SMILE Goes Gaming: Gamification in a Classroom Response System for Academic Teaching

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Abstract: The classroom response system SMILE (SMartphones In LEctures) is regularly used in academic lectures. Among other features, it enables lecturers to start quizzes that can be answered anonymously by students on their smartphones. This aims at both activating the students and giving them feedback about their understanding of the current content of the lecture. But even though many students use SMILE in the beginning of a course, the number of active participants tends to decrease as the term progresses. This paper reports the results of a study looking at incorporating gamification into SMILE to increase the students' motivation and involvement. Game elements such as scores, badges and a leaderboard have been integrated paired with a post-processing feature enabling students to repeat SMILE quizzes outside of the lectures. The evaluations show that the gamification approach increased the participation in SMILE quizzes significantly.

1 INTRODUCTION

SMILE (SMartphones In LEctures) is a classroom response system with different functionalities. One of its most popular features is the quiz functionality that enables lecturers to start multiple-choice or multiple-response quizzes which the students can answer anonymously using their internet-capable devices like smartphones, tablets or laptops. The lecturer sees how well students performed and can thereupon adapt the course of the lecture accordingly. SMILE has been used in academic lectures since 2011 (Kändler et al., 2012; Feiten et al., 2012).

Using a classroom response system with adequate quizzes is not only useful for students (to know if they properly understood the content of the lecture) but also for the lecturer (to evaluate if the given explanations were understandable and to activate the students to engage more with the lecture content). However, there has often been a noticeable decrease of participation during the term, resulting in only a small number of students still participating in the lecturer's quizzes near the end of term. There can be many reasons for that, such as students generally not attending the course any more, not understanding why using SMILE is useful, or simply not having fun using SMILE. So far we have only been able to verify that the first of these reasons – students dropping out of the course – is definitely a major contributor to this decrease of SMILE users. However, even among the remaining students there is a great potential to increase the number of SMILE users, which was the initial motivation for the study presented here.

We therefore extended SMILE by incorporating concepts of *gamification*, such as scores, badges, achievements, levels, pop-ups for feedback, a user-pseudonym appearing on a leaderboard, and an option for the students to personalise the colour scheme of their SMILE client. Additionally, students are now able to repeatedly answer the live quizzes outside of the lecture (e.g. at home). Lecturers are provided with an overview of statistics, such as gained scores and achieved levels. Furthermore, they are able to set parameters, such as the number of (correct) quiz answers required for certain achievements, or individual level names.

In this paper we describe an approach to determine game elements suitable for academic teaching purposes, based on concepts and definitions presented in literature. Furthermore, we report the evaluation of applying this first prototype in a Computer Engineering course for first semester students in the winter term 2017/18 at the University of Freiburg, Germany. The results are compared to the same course held the year before, where SMILE without gamification had been used. The evaluation shows:

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- a significant increase of SMILE usage compared to the winter term 2016/17.
- many students having fun using the new game elements and thus feeling more motivated to use SMILE.
- the potential of reaching the students not only during class but also outside the lecture via the quiz repeating system.

The remainder of this paper is structured as follows: Section 2 presents the definition and previous use cases of gamification. Section 3 then gives an introduction to the non-gamified version of SMILE before presenting the new gamification features and their relevance in the given context. Section 4 presents the evaluation results of the prototype's first use, before the conclusions are drawn in Section 5.

2 RELATED WORK

The word "gamification" was originally defined by Deterding et al. (2011) as the use of game elements in a non-gaming context. Their definition distinguishes between four different aspects shown in Figure 1: gameful design (gamification), (serious) games, playful design, and toys. They differentiate the concepts of *game* and *play*, with a *play* being free and a *game* having rules. *Whole* means that playing or gaming is in the foreground: for example in learning context where the students use games for learning. However, it is also possible to *partly* use game elements e.g. in non-gaming contexts. Regarding SMILE we have added game elements to its basic functionality, so our work falls into the gamification category.

Literature presents gamification as a powerful possibility to evoke desired behaviour (AlMarshedi et al., 2017). It has been evaluated concerning the increase of motivation and learning benefit (Sailer, 2016; Yildirim, 2017). Sailer (2016) discovered that scores, badges, leaderboards, avatars, etc. fulfil basic psychological needs. Satisfying these needs can have a positive impact on motivation and on quantitative and qualitative performance. Yildirim (2017) published a study that records the positive impact of gamification in a university lecture. Wang (2015) conducted a survey about whether game elements have a positive long-term effect, or whether there are "wear-out effects" when students get used to gamification. It was shown that gamification does in fact retain its positive impact on students regarding engagement, motivation, concentration and learning.

