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Two years of gamification of the course - lessons learned

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Abstract - **Gamification is used in different levels of education (elementary, high school, university). Many research studies deal with ways to improve the education process by using game mechanics and other game-based elements in their teaching activities. This paper presents our experience with a gamified course in two consecutive academic years. In the first year, half of the students used the gamified version of the course (experimental group), and the other half of the students did not (control group). In the second year, the entire student population of the course was using an improved gamified version of the course based on the feedback from the first year. We analysed the data and compared these two years in many elements.**

Keywords – gamification, e-learning, analysis

I. INTRODUCTION

Gamification has been applied in different levels of education (elementary, high school, university) over approximately the last 5 years. Many research studies deal with ways to improve the education process by using game mechanics and other game-based elements in their teaching activities [1]. An important part of the research in the field of education is what part of the course is involved in the research. If only a smaller part of the course (for example, one topic that corresponds to a chapter from common course literature) is included in the gamification research, or if there is a time limit of a few weeks of the course, then one cannot fully realize the good and the bad sides of gamification. Some students get excited when teachers use new methods and lose interest after a few weeks.

The course lasts much longer than a few weeks and it is much harder to apply gamification for the full course content and to keep students' interest during the entire education process, like one semester that usually lasts for 15 weeks.

This paper presents our experience with a gamified course in two consecutive academic years. We gamified the whole course content and learning activities. During the first year, half of the students were in the gamified version of the course as an experimental group, and the other half of the students were in the control group. The experimental group, based on their groupings, had all gamified experiences that standard Moodle distribution provides, and we added some plugins. The control group was not formally and fully included in all aspects of the gamified version of the course but the teachers manually recorded all their earnings (badges, experience points etc.) although the students were not aware of it. We made some comparisons based on these groups and their achievements, the usage of Moodle etc.

We analysed the questionnaires that the students filled in at the end of the course, and the remarks we made during the course. We considered them as inputs for improvements for the next year (for example we provided more information about the best award). In the second year, the entire student population of the course was using the gamified version of the course. We compared these two years in many elements. Some results were expected but some were not. Finally, we compared our experience with other research studies in the area of gamification.

The rest of the paper is structured as follows: Section 2 describes related work and Section 3 enumerates the used methodology. Section 4 presents the analysis we conducted based on different data sources. Section 5 suggests the future work and Section 6 offers a conclusion.

II. RELATED WORK

Gamification has been applied in many different areas. In [2] authors provide a detailed review of gamification usage in different areas like marketing, health and wellness, crowdsourcing, education, etc. In [3] authors did a review of gamification usage in a specific area called software engineering. According to another review [4] the most common context for the implementation is education. There are various elements in education that can be used for gamification. Only a few strategies, like badges [5], leaderboards [6], or combination of both [7] are used, but there are more than 100 strategies that can be used as indicated in [8].

The differences in the previous research exist in the length of the period in which gamification was performed, the elements used and the level of education. For example, in [10] authors have used gamification only for 6 weeks in the sixth grade of primary school. In [7] gamification was implemented in two communication courses using leaderboards and badges through one semester (16 weeks).

Such different research studies are valuable for gathering ideas and gamification strategies. The most interesting are gamifications implemented in computer science courses. We found two closely related works that were in the computer science domain, [5] and [9].

In [9] gamification was performed for one semester (14 weeks), focusing on gamification in the form of ranking blocks (in other words leaderboard) displaying the achieved points. They implemented the gamification in LMS Moodle in the first year of Bachelor's degree studies in computer

science. They state that "the results empirically proved that motivation decreases by introducing leaderboards in given circumstances (students, year, and specialization)" [9].

In [5] authors used gamification in Data structures and algorithms course for one semester. Authors had two groups of students and used badges as the gamification strategy. They "found no significant differences in the behaviour of the different goal orientation groups regarding badges when analysing the log data from the learning environment" [5].

