Engaging Students in Online Courses through Interactive Badges

Jozef Tvarozek, Tomas Brza

Abstract: *Lack of student motivation and high dropout rates plague the massive open online courses as well as small private online courses in blended university setting. Social and gaming incentives are increasingly introduced to tackle the problem. In this paper, we report on our approach to introduce achievements/badges and leaderboards into blended university programming courses. We piloted a new type of badge: the interactive badge, which we found better suited to measure genuine student interest than a self-report questionnaire did. Subsequently, we analysed how students engaged with the badges and how it affected their learning performance. Students engaged with the gamification elements in various ways, only 13.8% students engaged significantly with the badges, while 52.5% engaged only a few times. On average, we observed increased learning performance the more they engaged with the badges.*

Key words: *Student motivation, Interactive badges, Gamification, Badges, Online programming course, Blended university course, Technology enhanced learning.*

1. INTRODUCTION

Massive open online courses (MOOCs) seem to be the next major attempt at disrupting education worldwide. In addition to traditional blended university courses conducted using learning management systems, universities start to deploy MOOC-like small private online courses (SPOCs) [7] in order to increase instructor leverage, student engagement and learning performance.

Despite being prepared by world-renowned experts and educators, students in online courses suffer the same little motivation to continue, resulting in high dropout rates. Various approaches to challenge this problem were proposed, one of such is gamification [5], use of game elements to engage users in usually non-game contexts. In doing so, various forms of achievement badges, challenges, levels, points, rewards, and leaderboards are introduced in order to increase motivation and engagement [10]. In educational context, and online courses in particular, student engagement and motivation toward increased learning performance is desired. The effects of gamification vary depending on many factors and research in specific areas is required to gain better understanding about what game elements work at what conditions.

In our project, we seek to increase student motivation and engagement in blended university programming courses using gamification. Students in three courses (186 students) worked in an interactive online learning environment for programming exercises [12] enhanced with achievement badges and leaderboards. Student interest in the badges was measured both implicitly using a novel type of badges, interactive badges, and explicitly with a questionnaire. We examined ways how students engaged with the new incentives and the effects on their learning performance.

From the social psychological perspective, achievement badges serve several functions [3]: goal setting as a challenge for users to meet, instruction about activities that users can undertake, reputation as an assessment of user's expertise, interests based on past interactions, status/affirmation as an affirmation of user's accomplishments, and group identification as a shared experience. Various badging systems implement these functions differently having different impact on learners. Level of prior knowledge has been found to have effect on how students acquire badges [1]. Low-performing students find more interest in badges awarded for participation, which can as extrinsic motivators have detrimental effect on learning performance. Skill-based badges on the other hand, perceived more as intrinsic motivators, can possibly produce better learning. Educational effects of badges can be varied. In a case study of introducing badges and leaderboards to an ICT literacy university course [6], the experimental group with badges demonstrated better scores on practical assignments

while producing lowers scores on final written examination and lower overall class participation.

Achievement badges have been recently added to an online learning environment for programming exercises [9]. The study did observe differences in student behaviour between badges vs. non-badges condition. Only a small number of students received a badge (22% in the badges group and 9% in the control). The differences were mostly in the badge-defining activities (e.g. get exercise correct on first submission, or get full points on exercise and repeat the exercise at least a week apart). Provided that the control group did not have motivation to pursue these special goals, it is only expected that students in the control group did have lower badge counts.

In a case study adding badges to an online Data structures and algorithm course [8], no significant effects on student behaviour or course results were found, while additionally, emotional effects were mostly indifferent, with both very positive and very negative emotions expressed by some students. In a case study implementing badges into a C programming course [11], students generally enjoyed collecting the badges, while positively increasing their participation past the course requirements.

Badges have been found to have positive effects on discussion forum participation in online courses. In a large scale study [4], experimental group with badges produced 22% more answers and spent 13% more time within the online learning system. The way how badges are presented can also have an impact on the participation [2], showing students the future path to prospective badges as the most beneficial way.