Glover (2013) gives an overview of when and how gamification can be used in learning contexts. He

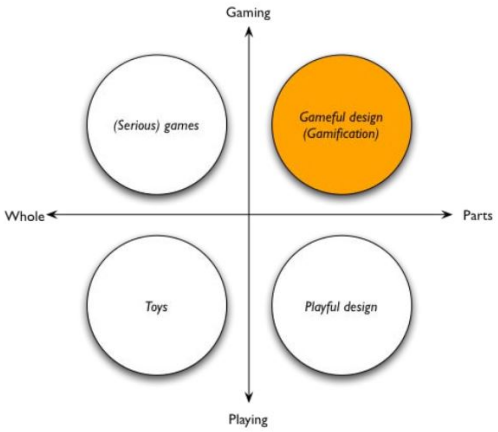

Figure 1: The difference between play and game, with play being free and game having rules, and between wholly and partly, with wholly meaning that the game or play is in the foreground and partly meaning that only some elements of gaming/playing are used. (Deterding et al., 2011).

proposed a set of questions to determine the use of gamification. In the following we answer these questions regarding SMILE, showing that the endeavour of gamification is recommendable:

- Q: "Is motivation actually a problem?"
  A: Yes, because the use of SMILE is decreasing during the term.
- Q: "Are there behaviours to encourage/discourage?"
  A: Yes, we want to encourage the use of SMILE.
- Q: "Can a specific activity be gamified?"
  A: Yes, the activity of answering quizzes can be gamified.
- Q: "Am I creating a parallel assessment route?"
  A: No, because as SMILE is anonymous, scores and leaderboards are disconnected from the formal assessment of learning.
- Q: "Would it favour some learners over others?"
  A: No, because the usage of SMILE is recommended but not required. Thus there is no favouritism at all.
- Q: "What rewards would provide the most motivation for learners?"
  A: We see scores, badges, achievements, levels, feedback pop-ups, a leaderboard and personalisation as promising (cf. Section 3.2).
- Q: "Will it encourage learners to spend disproportionate time on some activities?" and "Are rewards too easy to obtain?"
  A: No, because it is neither possible to obtain the rewards by spending disproportionate time nor are they too easy to obtain (also cf. Section 3.2).

Since 2011 the number of studies concerning gamification has risen significantly (Darejeh and Salim, 2016). In the following we present some of these studies and show what sets our work apart:

Berkling and Thomas (2013) implemented gamification into a course of Software Engineering at the Cooperative State University in Karlsruhe. They replaced the lecture with independent learning phases, using given material and a game environment. Students, however, were not able to cope with the free time management but 55% nevertheless liked the idea of a gamified lecture or at least thought that it would work with small adjustments. In our work we do not replace the whole lecture with self-regulated learning but only gamify SMILE, the classroom response system in use.

Denny (2013) published a study of a badge-based achievement system. In his large-scaled evaluation he found that a significant positive effect can be observed in the attendance of the online learning tool "PeerWise" without decreasing the quality of learning. Students have fun getting badges and seeing them in their user interface. In SMILE we go even further by including not only badges and achievements but also scores and a leaderboard.

The study of Cheong et al. (2013) concerns a gamified multiple-choice quiz tool that is used in several different Bachelor degree courses at the RMIT University of Melbourne. The authors did a survey with students assessing their subjective opinion of the tool. The engagement, fun and learning of the students were evaluated almost exclusively positively. We also use a quiz tool for our study but furthermore compare our observations with a previous year in which gamification had not been used.

Ohno et al. (2013) introduced "half-anonymity" and gamification into a lecture to increase the motivation and engagement of students to ask questions. They used the "Classtalk"-Software and developed an application the students could use to discuss quizzes online and vote for the answers until the lecturer closed the question. The 17 surveyed students overall evaluated the system positively and would have liked to use it in further lectures as well. In SMILE the students can use pseudonyms, which is similar to the "half-anonymity", but they can also stay completely anonymous if they want to. Furthermore, we also do quizzes during the lecture but the students are discussing "offline" (face-to-face) instead of online. Another difference is that our study has more participants.

The publication of Fotaris et al. (2016) describes a programming course that used the tools "Kahoot!", "Who wants to be a millionaire" and "Codecademy", readily providing different game elements. This course was compared to a control group not using gamification, regarding a number of key metrics like course attendance, course material downloads or final grades, and it was concluded that gamification is enriching for both students and instructors. In contrast to this study, we only use one system and apply all game elements to it.