Although [5] and [9] conducted the research in the area that we are interested in, they used gamification only for one semester whereas we used it for one semester in two sequential academic years. Furthermore, we used more gamification strategies as explained in [1].

III. METHODOLOGY

We have planned longitudinal research to study the effect of gamification in the course "Web design and programming" at the 3rd year of informatics undergraduate programme at the University of Zagreb. In [1] we explained how the course was prepared for gamification.

In academic year 2015/2016 there were two groups of students: one was an experimental group and the other was a control group. "We set 50% as maximum members for experimental group with 'first-come' principle and students got involved very enthusiastically so we got even numbers for both groups." [1] The experimental group used the new gamified interfaces and were given experience points, badges, etc. They were awarded during the course if they achieved some goals as explained in [1]. For the control group we tracked all the data manually without them knowing it, but they did not get any awards.

In academic year 2016/2017 all students were involved in gamification. At the beginning of the course they got some information about gamification, and about prizes and awards, but not how to achieve them. This was in contrast to academic year 2015/2016 when the students did not know what the awards were. Another difference was that in academic year 2016/2017 we made some changes to improve gamification based on students' feedback from the questionnaire at the end of the course. The main comment in their feedback was that we should state the possible awards at the beginning of the course. The following section offers other opinions and suggestions we got in the questionnaire.

In academic year 2015/2016, there were 75 students at the beginning of the semester, that were divided into the control group (38 students) and the experimental group (37 students). In academic year 2016/2017, there were 108 students at the beginning of the semester and they were all using the gamified version of the course as the experimental group did in the previous year. In both academic years, some of the students dropped out during the semester due to the fact that they did not satisfy some of the mandatory elements like minimum points from each of two midterms, minimum total points from all homework assignments, minimum points from a project.

TABLE I. NUMBER OF REQUESTS PER STUDENT

Academic Year Group	Average	Max	St. dev
2015/2016 – E	2026,0	3424,0	600,5
2015/2016 – C	1761,4	5951,0	932,7
2016/2017 – A	2107,3	4227,0	759,7

IV. ANALYSIS

In the following subsections we present some of the analyses we conducted based on different data sources.

A. Log analysis

As a data source we used Moodle course log that was exported and prepared for us by our Moodle administrator with the same structure for both academic years due to different Moodle versions. Then we removed all records made by teachers, administrators and test students. That was the initial database. Based on a preliminary analysis we decided to use mainly the records of the students that passed the course. The reason for that was that dropout students were gradually reducing their work on the course and we would get a steeper curve.

Table I shows the number of requests per student. In academic year 2015/2016 the maximum number of requests per student in the control group was almost twice as big as the number in the experimental group. Obviously, we did not expect that. The individual data showed that log records sum of two top active students from the control group was higher than log records sum of all students from the experimental group. The 2015/2016 experimental group had higher average number than the control group, but the students had less scattered usage of LMS than the control group. All three values (average, maximum, standard deviation) of the 2016/2017 group were higher than the values of the experimental group in the previous year. One might conclude that elderly colleagues could have advised the 2016/2017 students to be more active on LMS.

To get a clear picture of how frequently and when the students performed their learning activities, it is not enough to observe only the total number of requests per student. As a teacher, one would like to know whether the students are constantly active or whether they use LMS during the whole semester. For that case, we prepared average numbers of weekly requests per student for three previously mentioned groups but also for the students who dropped out in academic years 2015/2016 and 2016/2017. These two groups have FG suffix. Figure 1 presents a graph with all five groups. A quick look at the graph gives an impression of a slowly falling trend for all groups with few peaks and saddles. In academic year 2015/2016, the experimental group had higher values than the control group for almost all weeks except for the 9th and 10th week where the control group had a slightly higher value. All three 2015/2016 groups had the highest peak in the 5th week and a saddle in the 6th week due to the 1st midterm exam. The students had to prepare for the midterm exam and they had no other important activities on the course so they were using LMS less. The same was for the 2016/2017 group with the exception in the 12th week because it has a peak instead of a saddle.