The rest of the paper is structured as follows: Section 2 presents the design of the gamification elements within the online learning system, including the novel type of interactive badge designed to implicitly record student interest. Section 3 describes the online courses used, data collection and evaluation methodology. Section 4 presents the results and discussion about the findings. Section 5 concludes the paper.

2. INTERACTIVE BADGES AND ONLINE LEARNING ENVIRONMENT

Studies report that students generally have positive perception of badges, while at the same time very few actually engage with the gamification facilities (e.g. in [9] report only 22% and 9% students earn a badge). Self-report questionnaires that are usually used to determine the student engagement level may be susceptible to large response bias, as it is only expected that students want to appear engaged and please the teacher, in order to gain, at least hypothetically, a better course grade. In order to mitigate this problem, we devised an independent engagement measure – interactive badges, which implicitly gather engagement feedback based on student interactions with them.

An interactive badge is a badge with multiple states between which user transitions when interacting with the badge. Each of the states and the interaction serve a purpose. In our case, we designed a two-state badge, see Figure 1. In the closed state, a topical image about the badge is shown. The badge in this state should be interesting enough to attract students to interact with the badge. When moving mouse cursor over the badge (or alternatively touch it on a touch-enabled device) a visually pleasing animation "opens up" the badge, transitioning into the open state. The open state displays details of the particular badge, in our case the achievement or alternatively the requirement to earn the badge that has not yet been earned.

Figure 1. Interactive badges with two states: closed and open. In the closed state, only a topical image is shown. In the open state, the description of the achievement is displayed. Badges toggle between the states when student moves mouse cursor over the badge.

The closed state is the default state. The idea is that students genuinely interested in badges will open up the badges and see the details. Initially, when a student earns a badge a brief pop-up with a fast 500ms open-close animation is shown. The animation is deliberately fast enough to close the badge before it can be fully read, while at the same time demonstrating the badge's interaction ability. Engaged students re-open the badge to inspect it thoroughly, usually even multiple times to enjoy the animation.

The badges are aggregated in students' profiles, displaying all badges that the student earned, and the next level of badges in grayscale. The social aspects of badges are facilitated by leaderboards, see Figure 2. Student profiles are accessible through links on student names in leaderboards and forum posts. We use two types of leaderboards: course-wide based on number of exercises solved, and per exercise based on solution running time and the order in which students solved the particular exercise.

Based on the social psychological perspective as outlined in [3], we designed the badges for our online learning environment to serve following functions:

- Goal setting – students should be absolutely clear about how can they earn badges, and what to do to earn a badge (or a next level of a badge),
- Instruction – the online environment is simple enough, and we do not expect badges to provide any additional information about what can be done there,
- Reputation – students profiles display all badges, and leaderboards per exercise establish student's expertise showing the quality (running time) of solution
- Status/Affirmation – course leaderboard showing the number of exercises solved,
- Group Identification – inspecting the leaderboards and profiles, students can identify peers to follow (e.g. high achievers see how other high achievers proceed).