Also using a self-developed system, the study of Barrio et al. (2016) analyses the use of game dynamics and real-time feedback in "IGC", a classroom response system very similar to SMILE. In their system, however, the students are not completely anonymous as lecturers are able to see the browser types and IP addresses. For their study they used IGC in four 90-minute lectures and did their evaluation in four different categories: motivation, attention, engagement and learning performance. In contrast, SMILE is used during the whole term (26 90-minute lectures). We execute two evaluations in two different lectures using seven different question categories: attention, self-efficacy, meta cognition, motivation, understanding, fun and recommendation.

For our own work we focus on the suggestions by Follert and Fischer (2015) who already developed game design elements for the academic learning context. They used an e-learning platform called *Opal* where lecturers are able to distribute teaching material, while students can find study-related information and come together in working groups (TU Dresden, 2017). However, they never put forth an evaluation of their exploration in this field. We emulate their development steps for our own work as described in Section 3.2 and then also evaluate the resulting prototype in our whole-term field test.

3 GAMIFICATION IN SMILE

The main intention of adding gamification to SMILE has been to increase the students' motivation to persistently participate in the quizzes during the lectures. For this purpose we implemented several game elements into the client and the possibility of repeating quizzes outside of the lecture, for which the students would also get rewards in the gamification context. In this chapter, we briefly describe the previous non-gamified version of SMILE before explaining in detail the added game elements of the new prototype.

3.1 Non-gamified SMILE

The SMILE application consists of three modules: "Quiz", "Q&A" and "Feedback". Each module can

be accessed by the lecturer and the students in separate SMILE clients using a web browser on arbitrary devices. Furthermore, the lecturer is able to administer the modules in their client. As students remain anonymous, the lecturer cannot extract information about a specific student.

Via the Quiz module a lecturer has the ability to conduct multiple-choice or multiple-response live quizzes during the lecture. Students attending the lecture can answer a quiz in a fixed amount of time via the SMILE student client. After each quiz the lecturer is able to see a statistic about the given answers and can discuss and incorporate the results in the remainder of the lecture. It is up to the lecturer to publish the correct answer of a quiz as well as an explanation text to the students in the end.

The Q&A module is a forum where students have the opportunity to ask questions at any time. The questions can be answered by the lecturer, by teaching assistants (if available) or by other students. Furthermore, it is possible to up- or down-vote forum entries. There is no difference between the SMILE student or lecturer client for this module.

In the Feedback module the students are able to give live feedback during a lecture. To do so they use a slider in the student client to show whether they are keeping up with the content of the lecture. In the lecturer client the distribution of all slider positions is shown in a histogram, that may be interpreted by the lecturer in real-time to adapt the speed of the lecture accordingly. Furthermore, the students might be encouraged to ask questions if the lecturer chooses to publish this live histogram, when they see that they are not the only ones struggling.

Past evaluations of SMILE showed, however, that the Feedback module does not have the desired effect. Also the Q&A module has remained unused most of the times as most lecturers already use another forum for their lectures. The use of the Quiz module, however, was very successful in raising the students' interactivity and revealing their misconceptions (Kändler et al., 2012). For these reasons we only focus on the Quiz module for further investigation.

We dubbed the new SMILE version including game elements *gamified* SMILE. In contrast, the SMILE version without any new (gamification) features shall be called *basic* SMILE.

3.2 New Game Elements

To realise the gamification of SMILE we used game elements according to the eight gamification categories defined by Chou (2015): meaning, accomplishment, empowerment, ownership, social influence, scarcity, unpredictability and avoidance. Based on these categories, Follert and Fischer (2015) proposed their own game elements for academic teaching context in the e-learning platform "Opal".

Using the propositions of Follert and Fischer (2015) as orientation, we developed the following game elements in SMILE:

- a score system
- badges
- achievements
- a (named) level system
- a leaderboard
- pop-ups for feedback
- pseudonyms and choice of colour scheme

In addition to our literature research about possible game elements we did a pre-survey with 40 basic SMILE users asking for their opinion and wishes on introducing game elements into SMILE. The results showed that basic SMILE was considered to be very useful for understanding the content of the lecture. In addition to the current functionality a majority of students requested an option to answer the quizzes again at home. Thus, we implemented a facility to repeat quizzes outside of the lecture (*post-processing*). In the following, we explain how our developed game elements fulfil the eight different gamification categories of Chou (2015).

Meaning: The game elements of the *meaning* category aim to make the users aware of the bigger meaning (i.e. the purpose) behind the application (Chou, 2015). An intuitive welcome page explaining the benefits and the usage of the application e.g. with a tutorial could be an example for this category (Follert and Fischer, 2015). For SMILE there already exists an intuitive welcome page providing such explanations.