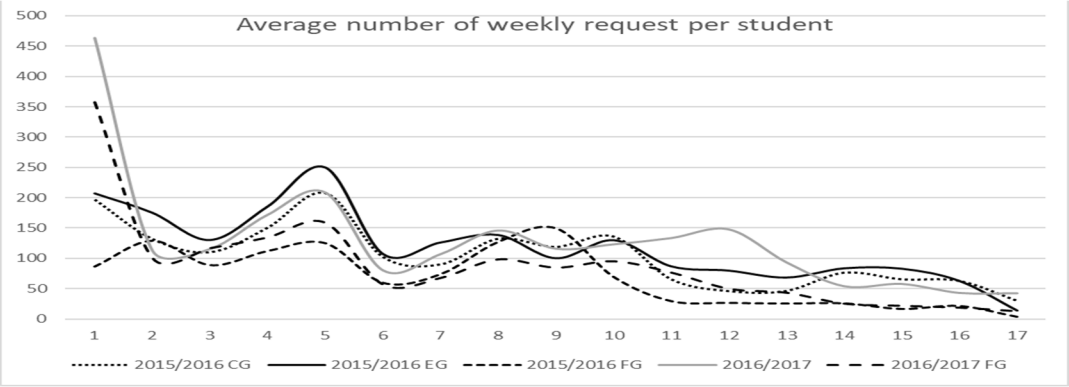


Figure 1. Average number of weekly request per student

The 2015/2016 group with dropout students (FG) had lower values than other groups for all weeks except for the 9th week. When compared to other weeks for that group, the highest value was in that week, and nobody expected it. Why? To give a quality answer we should filter the log data for that week and then sort out on activities. Definitely, the main reason was a student who worked on his Wiki seminar and had almost half of all requests for that week. We can also try to find the cause based on the course timetable to see what activities were performed during that week and the following one. In that case, we would think that the reason was the 4th homework assignment which was one of the most important. Moreover, we would have the wrong conclusion.

A curve for academic year 2016/2017 shows very intensive activities at the beginning of the course during the first week. Again, we must look at the log data for that week to get a proper conclusion. The most influenced students' activities were browsing the course in LMS. Then follow starting activities as "Introduce yourself", forum with Q&A, choosing lab group and seminar group, basic information etc. As in the previous year, the highest peak was in the 5th week and a saddle in the 6th week for the same reasons. The 2016/2017 group had higher values than the 2015/2016 experimental group from the 8th to 14th week. Most of the activities were forum for the 3rd and 4th homework, description of the 3rd homework, Wiki seminars etc.

The data presented here shows that the students from the experimental group had used LMS more than the students from the control group. In the case of academic year 2015/2016 the difference is about 13%. That could be due to the course gamification effect on the students so they want to be more present on LMS.

B. Badges

One part of gamification were badges, a detailed description of the badges system is given in [1]. In short, there were five categories of badges:

1. Medal – given to students who wrote the best homework.
2. Homework – given to students who achieved maximum points in two sequential homework assignments.
3. Forum – given to students with best comments or questions on homework assignment forums.
4. Midterm exam – given to students who achieved maximum points on midterm exams.
5. Test – given to students who achieved maximum points on self-assessment tests.

There were some other badges that we added in academic year 2016/2017: most active students, best video, best-written seminar, and badge for helping us improve the course.

Table II shows the number of badges per category. The column total presents the sum of all badges from all categories. Academic year 2015/2016 has three rows: the first row presents the achievements of the experimental group, the second row presents the achievements of the control group, and the third row shows the achievements of all students from 2015/2016.

Two questions were set. First, is there any difference in the number of gathered badges between the experimental and the control group of students in academic year 2015/2016? Note that we gave badges to the students in the control group when they earned them without their knowledge. Second, are the achieved badges different when we compare academic years 2015/2016 and 2016/2017? Since there are some badges that were newly added in academic year 2016/2017 they were excluded from the analysis. Also, "Best ERA model" badge was removed from the analysis because it depends on the number of students in academic year.