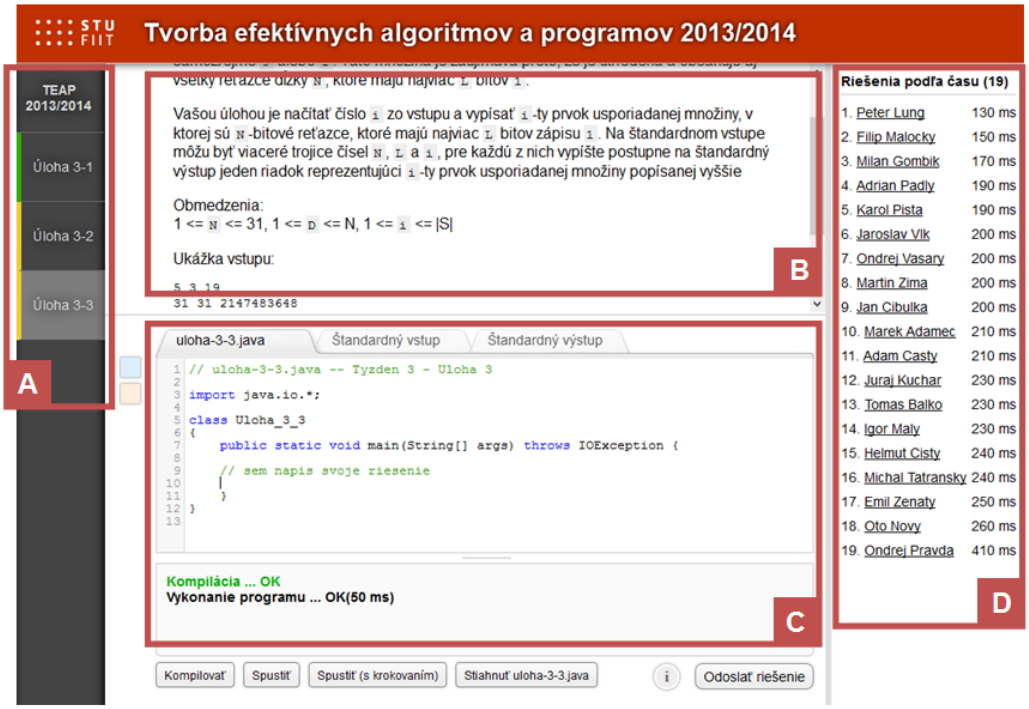

Figure 2. Online learning environment for programming exercises [12] enhanced with leaderboards and badges (not in figure). (A) list of exercises in a given unit, (B) exercise question, (C) solution editor, (D) leaderboard of students' solution execution times (students' names were changed) with links to student profiles displaying the earned badges.

The online learning environment for programming exercises we use [12] is similar to other such environments used in programming courses. Students are given weekly exercises, and they work on them during lab sessions and at home. In the online environment, students can edit solutions, compile and run against their own inputs, and submit for evaluation with limited number of attempts (usually up to 20 attempts).

The actual badges students can earn are mostly skill-based: number of exercises solved (levels: 1, 5, 10, 25, and 50 exercises), first one to solve an exercise (levels: 1, 3, 6, 9, and more exercises first solved by a student), individual badge per exercise showing the execution time for the solution, and a single participatory badge: submit a forum post (levels: 1, 5, 25, 50, 100 forum posts).

3. DATA AND METHODOLOGY

We examined data from three courses (186 students) – two introductory programming courses and one advanced algorithms course:

- Procedural programming within 4-year study programme (106 students),
- Procedural programming (repeat run for failed students) within 3-year study programme (52 students),
- Design of efficient algorithms (28 students).

The courses follow the traditional lecture-and-lab format, with two to three hours of lectures per week and two to three hours of lab sessions per week during which students solve programming exercises in C for the introductory courses and C/C++/Java for the advanced algorithms course. The exercises in the introductory courses are not mandatory and do not count toward the final grade. In the algorithms course, 30% of the final grade is determined by the exercises solved. Additionally, each of the courses has midterm and final written exams.

In evaluation we examine patterns how students use badges and leaderboards, i.e. the views of own profiles/badges, and views of the profiles/badges of others, and compare it to the perceived usage determined by the questionnaire. Additionally, we look into relation between badge engagement and traditional learning performance indicators. Besides traditional performance indicators such as students' solution attempts, we collected several specific data about the badge usage: badges earned, profile views, badge views (i.e. transitioning to the open state). At the end of course, students were given a short survey (Table 1) about their attitudes toward the gamification elements.

