

# Increasing students' motivation by using virtual learning environments based on gamification mechanics

Implementation and evaluation of gamified assignments for students

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## ABSTRACT

Increasing students' motivation is an essential task during the educational process. One of the possible ways how to achieve this is to use innovative educational mechanics, such as gamification. Gamification provides an opportunity to extend regular learning management systems and virtual learning environments with game-like elements, such as points, levels, and meaningful narrative. This paper describes the implementation and usage of gamified assignments in Web Development. Firstly, we analyzed gamification possibilities in higher educational institutions. After each assignment, we gathered feedback from students to study their involvement, motivation, and influence of gamification on how the information was perceived. Based on the results, several suggestions for the improvement are discussed, such as adaptive variable difficulty or making the achievements public in order to increase social motivational drive influence.

## CCS CONCEPTS

• Human-centered computing → Web-based interaction • Applied computing → Learning management systems

## KEYWORDS

Gamification, students' motivation, adaptive learning, open source educational software

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## 1 INTRODUCTION

Quite often in higher education institutions' teachers face the problem of low students' interest and engagement. That's why increasing students' motivation is an important task in the educational process [1]. Since higher education is an active and participatory activity, it requires motivation not only to begin but also to keep up with the process. Researches show that when elements of self-direction and autonomy are required for the educational process, which is the case for university students, even higher level of motivation is required [2]. Therefore, students' motivation plays a significant role in their successful higher education. Recently, in various areas where individuals' participation and motivation are engaged, gamification mechanics are considered. Furthermore, since nowadays almost every institution has an online learning management systems (LMS), and gamification originates from the digital media area - it is a perfect fit for extending the existing LMS.

All educational system might be considered already gamified: when viewing marks as achievement points, and grades - as levels. Students need to gain a certain amount of points to get to the next «level». Of course, studying at university is not a game, but that does not mean it is not possible to enhance studying efforts through game elements or with a game design within a common LMS [3]. Many researchers suggest adding the deeper level of gamification to the educational process, involving also separate courses or tasks. Some of them show that gamification helps to increase students motivation [1] [4] [5] [6]. It was firstly observed during studying the effects of the increase of the motivational and emotional insolvent during playing the video games [7]. The basic idea of gamification is to study, use and

replicate the same motivation and flow of the users in other fields.

Currently, scientific discussion about gamification is mainly connected with game elements like points, badges or leaderboards [3]. This research studies the opportunities of integration of completely gamified framework into Informational Technology students' labs. In the next parts of this research, it is shown, how it is possible to create such a framework, which would use various game elements to influence different motivation mechanics. And finally, opportunities for several extensions, such as publicly visible results and algorithms for variable difficulty are discussed.

The main idea is not to make studies easier by applying game-like techniques, but to discuss a different approach to the educational process by trying to motivate students more and help them to achieve the state of the flow during working on the assignments.

## 2 DEFINITION OF GAMIFICATION

Term «gamification» originates from a digital media industry, and mainly from a marketing area. There is a research [8], which studied 119 publications which had gamif\* in their title and were published between 2000 and 2014 years. It was found out that the biggest part of those papers define gamification as the application of gaming mechanics and elements in non-game environments. Also, there mainly is a clear difference between a game-based learning and a gamification. There exist several definitions of gamification. The most popular one comes from an article by Deterding et al [4]. According to Google Scholar on 24.06.2018, it was already cited 3718 times (<https://goo.gl/cwKrsA>).

Gamification is described there as the use of game elements characteristics in non-game contexts. Such elements might be: points, badges, progress bars, meaningful stories, profile development and etc (Table 1).

**Table 1: Game elements and their functions in gamification**

Game element	Functionality
Levels	Show the participant's status, ranking and progression.
Challenges and Quests	Are based on a point system and are needed to be achieved with specific effort. This effort motivates and enforces participant's progression.
Competition	Taking part in a contest. Motivates to finish the task quicker or better.
Cooperation	Motivates participants to work together and to collaborate in order to achieve better results.
Narrative	Consistent storyline, a background complex task which triggers fantasy as a

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motivational factor.

