Using Gamification for Technology Enhanced Learning: The Case of Feedback Mechanisms

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Abstract — **Motivation of students is crucial for effective usage of technology enhanced learning. Still, many approaches fall short in supporting long-term motivation. This paper presents the results of six studies using feedback mechanisms to increase user participation with different learning tools. Additionally a new feedback is introduced, called Social Ranking Feedback.**

Index Terms — **Feedback, Motivation, Experiment, Learning**

I. INTRODUCTION AND RELATED WORK

CONTRIBUTING to a knowledge management tool like a wiki needs commitment from all participants because usually they are responsible for the integration and enlargement of the knowledge base. This knowledge creation is comparable to the concept of communities of practice [1]. Unfortunately these communities and knowledge management in general suffer from the free rider problem [2], which is also knows as social dilemma [3]. Usually monetary incentives are used to increase participation and motivation but these incentives often don't take into account the measurement of objective and individual effort [4]. Also extrinsic motivators like monetary incentives can lower significantly the attitude to share knowledge [5]. Finally the psychological phenomenon of reactance can demotivate individuals to share their knowledge because they might fear a restriction of their perceived individual freedom [6]. Therefore non-monetary incentives are considered superior to achieve long lasting participation [7], or a mix of monetary and non-monetary incentives [8]. According to Cheshire some possible alternatives are altruism, selective incentives, to prevent anonymity of participants inputs, or reputation [9]. Additionally some empirical results suggest that perceived uniqueness, goal setting, social approval, or the perception of cooperative behavior can help to increase motivation [10], [11].

Gamification is already part of an ongoing scientific investigation to analyze the possibilities for user motivation [12], [13]. There are many different game elements which can contribute significantly to motivation, like badges or barnstars, which are an application of badges to Wikipedia [14], [15]. Also other studies suggest that ranking is another game element which can help to increase participation [16]. However feedback has been identified as one key element of gamification [17] and is being recently investigated in social

media systems [18]. According to Antin and Churchill feedback can be seen as goal setting (see also [19]–[21]), that is a hint to guide participation in a desired direction, to get reputation, for the verification of an achieved goal as a kind of status, or as some part of identification in an online community [14]. One possible way to make use of feedback for technology enhanced learning are feedback mechanisms, which have been introduced first by Cheshire and Antin with three experimental studies [11]. This paper extends the knowledge about feedback mechanisms and summarizes the results of six studies in two different settings: course wikis and a game to support learning analytics [22], [23]. Besides that the combination of the results is novel, [22] has not been put into the context of gamification and [23] is unpublished work, only presented at a workshop.

II. METHODS

A. Course Wikis

Cheshire and Antin [11] used for their studies three different feedback mechanisms: gratitude, historical reminder, and relative ranking. These feedback mechanisms have been adapted to support five different course wikis for the present paper. 620 participants registered in total for five studies with remaining 436 participants who have at least one edit. Because feedback is only shown if someone makes an edit, users with zero edits can not be considered for the statistical analysis. The aim of the experiments was to investigate if feedback leads to an increase of contributions in a course wiki.
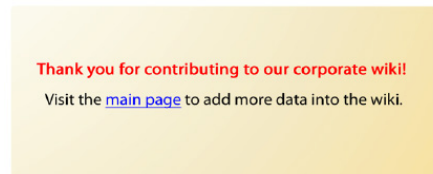

Fig. 1. Gratitude Feedback.

Figure 1 shows a very basic form of feedback, which is gratitude. This feedback expresses thankfulness without any further information.
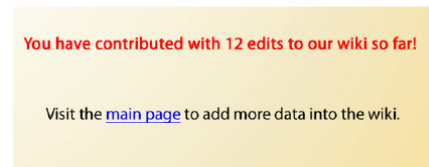

Fig. 2. Historical Reminder Feedback.

The historical reminder feedback shown in Figure 2 gives information about how many edits a user has done so far.

You are in the top 80% of our wiki contributers so far!
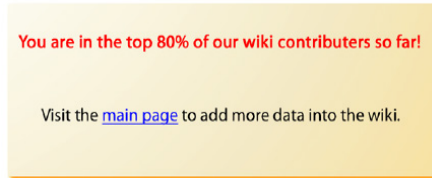
Visit the main page to add more data into the wiki.

Fig. 3. Relative Ranking Feedback.

Relative Ranking Feedback as displayed in Figure 3 abandons the individual aspect of feedback and takes into account that a wiki takes place in a virtual social community.

These three feedbacks are the ones which has been used already successfully by Cheshire and Antin to increase participation [11].

Position	Name	Edits
151	Hans Maier	15
152	Klaus Müller	13
153	Götz Bürkle	12
154	Silke Dehner	11
155	Jörg Hausmann	10

Visit the main page to add more data into the wiki.