Table 1. Self-report survey about gamification engagement

Question 1 (Q1): What do you think about the badges? (1) Interesting, I tried to collect them. / (2) They are fine, but I was not interested. / (3) They are useless. / (4) I did not notice them.
Question 2 (Q2): What do you think about the leaderboards? (1) I checked them, and tried to get the best position. / (2) I was interested in others, but did not try to improve my position. / (3) I was not interested. / (4) I did not notice them.
Question 3 (Q3): Did badges / leaderboards motivate you? (1) Absolutely / (2) Quite a lot / (3) Average / (4) Only little / (5) Not at all.

4. RESULTS AND DISCUSSION

We collected data on 186 students (Table 2). Students in the introductory programming courses solved reasonably large portion (80.3% and 64% respectively) of the available exercises, each using a relative modest number of submission attempts (2.74 and 2.25 respectively). The advanced algorithm course proved to be a challenge with the average of only 33.1% exercises solved, using a higher number of attempts 3.74. Next, let us examine the gamification engagement as per the survey's answers. Students felt most engaged with the badges (Q1) and leaderboards (Q2) in courses ALG and PP(3), with PP(4) course distinctively less engaged. On the other hand, the implicit indicators suggest, that on average only 0.78 own-profile views and 1.46 own-badge interactions per student were observed. The same tendency occurs with the profiles and badges of others. Moreover, PP(3) course reported the highest motivation from badges (Q3, value 2.32) among the courses, while having the worst implicit engagement (as discussed before).

Table 2. Descriptive statistics of the three courses (186 students) used in evaluation

course	n	pass rate	ex. total	avg exercises solved (attempts per ex.)	avg # badges earned (sd)	avg # profile views (sd) avg # badge interactions(sd)		avg Q1 (sd)	avg Q2 (sd)	avg Q3 (sd)
						own	Others			
PP(4)	106	56.6%	38	80.3% (2.74)	4.42 (1.29)	1.10 (2.62) 2.03 (3.81)	4.33 (7.60) 3.32 (6.39)	1.58 (0.65)	1.65 (0.76)	2.67 (1.20)
PP(3)	52	65.4%	64	64.0% (2.25)	4.60 (0.87)	0.78 (1.58) 1.46 (1.69)	2.58 (3.67) 2.09 (3.01)	1.44 (0.56)	1.35 (0.54)	2.32 (1.01)
ALG	28	82.1%	30	33.1% (3.74)	3.07 (1.02)	2.04 (3.60) 4.61 (4.93)	6.29 (9.53) 4.68 (7.03)	1.43 (0.63)	1.21 (0.42)	2.43 (0.50)

Let us examine the disagreement between the explicit survey answers and implicit data from profile views and interactive badges in more detail. We analysed the average number of profile views and badge interactions for different values of answers to Q3 in Table 3. The results indicate several inconsistencies in students' own perceptions about engagement. In PP(3) course, students exhibited almost the same number of profile views and badge interactions across all levels of self-reported engagement (Q3). In PP(4) course, the top end (as self-reported by students – Q3, value 1) exhibited

average and below average engagement levels. Students also could not accurately assess (or admit) proper levels of motivation at the low end (Q3, values 4, 5) and were still showing some interest in gamification. In summary, the implicit data from interactive badges suggests a different student engagement than that reported from self-reported surveys.

Table 3. Average (st.dev) profile views and badge interactions for different Q3 survey answers

Course \ Q3	1	2	3	4	5
PP(4) profiles	4.8 (9.0)	14.4 (18.4)	6.1 (6.1)	3.0 (2.1)	2.3 (2.0)
PP(4) badges	4.6 (7.0)	13.9 (18.0)	7.1 (8.9)	1.8 (1.6)	2.9 (1.7)
PP(3) profiles	3.8 (3.2)	4.9 (6.7)	2.8 (3.0)	1.0 (1.4)	0.0 (-)
PP(3) badges	4.6 (4.0)	4.8 (5.6)	2.9 (2.2)	1.0 (1.4)	0.0 (-)
ALG profiles	-	16.4 (19.6)	3.7 (1.6)	-	-
ALG badges	-	17.2 (15.8)	4.0 (2.6)	-	-