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Another research [9] adds the following constraints to describe how gamification is different from other terms, such as serious games or games:

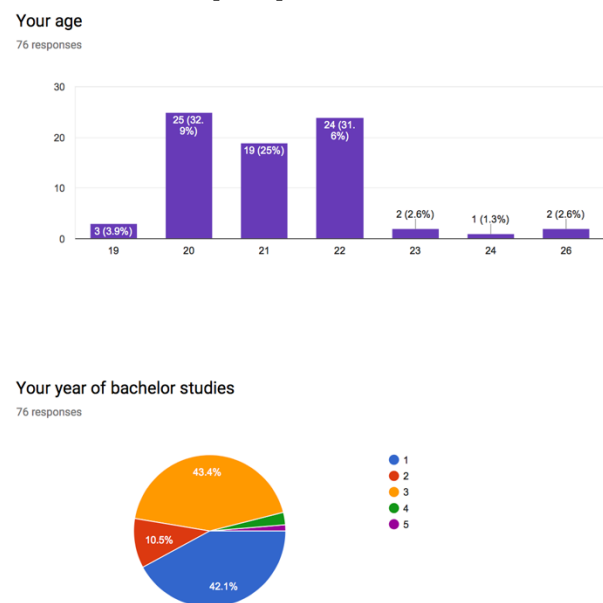
1. More gameful, than playful;
2. not a complete game;
3. both a tool and game;
4. not primarily for entertainment;
5. not a pervasive game.

Virtual learning environments (VLE) allow university teachers to share different knowledge media with their students, iterate with students and monitor the statistics [10]. In VLEs known as Massive Open Online Course (MOOC), the majority of empirical studies have already proven the positive effect of implementation of the gamified elements [11]. We suggest that the same strongly positive effect would be achieved in the higher educational institutions VLEs too.

## 3 CASE STUDY: USING GAMIFICATION IN WEB DEVELOPMENT EDUCATION

### 3.1 Research Environment

This research was conducted while teaching a Web Design course for bachelor students in Brno University of Technology. The collection of data was carried out by voluntary focus groups, questionnaires and expert interviews. Figure 1 shows the information about the participants.



**Figure 1: Participant's age and year of bachelor studies**

### 3.2 Using Existing Open Source Gamified Learning Environment

As the first step of this research, students were given a choice, which type of the exercise they would like to do: a regular one, or a gamified task. For a gamified task, already existing open-source platform was selected (<https://flexboxfroggy.com>). Majority of students selected gamification, and this shows high interest in this area. Students were then asked why they made this selection. Answers of those who selected gamified task can be divided into several bigger logical groups (listed in the order of popularity, from highest to lowest):

1. more fun
2. should be easier
3. clear goal and progress tracking
4. more comfortable and interactive way of education
5. want to try something different

The first motivational group, «more fun» is clearly correct because we used game elements which are fundamental to gamification. And that can help to achieve the state of the flow, as mentioned before. We'd like to discuss more the second group «should be easier». The amount of new information in the gamified task was even bigger, then in the regular task, because it was well structured and there was no need to write additional code or some wrappers, students needed only to solve tasks relevant to each new thing they've been shown. However, because this task was presented as a game, students had a subjective feeling that it is being easier.

It was observed that students were more involved in the process, and afterward, they left nice and engaging feedbacks.

Among the reasons why students hadn't selected the gamified was mentioned only one: that it isn't connected with other exercises in the course. This shows the importance of applying gamified techniques to all course altogether, and not only to some parts of it. This is going to be solved in the next stages of this research.

Moreover, some students opted for both versions, even though they could receive only one mark for this assignment. This also shows additional motivation.

After the lab, we asked students to evaluate their motivation and also how likely would they select a similar gamified task for the next lab. Obtained results were quite promising, as shown on the Figure 2.

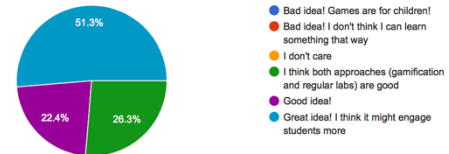
Since the feedback from students was positive, and they definitely have shown a lot of engagement, it was decided to develop one more gamified task. It is based on the previous open source one but covers a new topic – jQuery.

### 3.3 Development of a Gamified Virtual Learning Environment for Studying jQuery

Developed platform is named bombsQuery (Figure 3) and is aimed to teach the basics of jQuery. The narrative is going around the need to clean the field from all bombs, marking them with the help of white flags. To make it work, students need to write a particular part of jQuery code, as described in the task. Apart from the text of the task, each level contains some theoretical part, hints for the students and examples (Figure 3).

What do you think about using gamification or even games during your computer labs?

76 responses



How likely would you select gamified task on your future computer labs?