Fig. 4. Social Ranking Feedback.

Additionally in Figure 4 the Social Ranking Feedback is introduced. This feedback is novel and was not part of the studies of Cheshire and Antin.

Social Ranking Feedback aims to provide more information and additionally has a competitive gamification element which is implemented as a ranking. Interestingly, only 2 positions above and below the own position are displayed, which distinguishes the social ranking from a regular ranking.

The reason behind this procedure is that displaying the complete ranking might demotivate individuals which join later the wiki and therefore might become frustrated because the top places are out of reach. Instead the display of users which are in range of ones own so far done participation might encourage for more edits. The comparison with others has related to feedback a huge potential for motivation [24], [25]. One big difference of the Social Ranking Feedback in comparison to other studies, like e.g. the studies of Kuhnen and Tymula [16], is that not the complete ranking is shown and that it is not anonymous. An increase of participation is anticipated by showing real names and excerpts of the ranking.

The use of different feedback is suggested by Fischer, because there is no perfect feedback for everyone but individual preferences can be important [26]. Each feedback was shown only once immediately after an individual conducted an edit in the course wiki. This was due to the fact that the uniqueness of the feedback should not be spoiled by showing it excessively [10].

The sample of 620 subjects consisted 72% male and 28% female students with a mean age of 23.61 years and a standard deviation of 3.75 years. The total number of edits for all five studies is 10.974.

The students had to answer and discuss various questions regarding the topics of the courses they took at the Karlsruhe Institute for Technology. Bonus points for correct answers were awarded. They were no bonus points for quantity but just for quality. More information about the analysis can be found in the corresponding article [23].

B. Game to Support Learning Analytics

A different approach was taken for the sixth study. The previous empirical results about the beneficial provision of feedback are subject to different pedagogical limitations, e.g. by providing extra course credit for participation and therefore possibly damaging the ceteris paribus rule [27].

The sixth study conducts an altered approach to avoid such limitations. The aim is to investigate if the provision of feedback leads to continued playing of a game composed as a standard test with multiple choice questions. There was no incentive offered to the subjects and thus participation was voluntarily. The task for each subject was to play the game as long as they want. For example, they could play only one question and leave the experiment without any penalty. The maximum number of available questions was 75.

A student assistant at a public place at the campus asked each subject in person, if they want to participate in a research study. If they agreed, they got an internet link on paper and could easily access the experiment from any place. At the beginning of the experiment, the instructions made clear that each subject could play the game as long as they want. In addition, the subjects need to enter a nickname at the beginning of the experiment. If they wanted to quit the game and the experiment, they just needed to push a 'quit' button at any time of the experiment. Ceteris paribus, three different visualizations of feedback and one control condition have been used: no feedback at all (control condition), right/wrong, social ranking, and a combination of right/wrong and social ranking feedback.

55 students took part in this study (69% male and 31% female). Nineteen subjects answered all 75 questions. Each participant was randomly assigned to a condition, three with feedback and one without any feedback. There was no switching possible between the different conditions, each subject stayed the whole time in the same condition. More details can be found in the corresponding article [22].

III. RESULTS

A. Course Wikis

TABLE I
MULTIPLE REGRESSION RESULTS

Experimental Condition	N	M	SD	β
Gratitude	83	28.42	24.67	0.14*
Historical Reminder	70	24.09	27.67	0.07
Relative Ranking	66	29.06	26.71	0.14*
Social Ranking	90	24.42	27.44	0.17**
Random	18	7.67	8.77	0.01
Control Group	109	14.88	15.32	-
Summary	436	22.75	24.42	-

* $p < 0.05$; ** $p < 0.01$

The inferential analysis gives support to the usefulness of feedback. In particular, gratitude, relative ranking and social

ranking prove to be very valuable to motivate students. Table I shows the results of the multiple regression analysis.

A random condition was used in one study showing random feedback. Because the participants perceived this condition as irritating, it has been removed from the remaining four studies.

Gratitude Feedback, Relative Ranking Feedback and Social Ranking Feedback are statistically significant. Additionally the Social Ranking Feedback has the highest beta-coefficient and thus is the most effective feedback mechanism. The multiple regression takes into account that the five studies did not have all the identical characteristics. According to Field dummy coding for the regression is necessary and was performed with the control group and the biggest study serving as control groups for the analysis, with the goal to level the different studies even [28]. The explained variance is $R^2 = .11$, with $F = 6.10$, $df = 426$, $p = 0.00$.

B. Game to Support Learning Analytics

Table II gives an overview of the results regarding the different feedbacks for the sixth study and if subjects in the feedback conditions played longer than in the control group without any feedback.