Accomplishment: This category contains elements to increase the motivation for making progress or developing skills (Chou, 2015). In this context, reward mechanisms such as badges or scores are very important (Follert and Fischer, 2015). To apply this category to SMILE we implemented a reward system containing scores, levels, badges, achievements and a leaderboard. The students can achieve scores for participating in the live quizzes during the lecture with additional scores for the correct answer (cf. Figure 2). A similar score system is applied for repeating the quizzes outside of the lecture. To prevent students from getting huge amounts of scores by just repeating quizzes over and over again, there is a time period after each quiz trial in which no further scores can be obtained. The length of this delay doubles after each trial. The accumulation of the scores allows

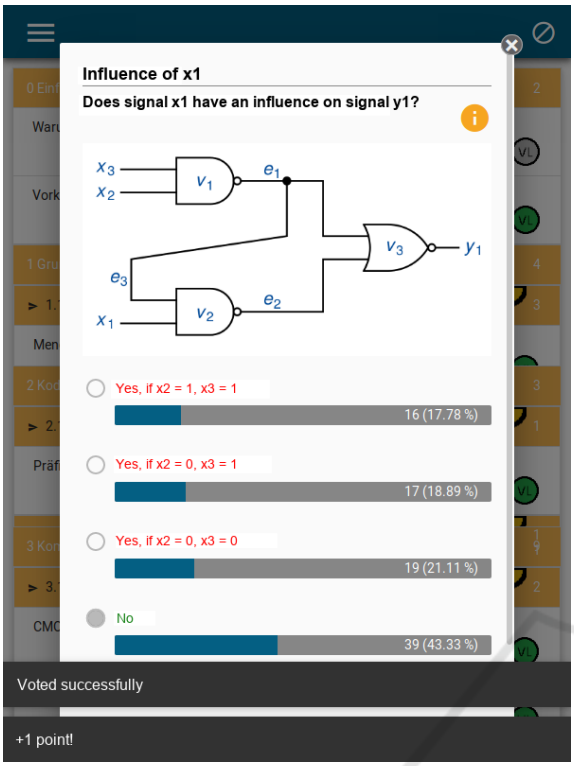

Figure 2: An example of an answered quiz including the pop-up feedback stating the number of gained scores.

students to gain certain levels and to compare themselves with other students via a pseudonym ranking in a leaderboard which can be seen in Figure 3. Furthermore, each student can follow her/his own progress over time shown in a score chart (cf. Figure 4).

Students can earn three different badges for each quiz by answering it (1) during, (2) outside of the lecture and (3) by giving the correct answer in three different trials. Collecting one badge category for all quizzes in a chapter is rewarded by a virtual trophy for

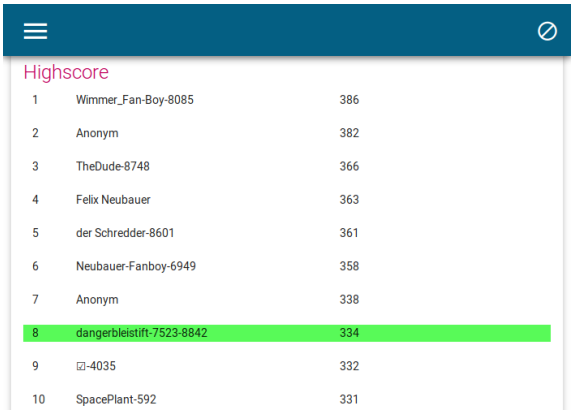

Figure 3: The leaderboard of our course viewed by the client of a student with "dangerbleistift-7523-8842" as pseudonym.

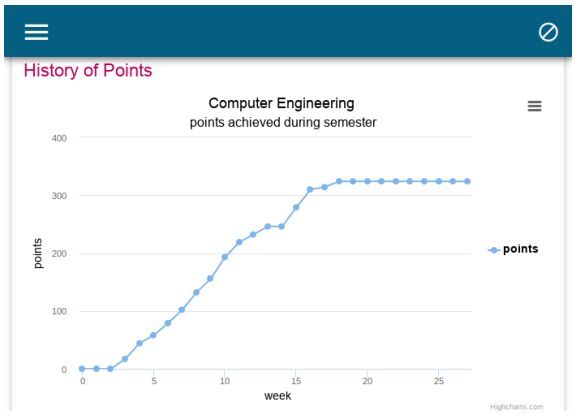

Figure 4: A score chart example of a participant of our course in the winter term 2017/18.

this category in the chapter (cf. Figure 5). Finally, we also provide some achievements, e.g. for the amount of answered quizzes, for fast and correct answers or the amount of quizzes all badges are achieved for.

