


Fig. 1. Database scheme for the online platform

Each table in the database is represented by a corresponding model that makes the table data available to its controller and defines the relationship to other tables. A model can have multiple views, which are responsible for displaying information (e.g. an overview over available quests) and for processing user inputs. The controller serves as an intermediary between a model and its views, performing various user-defined functions on the model's data (e.g. calculating XPs) and passing the results to a view. Users are divided into *players* and *administrators* through the *role* attribute. The role governs global permissions, as well as the presentation (*view*) of the main page. The acts, quest lines, quests, levels and achievements tables hold the static game information. The exercises associated with a quest are implemented in the corresponding *controller* and displayed via the associated *view*.

Each student’s progress is tracked in the `players_quests` and `achievements_players` tables. The conditions for achievements are implemented at the appropriate places within the code. As soon as the requirement is fulfilled, the appropriate entry is made in the `achievements_players` table. The `players_quests` table not only keeps track of which quests a student has finished, but also stores additional information like the date of completion and whether an exercise was solved on first try, as well as whether or not a student has already unlocked a quest. The `guilds` table contains all guilds, while the `guilds_players` table associates each player with his guild. The `guildquests` and `guildquests_guilds` tables function like the `quests` and `players_quests` tables.

4 Evaluation – Measurement of a Game

For the evaluation of *The Legend of Zyren* we developed a research model that covers all relevant aspects that are significant for the realization and the analysis of the approach. In this paper we present only a detail of the results focusing on the quality of the represented content, the platform as a gamified teaching-learning project and the gameful design concept in general. The central research questions that motivate this paper are:

- RQ1: Is the representation of the content appropriate for the intermediation and the recap of the learning content?
- RQ2: Is the use of the platform success-promising for the intermediation of the course content?
- RQ3: Can students be supported by targeted use of gameful design in didactics to learn information literacy?

The analyzed aspects ranged from the representation of the content through the concept and its usefulness over the intermediation of the content to a general analysis of the gamified concept regarding learning success, which were represented through various hypotheses (Table 1).

Table 1. Evaluation overview containing research questions and hypotheses

Research Question	Hypotheses
RQ1: Quality of Content	H1.1: Perceived Quality of Content [21, 22] H1.2: Mediation of Information Literacy [21]
RQ2: Platform	H2.1: Acceptance and Use [23] H2.2: Perceived User-Friendliness & Usefulness [24] H2.3: Perceived Security / Trust [25, 26] H2.4: Perceived Fun [27, 28, 29]
RQ3: General Concept	H3.1: Guilds [5, 16] H3.2: Game Elements [7, 8, 14, 30] H3.3: Content Mastery & Learning Outcomes [6-9, 16, 31]

- H1.1: The learning content was fluently/well embedded in the gamified framework.
 H1.2: The used concept for the mediation and recap is appropriate for the intended purpose
- H2.1: The platform is accepted and regularly used by the students.
 H2.2: The students perceive the platform as useful and the design as user-friendly.
 H2.3: The platform is perceived as secure and trusted.
 H2.4: In the use of the platform the students experience fun and motivation.
- H3.1: The concept of guilds influences the learning behavior of the students.
 H3.2: The use of game mechanics has a positive influence on the learning motivation.
 H3.3: The gameful design effects that the students are more motivated and deal with the lecture content more intensively and internalize it better. The content mastery has a direct impact on the learning outcomes.

5 Results

The first analyzed research question (RQ1) dealt with the quality of the teaching content. 75.8% of the students agreed with the statement that the content of information literacy instruction was well presented on the platform ($n = 91$). The majority of the participants also perceived the connection of lecture content and story as successful. Only 24.0% of the students disagreed with their fellow students ($n = 91$). The transition between the story line and the information literacy quests are perceived as fluently by 53.8% of the students. Therefore it can be said that hypotheses H1.1 concerning the perceived quality of content is confirmed. In terms of the hypothesis that focuses on the mediation of the teaching content, the students consider that the varied assignments of tasks boost their attention and prevent them from becoming easily exhausted by the quests (53.8% of $n = 91$). Moreover the division between main quests for general recap of teaching matters and optional side quests to intensify knowledge proved to be very appealing for 86.8% of the students ($n = 91$). To sum up, the quality of content is assessed as positive. Both perceived quality concerning the representation of the content, as well as realization of the mediation are well received by the students.