TABLE II
QUESTIONS ANSWERED

Condition	N	M	SD
No feedback	13	40.31	19.29
Right/Wrong	15	54.27*	22.81
Social Ranking	14	55.14*	20.63
Both Feedbacks	13	56.69*	21.19

* $p < 0.05$

The results of the Mann–Whitney inferential test show that the feedback conditions outperform the control condition. But these positive results come with a drawback, namely the time on task. The results for the average time needed for each question are shown in Table III. Remarkably the new feedback generated statistically significant more time to answer the questions than the traditional feedback.

TABLE III
AVERAGE TIME NEEDED FOR EACH QUESTION IN SECONDS

Condition	N	M	SD
No feedback	13	14.58*	12.63
Right/Wrong	15	9.10	1.80
Social Ranking	14	13.56***	4.34
Both Feedbacks	13	11.34*	2.92

* $p < 0.05$; *** $p < 0.001$

Figure 5 shows a box plot of the four different conditions. Also a comparison for gender differences is displayed. In general male participants answered more questions (M = 53.26, SD = 21.23) than female subjects did (M = 48.41, SD = 21.67), but this difference is not statistical significant.
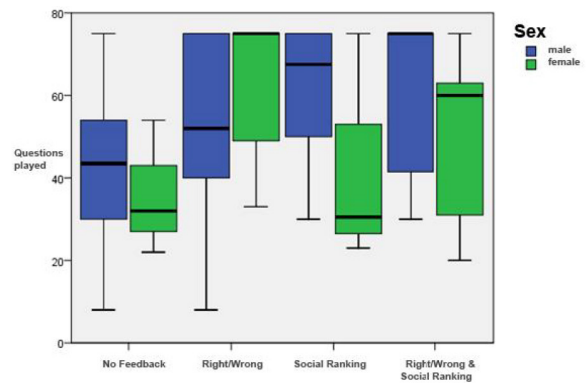

Fig. 5. Box plot overview for the four conditions and additional analysis for the different genders.

The analysis of the data reveals that feedback motivates to engage longer with the game, but an unexpected visualization could make the subjects need more time to conduct the experiment which is a considerable drawback. It is clear that the subjects with unfamiliar information (no feedback, social ranking or both feedbacks) on average needed longer for each question instead of the condition with the right/wrong feedback.

IV. DISCUSSION

The goal of the first five studies was to investigate, if feedback mechanisms can raise the participation in course wikis and if so which gamification elements perform best. The Social Ranking Feedback achieved by far the best results, whereat the feedback mechanisms in general show a statistically significant impact on user motivation. Gratitude and relative ranking are considerable alternatives, which also obtained statistical significant results. This is in line with other empirical results for relative ranking [11] and gratitude [2], [10], [11]. In summary using Social Ranking Feedback to increase user engagement worked very well for these five studies. A combination of competitiveness and additional information makes this feedback a well implemented gamification element.

The sixth study did take a different approach without using any additional incentives for a game to support learning analytics. The average participant in the feedback conditions played the game longer than in the no feedback condition. Despite this interesting result, participants in the feedback conditions need to elaborate longer if provided with missing or unexpected feedback. One possible explanation for this result could be a longer cognitive processing time by the subjects. Because no further measures were applied, other explanations despite cognitive workload could be responsible for this result. Additional interpretations need to be taken into account. For example, environmental factors (e.g. usability) and personal characteristics (e.g. intrinsic motivation) need to be included and analyzed in future studies as well [21].

Another issue to consider is the focus of only incentivizing quantity and not quality. Besides the problem of assessing quality, a recent study has shown that the valence of feedback

can advance unwanted effects on participation [18].

These results maybe are only applicable to this kind of game and cannot be generalized to other learning situations. Further experiments are needed to verify the presented results.

Finally, this research is a unique approach which is hardly comparable to other studies. This due to the fact, that only quantitative aspects are relevant for the feedback. Also the feedback is generated automatically and not by humans [18].

V. CONCLUSION

This article summarizes the findings of six different studies regarding the effectiveness of feedback mechanisms for user motivation in different settings. The results show clearly that providing feedback mechanisms can enhance the participation of users to provide knowledge in a shared information pool like a wiki. Especially the Social Ranking Feedback At this point the use of feedback mechanisms to support technology enhanced learning is strongly recommended.

Nevertheless, by boosting participation, we do not only raise motivation of the subjects and students, but we can also gather more data for e.g. learning analytics and other related fields. Further field experiments are planned with this kind of feedback, e.g. to improve Massive Open Online Course (MOOC) services.

The development of successful and motivating applications to enhance user motivation is still considered more an art then scientific work [13]. "Fun is not a panacea" and it still very difficult to decide which game elements to use to enhance long term motivation [29]. The newly introduced Social Ranking Feedback proves to be a valuable addition to the possibilities of gamification. This feedback mechanism should be considered for new and existing applications, where user participation is crucial for the success of an online community.

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