Empowerment: Challenging and encouraging the creativity of the user as well as direct feedback from and to the users are the main goals of the game elements contained in the *empowerment* category (Chou, 2015). For Opal, Follert and Fischer (2015) recommend feedback and valuation symbols e.g. in forums. In SMILE there is already a dedicated module to give live feedback during the lecture (see Section 3.1). Furthermore, the Q&A-module is a forum including different feedback and valuation symbols (e.g. "thumbs-up") to show that a forum entry is considered useful. However, as these modules are not used regularly in lectures, we decided to establish a sense of empowerment in the Quiz module by giving direct feedback in form of visual pop-ups in the user interface. After submitting the answer to a repeated quiz students are thus informed about whether their answer was correct, about the score they gained as well as the current time delay until scores can be obtained for repeating this quiz. Such a feedback can be seen in Figure 2. During live quizzes in the lecture the information about the correct answer and obtained scores are not revealed until the lecturer unlocks them, typically after the discussion.

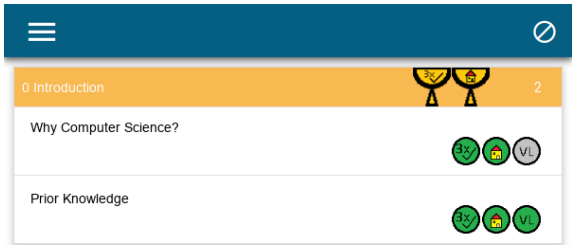

Figure 5: An example of the students' overview over all quizzes with their gained trophies and badges.

Ownership: The personalisation of the application is part of the *ownership* category (Chou, 2015). This category is not considered in Opal (Follert and Fischer, 2015). To provide options for customisation in SMILE, we introduced the facility for the students to choose an individual colour scheme for the client (Figure 2–5 show the blue colour scheme) and to set a pseudonym which is used in the leaderboard (cf. Figure 3). If no pseudonym is used, the students remain anonymous. The pseudonym can be changed and reset at any time.

Social Influence: The game elements allowing interactions with other users are covered by the *social influence* category (Chou, 2015). In Opal, this is solved by chats and a service for private messages (Follert and Fischer, 2015). In SMILE, messages can only be exchanged in the Q&A module which is not used in the considered lecture. However, the implemented leaderboard covers the social influence. The board lists the top-ten students, either completely anonymous or by their voluntarily chosen pseudonym. Additionally, students can see their own score for comparison (cf. Figure 3). This ensures that students are able to compare themselves with the best ten students even if they do not know who they are. But the students still have the option to loosen their own anonymity by using and sharing pseudonyms to be able to compare themselves with a restricted group of people, e.g. their friends.

Scarcity: Some game elements (e.g. achievements) are not supposed to be gained immediately by the user. Such elements belong to the category of *scarcity*. The idea is that the resulting impatience leads to a permanent fixation of the users to the content, increasing the invested time (Chou, 2015). Follert and Fischer (2015) used applications such as showing further education courses (e.g. "Cross marketing") in Opal to gain scarcity. In contrast, we achieve scarcity by limiting the scores for repeated quizzes using an increasing time delay. This ensures that the high levels cannot be reached too easily. Also some badges and achievements can only be achieved over time by e.g. constantly attending the live quizzes in the lecture.

Unpredictability: The game elements in this category are meant to be surprising to the users (Chou, 2015). While there are no unpredictable elements integrated in the Opal platform (Follert and Fischer, 2015), SMILE implements the concept of unpredictable level names and level-up limits. These parameters are chosen by the lecturer. The students only know their current level name and the score necessary to achieve the next higher level. After a level-up this information is revealed for the new level. As the transparency of the score and achievement system is an important aspect in SMILE, we decided to refrain from further unpredictability.

Avoidance: The *avoidance* category contains game elements that motivate the usage of the application to prevent negative outcomes (Chou, 2015). Follert and Fischer (2015) strongly recommend not to use punishment mechanisms as it can have negative effects on students' affection towards learning. We are also not using punishment of any kind. One could argue, however, that dropping lower on the leaderboard can be perceived as a negative outcome that eager students want to avoid by continuously earning as many scores as possible.

4 EVALUATION

The first prototype of gamified SMILE, including all game elements described in Section 3.2, was used in a Computer Engineering course for first semester students in the winter term 2017/18. The results from this extensive field test were then compared to the previous winter term in which the basic version of SMILE was used, allowing for a direct comparison between the basic and gamified versions of SMILE. In both terms the course was given by the same lecturer.