76 responses

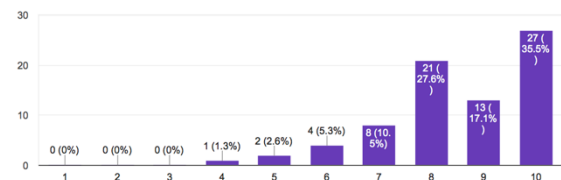


Figure 2: Student's evaluation of their satisfaction with the first gamified assignment

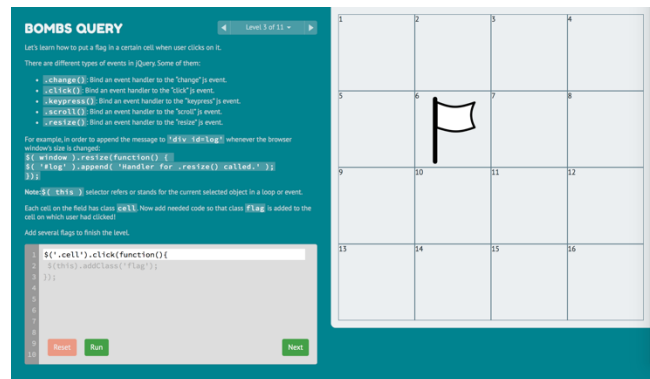


Figure 3: bombsQuery interface example

Participants could see their current progress, and how many levels should they complete to finish the assignment. The correct code is checked automatically, and the next level starts immediately after the correct answer was entered.

All levels are stored in the separate JSON file, with each level description having the following structure:

```
name: '1_put_bomb',
lines: 1,
instructions: "",
before: "",
after: "addBomb.addClass('bomb')",
check: 'bomb#5',
field: 'blank',
button: false,
counter: false,
```

```
check_semicolons: true
```

This allows to add more levels in the future and to keep reusable starting field configuration or checks for the code correctness. Moreover, this allows providing immediate feedback to the students.

Developed platform is open-source (<https://github.com/lirael/bombsQuery>) and is currently available online at: <https://lirael.github.io/bombsQuery/index.html>.

### 3.4 Motivational Aspects

Concerning motivation, we tried to study the impact of gamification on some specific motivational mechanisms, described in [12] and [13]. One way to study different motivational factors is to use Octalysis Framework [13]. The framework includes the following core drives of gamification:

1. **Epic Meaning & Calling** – players are doing something greater than themselves or they feel like they were “chosen” to do something
2. **Development & Accomplishment** – making progress, developing skills, and eventually overcoming challenges
3. **Empowerment of Creativity & Feedback** – users are engaging in a creative process where they have to repeatedly figure things out and try different combinations
4. **Social Influence & Relatedness** – all the social elements that drive people, including: mentorship, acceptance, social responses, companionship, as well as competition and envy
5. **Unpredictability & Curiosity** – wanting to find out what will happen next
6. **Loss and Avoidance** – motivation to avoid something negative from happening

Table 2 shows how all of these factors are implemented in the bombsQuery platform.

**Table 2: Game mechanics and game design elements used in bombsQuery platform**

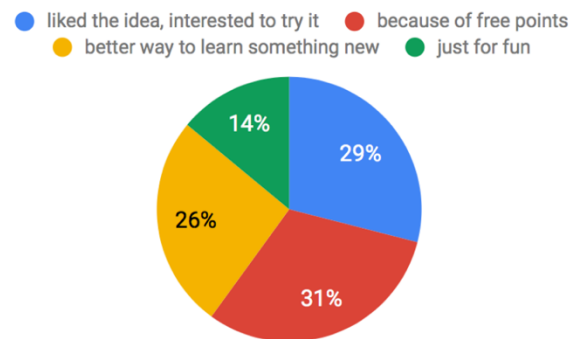
Motivational drives	Used game elements
Epic meaning, narrative	Welcome text in the first level, meaningful task description in each level, kept within the same narrative.
Development, accomplishment	Progress bar for keeping track of finished levels
Stimulus for creativity and feedback	Immediate feedback, expressed in automatic passing the level; possibilities to write the code in different ways to achieve the same goal
Social relationships	Is not implemented in the current stage, but would be integrated later

	in a form of publicly visible status and a possibility of peer review for selected tasks
Curiosity	Next levels are hidden before the current one is completed.
Loss	Should not be implemented in the educational tasks

## 4 EVALUATION AND DISCUSSIONS

The second task (completion of all bombsQuery levels) was voluntary again, but in the same time, awarded with additional points in the mentioned before Web Development course. An interesting observation is that even those students whose marks wouldn't be affected by these points, took part in the experiment anyway, just out of their interest. We also asked students to provide detailed feedback about their experience and they did so with a high level of accuracy and engagement, providing detailed feedbacks and answers. Majority of them also mentioned that they are happy to help to improve the educational process.

After the task students were asked why they selected it. Figure 4 shows the occurrence of answers divided into logical groups.