The second research question RQ2 is based on the platform. The hypothesis H2.1 considers that the students accept the platform as a learning system and regularly use it. At the beginning 138 students registered on the platform. 84.1% of the students actively participated in the course and regularly used the platform. The remaining 22 users dropped out of the course, which corresponds to a normal dropout rate. 105 students passed the course successfully and reached the foreseen number of experience points. Most of the students even used the platform beyond this point. Based on this obligatory point level, the mean value is around 168.5 percent.

Hypothesis H2.2 focuses on user-friendliness and usefulness. Use and onboarding process are perceived as easy and uncomplicated. Thus it appears for example for 78.0% of the students ($n = 91$) that the first interaction on the platform is obvious and linked with positive feedback. Above all, the opportunity for flexible timing regarding

the work load is conducive for the students' learning behavior (58.4% of $n = 91$). The perceived usefulness of the platform is investigated by the factors of usefulness in general, the additional value for exam preparation and individual learning success. The students rated usefulness in 94.6%, surplus value in 95.7% and their personal learning success in 89.1% of all cases as positive ($n = 91$). The assumption of perceived security and trust is concerned with the students' feeling of safety and confidence in the accuracy of the platform. 65.6% of the students consider that they trust the platform, e.g. in calculating XP correctly and processing the solutions ($n = 90$). Perceived trust also regards whether the students have the feeling that they are kept under surveillance by the point and level system. Only 15.4% ($n = 91$) have the impression that these game mechanics are also an interception method to observe their individual working progress. The last hypothesis for research question RQ2 deals with the aspect of fun, which also includes motivation and flow. We can state that 82.5% of the students have fun with the platform and enjoy solving quests ($n = 91$). 77 of all respondents (85.6%) are motivated by the story and the challenge of fulfilling tasks. Furthermore, 59.4% of the participants lose their sense of time and are completely absorbed in the world of Zyren ($n = 91$) to the extent that they achieve the feeling of flow and immersion.

The third research question deals with the general concept of gameful design. Hypothesis H3.1 focuses on the guild concept as a combination of collaborative and competitive patterns. Almost 73% of the students registered an increase of their engagement through the competitive context ($n = 91$). Furthermore, in half of the cases the students say that the guild concept has a positive influence on their learning behavior (49.5% for $n = 91$). The guilds also functioned as collaborative learning groups for the final exam (48.8% for $n = 91$). Hypothesis H3.2 analyzed the influence of game mechanics on the students' motivation. 83% of the participants are of the opinion that the use of game mechanics is a creative learning alternative. 82.5% ($n = 91$) favorably view the aspect of fun in the platform. In regard to the restructured tutorials with the guild quests, fun is rated positively in 91.9% ($n = 111$) of cases. For the traditional tutorial, consisting of theoretical recap and exercises, the fun factor only achieved a rate of 72.6% ($n = 112$). In terms of motivation, 85.6% ($n = 90$) and 81.3% ($n = 112$) of the students confirm that the platform and the guild quests have a positive influence on their engagement - the value for the traditional tutorial just reaches 76.4% ($n = 110$). Additionally, content mastery and the learning results benefit from gameful design. As already shown with RQ1 the content is well-embedded into the platform and the supportive concept promotes the intermediation of the teaching matters. To enhance the learning experience, the project is created in such a way that the acquired knowledge of an earlier level is required to complete the higher ones. In 73.6% of the cases ($n = 91$) the students intensively perceived this aspect in their learning progress. Furthermore, the feedback loops (in the form of tutors' response) are an important catalyst for content mastery. In most cases the feedback provided for the students' submitted tasks was sufficient and helpful for the learning process. In addition assistance in achieving the educational targets is rated as appropriate (Fig. 2). These positive results are related to the fact that 97.8% of the students consider the support of the tutors as adequate ($n = 91$).