Preliminary analysis of how students engage with the badges and leaderboards suggests that students generally examine profiles and badges of top ranked students, female students, and friends within the study group. Almost half of the top students based on course grade shows low engagement indicators, being indifferent to gamification. The other half of above average students demonstrated high engagement levels, suggesting the gamification had a positive effect on their learning performance. On the other hand, a considerable number of below average students did show significant engagement levels, suggesting that gamification is a kind of procrastination exercise for them.

When examining correlations of engagement with learning performance indicators, generally positive effects were found. In PP(4) course, the relation between engagement and number of problems solved produced $r = 0.27$, and with final grade ($r = -0.36$). In PP(3) course, the correlations are 0.51 and -0.19 respectively. In the ALG course, the correlations are 0.41 and -0.23 respectively.

5. CONCLUSIONS

In summary, we designed a novel type of badge – interactive badge – to implicitly monitor student engagement. We implemented interactive badges into three online programming courses in university setting, and demonstrated that they might be better suited to measure gamification engagement than a typical self-reported survey. Furthermore, the data suggests a positive effect of the proposed gamification elements on learning performance.

The selection of available badges in the courses was relatively limited and a wider range of badges might provide even better results. More research needs to be done to better understand how different groups of students engage with the gamification elements in context of blended university courses.

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REFERENCES

[1] Abramovich, S., Schunn, C., Higashi, R. M. (2013). Are badges useful in education?: it depends upon the type of badge and expertise of learner. Educational Technology Research and Development, 61, pp. 217-232.

[2] Anderson, A., Huttenlocher, D., Kleinberg, J., Leskovec, J. (2014). Engaging with massive online courses. In International conference on World wide web (WWW 2014), pp. 687-698.

[3] Antin, J., Churchill, E. F. (2011). Badges in social media: A social psychological perspective. In Human Factors in Computing Systems (CHI 2011), ACM.

[4] Denny, P. (2013). The effect of virtual achievements on student engagement. In Human Factors in Computing Systems (CHI 2013), ACM, pp. 763-772.

[5] Deterding, S., Dixon, D., Khaled, R., Nacke, L. (2011). From game design elements to gamefulness: defining gamification. In International Academic MindTrek Conference: Envisioning Future Media Environments, ACM, pp. 9-15.

[6] Domínguez, A., Saenz-de-Navarrete, J., De-Marcos, L., Fernández-Sanz, L., Pagés, C., Martínez-Herráiz, J. J. (2013). Gamifying learning experiences: Practical implications and outcomes. Computers & Education, 63, pp. 380-392.

[7] Fox, A. (2013). From MOOCs to SPOCs. Communications of the ACM, 56(12), pp. 38-40.

[8] Haaranen, L., Ihantola, P., Hakulinen, L., Korhonen, A. (2014). How (not) to introduce badges to online exercises. In Tech. symposium on Computer science education, ACM, pp. 33-38.

[9] Hakulinen, L., Auvinen, T., Korhonen, A. (2013). Empirical study on the effect of achievement badges in TRAKLA2 online learning environment. In Learning and Teaching in Computing and Engineering (LaTiCE), IEEE, pp. 47-54.

[10] Hamari, J., Koivisto, J., Sarsa, H. (2014). Does Gamification Work?--A Literature Review of Empirical Studies on Gamification. In System Sciences (HICSS), IEEE, pp. 3025-3034.

[11] Ibanez, M., Di Serio, A., Delgado Kloos, C. (2014) Gamification for Engaging Computer Science Students in Learning Activities: A Case Study. IEEE Transactions on Learning Technologies, to appear.

[12] Navrat, P., Tvarozek, J. (2014). Online Programming Exercises for Summative Assessment in University Courses. *CompSysTech'14*. ACM, to appear.

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