**Figure 4: Students motivation evaluation**

Results show that many students selected this task to learn something new, and because they were interested in the new concept of game-based learning. Even though 83% of students said that they like the game, some of them mentioned that it was too complicated, and some - that it was too easy for them. This brings us to a discussion of dynamic difficulty adjustment in gamified labs for students, described in the next part of this article.

Among other benefits of this approach are also some, which are not connected to the motivation. One such benefit is that these gamified assignments can easily be translated, hence are suitable for the exchange students. Moreover, because of the ease of use, translation and automatic review, they can also be extended to a complete MOOC course and published on one of the platforms (such as <http://edx.org> or <https://www.coursera.org>).

One possible negative side of using such gamified platforms, which we'd like to discuss, is if the role of a teacher isn't decreased with it. As described above, both existing studies on the gamification, and this research, already have proven that gamification improves student participation. However, there also are studies which prove that these effects might be achieved only with the active involvement of facilitators, who support the educational process [14], [3] In this case teacher's role is to create dynamic collaboration between students. They need to involve students in the educational process by triggering them to be active and providing additional feedbacks and comments.

## 5 PROPOSED EXTENSIONS

### 5.1 Variable Adaptive Difficulty

Objective discussed in this chapter is not only to teach students up to the point where they can pass the exam with a required knowledge level but also to teach them something new. That's why we need to measure students' knowledge at the beginning and track the progress. Moreover, since different students start the course with a different level of experience in this area, and also, they have different abilities – sometimes the adaptive difficulty is a good solution. The excellent demonstration is the Figure 5, which illustrates the answers to the question if students need more hints in the level description.

Would you like to have more hints or documentation?

71 responses

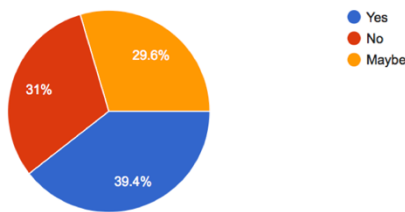


Figure 5: Participant's opinion on the task difficulty

The need for additional hints is divided almost evenly in thirds. The adaptive difficulty is widely used in games. Studies show that there are several factors which can influence the flow experience, such as previous life experience or self-confidence [15]. The idea for the first major extension is to provide variable difficulty to the bombsQuery platform. This can be achieved by measuring the time which student spend on each level, and also the number of wrong tries. Based on the collected data the level of the user would be determined. And based on the level – the number of hints and the code which is already written for the student might be adjusted accordingly.

### 5.2 All Course Assignments Integrated into One Gamified Platform

In order to have more game elements available for the future use, it is better to integrate all course assignments into the same gamified platform. During analyzing the questionnaires with students' feedbacks, it was observed that some of them get frustrated when tasks during the same course are not connected or have different logic and require a different approach. Narratives of single tasks might be different, but badges and achievements should be kept the same during all course. This would also help to keep the same structure and logic of all tasks.

### 5.3 Adding Social Influence Motivational Drive

The social influence motivational drive is rather important and can be involved with the help of such elements, as peer review, public leaderboards, and competitions. For example, students might be proposed some additional points for taking part in additional challenges.

### 5.4 Grouping Students and Using Advanced Learning Dashboards

In order to help teachers with mentoring students, advanced dashboards for LMS are needed. When gamification would be combined with advanced data analysis, such as data mining, several conclusions could be made. For example, it is possible to group students by similar characteristics and reactions to educational strategies, or to group those who are hint-driven or failure-driven and find common misconceptions that students possess, by observing logs. While making the more in-depth analysis of the motivational drives, it might also be possible to detect students with low motivation and try to engage them more, involving other aspects of motivation. There already are some tools, which can help to classify students, for example, TADA-Ed [16] or Moodle Data Mining Tool [17], but while using them, teachers need to have specific data-mining knowledge. The proposal here is to perform these classifications and predictions automatically in the background, using advanced learning dashboards to display the results [18].

## 6 CONCLUSIONS

In summary, we evaluated the influence of gamified tasks and students' motivation and engagement in the educational process. After testing and receiving feedback from students, proposed extensions and improvements are suggested. Based on the existing researches and collaboration with teachers we developed a framework for a gamified experience in Web Development course exercises. The same framework might be used for other assignments too, only tasks descriptions and checks should be adjusted. It is possible due to the modular system of the framework. The main extension on which the future work is planned – is the adaptive variable difficulty, based on students' previous knowledge and experience, and applying gamification mechanics to all assignments throughout the course.

Analysis of the questionnaires, held after the course was finished, showed great students' interest in this kind of tasks. They are ready to collaborate and to be engaged in the educational process more.

In this research gamification is not considered for making the process easier, it refers to a mindset, which can help involvement and motivation to play the leading role during the design of educational technologies and learning scenarios [3].

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