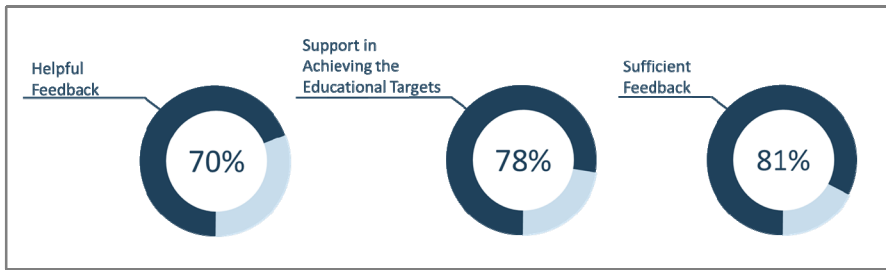


Fig. 1. Support by the tutors (n = 91)

To have a closer look at the success of the gameful design approach we analyzed the correlation between the final grades and the achieved XP. As the XP could be earned on the platform and during the practical sessions, the measurement considers both sub-projects and represents the influence of The Legend of Zyren in total. The analysis of the correlation shows that there is a strong tendency: the higher the involvement in the project, the better the final grades (Table 2). The Pearson coefficient of 0.614 shows a strong dependency between the grades and the achieved XP. In addition to that, we compared the performance record of the gamified course with the traditional teaching methods. With teacher-centered teaching the students achieved a grade point average of 1.5 (letter grade: ~C- to D+). The introduction of the gamified concept led to an increase of grade point average to 2.1 (letter grade: ~C+ to C). The failure rate was reduced from 44.0% to 30.8% within one year.

Table 2. Comparison of the performance records

Letter Grade	Summer Semester 2012 (traditional teaching)	Summer Semester 2013 (The Legend of Zyren)
A/A+	7.1% (6)	22.0% (20)
A-	9.5% (8)	7.7% (7)
B+	3.6% (3)	7.7% (7)
B	2.4% (2)	6.6% (6)
B-	6.0% (5)	4.4% (4)
C+	8.3% (7)	6.6% (6)
C	3.6% (3)	9.9% (9)
C-	6.0% (5)	-
D+	4.8% (4)	-
D	4.8% (4)	4.4% (4)
F	44.0% (37)	30.8% (28)
Average Grade (GPA)	1.5	2.1
# Participants	84	91

6 Conclusion

The process of playing is omnipresent in the human development. With the emergence of the digital era, the game industry experienced an economic recovery and digital games entered everyday life. Since the elements used in these games bear a high potential of driving motivation, gamification also offers a fitting tool for higher education. Game elements in the form of quests, experience points, levels or achievements correlate with game dynamics that drive intrinsic features such as reward, competition or self-expression, and influences motivation. Furthermore, the students, as well as the supervisors, get an overview of the learning progress through the measurable system of XP and levels supported by a visually displayed ranking.

The implementation of *The Legend of Zyren* includes all of the important game elements presented by the current state of research. The final evaluation of the project analyzed the platform, the content with regard to its implementation in the gamified setting and the concept in general. The results of all analyzed dimensions confirmed the projects' success and demonstrate the positive effect of game elements on Information Literacy instruction.

However, aspects like flexible time management could be improved. As some students had problems regarding this aspect, an implementation of deadlines for the hand-in quests could be an option of further improvement. A general point for discussion is the visual design of the platform. As the game is a text-based adventure, it merely contains text-blocks and several graphics. An implementation of more dynamic elements could therefore be a possibility to improve the platform in terms of the gaming experience.

In conclusion, this paper shows that the implementation of gameful design is definitely a possible realization of a new teaching and learning method in the area of Information Literacy. *The Legend of Zyren* demonstrates that gamification is a promising way to enhance students' motivation, increases their overall enjoyment and supports content mastery. It should be noted that gamification is not meant as a substitute for students' intrinsic motivation to learn, but simply a framework to support and extend it.

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