The goal of the evaluation has been to measure whether the introduced game elements have an effect on the students' participation, attention, self-efficacy, meta cognition, motivation, understanding, and fun. The effect on the students' participation is analysed in Section 4.1 by means of statistical information provided by SMILE. The evaluation of the other effects has been done via questionnaires created just for this purpose. The analysis is described in Section 4.2. We finally discuss our results in Section 4.3.

4.1 Participation in SMILE

The Computer Engineering lecture under consideration is a course for first semester students with usually about 250 participants. To be precise there were 266 registrations for the winter term 2016/17 and 248 for 2017/18. From these registrations, 170 took the final exam in 2016/17, 151 in 2017/18.

We measured the number of students participating in each SMILE live quiz during the lectures for both terms. Figure 6 shows this data in one graph for comparison. The gaps in the curves stem from single quizzes that were used in one term but not in the other. It can be seen that the number of participants in 2017/18 is on average 2.4x as high as in 2016/17, even

though the number of registered students was almost equal (even 1.07x lower in 2017/18).

Furthermore, the increased participation rate continues until the end of the term. When we compare the average number of participants in the last quarter of the term (starting with quiz 30) to the maximum participation in *any* quiz of the same term, we see that in 2017/18 there are still 41% (about 58 students) taking the quizzes, opposed to only 27% (21 students) in 2016/17. When we compare the number of students still active in the last quarter of the term to the number of participants in the final exams, the difference is even higher: more than 38% (of 151) in 2017/18 and less than 13% (of 170) in 2016/17.

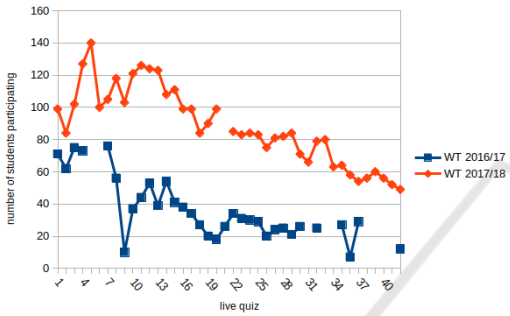

Figure 6: Number of students participating in SMILE quizzes: winter term 2017/18 (orange) compared to winter term 2016/17 (blue).

For the winter term 2017/18 we also have additional information regarding the general usage of SMILE provided by the new statistic feature. This includes that a total of 229 students registered at least once in SMILE. Figure 7 shows the number of participating students per week in 2017/18, either in live quizzes or repeating quizzes. The statistic accumulates for each week all students who obtained at least one score in that week. The lecture started in the third week of the term and lasted until week 19. There were two courses each week including different numbers of live quizzes with two exceptions: in week 13 and 14 no lecture took place (Christmas holidays) and in week 19 there was no live quiz in the lecture. The final exam took place at the first day of week 26.

Even though the overall participation of students is sloping during the term (as students drop out of their studies), Figure 7 shows that at the end of the lecture (week 18) still about 80 students were using SMILE. Considering the two outliers in the Christmas break and the time between the lecture and the exam, up to 32 students used SMILE in their holidays and for preparation of the exam. This can be interpreted as a lower bound for the usage of the post-processing system of SMILE as in other weeks including live quizzes the students might have used this feature even more extensively. As the post-processing and the gamification features have been introduced simultaneously, it is not possible to evaluate the impact of gamification on the usage of the post-processing. Nevertheless, the data shows that this feature is definitively used.

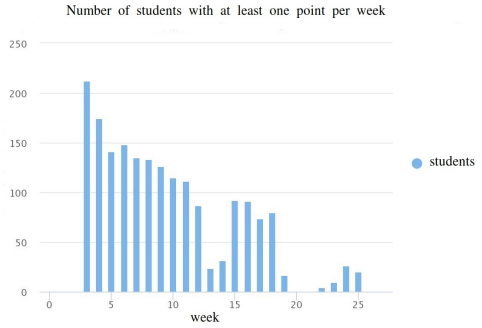

Figure 7: Number of students participating in SMILE by week in the winter term 2017/18.

All in all, the data shows a significant improvement in the participation numbers from winter term 2016/17 to 2017/18 as well as an active usage of the new post-processing feature in SMILE.

4.2 Survey Analysis

To measure the influence of gamification on the students' behaviour and learning we designed three evaluations: The first one – a pilot survey performed prior to the first "official" use of gamified SMILE in the actual course – targeted former participants of basic SMILE quizzes to attend a contrived lecture asking for their opinion about the new features. A second one was handed out in a lecture shortly before the Christmas break and a third one close to the end of term, to get a final assessment. Every survey was designed as a paper questionnaire to be answered anonymously.

The questionnaires were all structured as follows: The first part consisted of several demographic items. The second part consisted of self-assessment regarding the course itself (irrespective of SMILE) and the perceived improvement of the lectures by using gamified SMILE. Furthermore, as the students had never attended a lecture using basic SMILE, they were asked to estimate the improvements caused by the gamification or the post-processing feature. The second part focused on:

- *attention*: attentiveness during lecture
- *self-efficacy*: feeling able to answer exam questions
- *meta cognition*: interest in further information
- *motivation*: motivation to learn and to pay attention

- *understanding*: comprehension of taught content
- *fun*: enjoyment
- *recommendation*: suggestion of the use of SMILE to other lecturers or other students

The third part consisted of questions regarding the user-friendliness of the web interface while the fourth part was a section for further comments to not only get quantitative results but also qualitative answers.

Except for the fourth part all questions were to be rated with a number between 1 (dislike/not useful) and 5 (like/useful) or the option to abstain from voting. If a question was not answered, we considered it as an abstention from voting. In the following we define a question as answered positively if the mean of the given answers is greater than 3, and answered negatively if the mean is smaller than 3. A positive outlier is a question with a mean over 4.5, a negative outlier a question with a mean below 2.

Pilot Survey

The pilot survey[1] was designed to gain user information about the effectiveness of the game elements and of the user friendliness of the web interface to be able to make adjustments before the actual start of term. For this purpose the lecturer gave a contrived lecture for 17 voluntary students on one chapter of the upcoming Computer Engineering course in which gamified SMILE was used. The participants were afterwards asked to fill in a questionnaire that also contained questions regarding the understandability of the questionaire itself. This was to potentially improve the questionnaires of the upcoming two evaluations during the term.

Overall, gamified SMILE was rated very positively (91% positive answers in the questionnaire). Although the students rated the contrived lecture as not exciting – not even with gamified SMILE – and were not motivated to pay attention initially, SMILE managed to induce certain motivation by the means of the reward system. The reason for the initial lack of motivation and excitement though might be that the lecture was contrived and thus without a subsequent examination. The participants had a lot of fun using gamified SMILE and stated that its use (quizzes) was beneficial for understanding the content of the lecture. Nearly all of them would recommend gamified SMILE to other lecturers and students (mean value over 4.5; no single value below 3).

SMILE was considered user-friendly, with some remarks in the comment section that were taken into account for small adjustments before the actual start of term, as were comments regarding bugs in the system. The other comments were mostly positive, like some stating they already experienced a positive effect towards learning. As the understandability of the questionnaire was evaluated positively (mean over 4.5) we used the same question types in the two other questionnaires during term.

[1]Not to be confused with the pre-survey mentioned in Section 3.2.

Mid-term Evaluation

The second evaluation was carried out after two consecutive lectures in which even more quizzes than usual (about five as opposed to the usual one to three) were performed to focus on the integration of SMILE into the lecture. 86 first semester students participated in this evaluation.

The two lectures themselves were perceived positively in every aspect. The students liked the additional SMILE quizzes, but were indecisive whether they gained a benefit compared to the other lectures with less quizzes. Gamified SMILE was rated positively regarding attention, motivation, understanding and fun. The game elements in particular were evaluated as motivating for the usage of SMILE, enhancing the attention during the lecture and being fun.

As in the pilot survey, the recommendation of SMILE to other lecturers and students was rated positively (positive outlier). Also the usability was complimented (positive outlier), especially the quiz functionality and achievement overview.

On the other hand, the self-efficacy and meta cognition for gamified SMILE was rated negatively by the students. However, this is not very surprising as the SMILE quizzes only cover the content of the lecture, neither providing exam questions nor further information. Furthermore, in the students' opinion the game elements did not turn out to be useful for the understanding and motivation to follow the lecture.

The section for further comments contained both positive and negative comments. While the game elements were mentioned positively, the students complained about bugs in SMILE (that did not occur in the smaller pilot test group) as well as the WiFi in the lecture hall and SMILE itself being slow.

Final Evaluation

The last evaluation focused on the use of gamified SMILE and its post-processing functionality during the whole winter term 2017/18. 56 students participated in the survey.

The course itself was again evaluated positively in every aspect. The evaluations regarding gamified SMILE as well as the benefit of the game elements

themselves were quite similar to the mid-term evaluation. Once more, attention, motivation, understanding and fun were rated positively for gamified SMILE. Also the game elements were seen to be fun and to motivate the usage of SMILE. However, the influence of gamification towards attention had shifted from significant to less significant.

As in both prior surveys the majority of the students would highly recommend gamified SMILE to other lecturers and students. Despite the request of the students in the pre-survey (cf. Section 3.2) to be able to repeat SMILE quizzes outside of the lecture, the post-processing feature – while students were generally using it – was rated negatively. Questions regarding usability were left out in this final evaluation as no usability adjustments had been done after the mid-term evaluation that already covered this topic.

In the further comments section the functionality of SMILE was complimented whereas there were some critics towards SMILE being slow and some minor bugs. Except for the post-processing feature the game elements were mostly well perceived.

4.3 Discussion

Observations show that the usage of SMILE is sloping. This has natural reasons as the attendance of students in the lectures is decreasing and many students quit their studies during the term. Nevertheless, we observed a significant increase of the participation in SMILE quizzes comparing the winter terms 2016/17 and 2017/18. As there were almost no changes in the flow of the course (aside from the participating students) it is plausible that the increase is induced by the newly implemented gamification features as well as the post-processing function in gamified SMILE.

Furthermore, when considering the evaluations, gamified SMILE turned out to be very useful for the students' attention, motivation and understanding. Figure 8 shows that a majority of the students had fun using gamified SMILE during the term. Also, many students stated that the game elements were the main motivation to use gamified SMILE. But it can be seen in Figure 9 that this was not true for all students as a considerable amount of them strongly disagreed or were just not sure about the impact of gamification on their motivation. On the other hand, nobody reported a negative effect of gamification, e.g. distraction from learning. Furthermore, nearly all students enjoyed the full "gamified SMILE package". Thus, we conclude that the effect of gamification depends on the individual.

Another aspect to consider is the post-processing feature. It was highly requested by the students in the pre-survey and used even during the holidays. However, the final evaluation shows that the post-processing feature is not perceived as helpful by the students. Nevertheless we see great potential in this functionality which shall be further explained in the following final section.

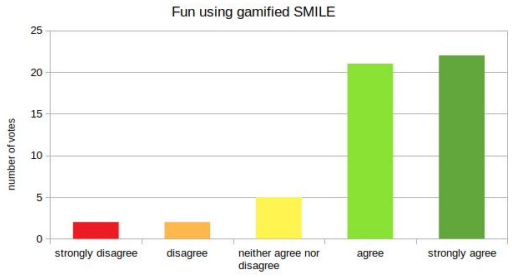

Figure 8: Answers of students to the question regarding the fun they have using gamified SMILE.

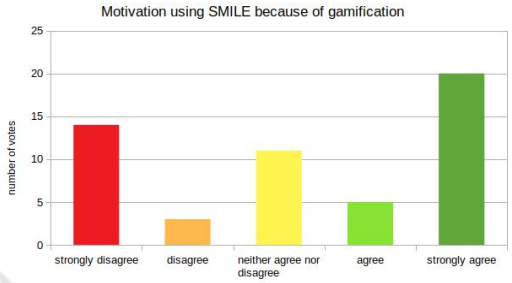

Figure 9: Answers of students to the question regarding their motivation to use SMILE because of the game elements.

5 CONCLUSIONS

Literature presents gamification as a promising approach to increase the motivation of students to participate more in lectures, to invest more time into learning the content of the lecture and to have more fun learning. To take advantage of this, we included game elements like scores, achievements, badges and a leaderboard in our classroom response system SMILE. Furthermore, we implemented a feature for students to post-process the lecture's content by repeating the live quizzes of the lecture at home. We observe that gamification has significant positive effects on the usage of SMILE in lectures. This increased usage is desirable since SMILE enables the lecturer to see which content is already understood and which topics need further explanations. The self-assessment in the evaluation also indicates a positive effect on most students as they have fun and are motivated to use gamified SMILE.

The most requested feature of the pre-survey, an option to answer quizzes outside of the lecture, was the only aspect that was overall evaluated negatively. Nevertheless we do not want to discard this idea but plan on improving this feature by adding a functionality for students to submit their own quizzes that can be accessed and answered by other students. This will furthermore increase empowerment, ownership and social influence. This modified feature is planned to be given a trial in our Computer Engineering course in the summer term 2019. We will then elaborate how students perceive this functionality in order to rate the benefit of such a feature for a classroom response system in general. We assume that also the meta cognition will be improved as the option to create own quizzes (for others) might activate the students to think outside the box of the course. Furthermore, adding exam-like quizzes by the lecturer or the teaching assistants (or the students themselves) could also have a positive effect on self-efficacy.

As students would recommend the gamified SMILE to other students and other lecturers we can say that the integration of gamification in SMILE was useful and well perceived and thus will be used in future lectures. Our results thus suggest gamification to be useful for other classroom response systems as well.

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