From Table II, one can see that in academic year 2015/2016 there is a difference between the control and the experimental group. The difference is more noticeable in Table III, which shows the same data in percentages. It is clearly visible that 2/3 of the badges in every category are taken by the experimental group. Note that badges were given to students based on *quality of completion* of certain activities for which all students had the same chance to do.

Also for Medal, Homework assignment (HW Assign.) and Midterm exam category, badges were given for quality of activities on which students' final grade depended.

TABLE II. NUMBER OF BADGES PER CATEGORY

Ac. year group	Total	Medal	HW assign.	Forum	Midterm exam	Test
2015/2016 – E	34	12	4	15	1	2
2015/2016 – C	17	7	2	7	0	1
2015/2016 – A	51	19	6	22	1	3
2016/2017 – A	51	19	7	12	1	13

A–All students, E–Experimental group, C–Control group

Based on these results, it can be stated that there is a difference of gathered badges between the experimental and the control group of students in academic year 2015/2016. It can be concluded that the experimental group was motivated to invest more time to do the activities better with the perspective of maybe getting an award.

Table IV presents the total number of badges in the two years. There was a higher number of gamified students in academic year 2016/2017 than in academic year 2015/2016 so we expected that there would be an increase of achieved badges in categories that are not competitive like Homework assignment, Midterm exam, and Test category, and the same number of badges in the competitive categories like Medal and Forum. Table IV shows that in academic year 2015/2016 students got more badges in the Forum category than in academic year 2016/2017. There is a -46% decrease in academic year 2015/2016 when compared to 2016/2017. The Self-assessment test category has a 333% increase and the Homework assignment has a 17% increase in academic year 2016/2017.

The results in the Medal category are not surprising since in both years the top 3 or 4 homework assignments were awarded and the number of badges was the same. The Homework assignment and the Midterm exam category had a different effect. We did not expect that only one more student would achieve maximum points on two sequential homework assignments and for the Midterm exam, there was the same number of students. We must state that for the Midterm exam it is hard to get maximum points but it was not so hard for the Homework assignment. The Test category had a big increase and that was expected. It partially depends on a higher number of students but we believe that gamification had some impact although we do not know to what extent.

The biggest surprise was the Forum category due to a decrease instead of an increase. This maybe happened because students better understood the homework assignment in academic year 2016/2017 that led to less questions and the students did not know what to ask. The only questions in academic years 2015/2016 and 2016/2017 were more or less related directly to misunderstandings of homework assignments.

Based on the results form Table IV we conclude that gamification does not have such a big impact as results suggested for academic year 2015/2016. There is a need to use gamification for a few more years to discover the real impact.

TABLE III. PRECENTAGE OF ACHIVED BADGES IN 2015/2016

Group	Total	Medal	HW assig.	Forum	Midtem exam	Test
Experi-mental	66.7%	63.2%	66.7%	68.1%	100.0%	66.7%
Control	33.3%	36.8%	33.3%	31.8%	0.0%	33.3%

TABLE IV. NUMBER OF BADGES FOR ALL STUDENTS

Ac. year group	Total	Medal	HW assign.	Forum	Midterm exam	Test
2015/2016	51	19	6	22	1	3
2016/2017	51	19	7	12	1	13
Difference	0	0	1	-10	0	10
Difference in %	0%	0%	17%	-46%	0%	333%

C. *Weekly surverys*

Early feedback is important to teachers to know how satisfied the students are with the course and to enable them to react if there is a reason. To obtain that information, we gave students short surveys so they would provide us with feedback on the last week's course material, teaching methods and satisfaction with the teacher. In the gamified version, we extra rewarded students who fill out such surveys.

Figure 2 shows that the interest in filling out these surveys decreases over the semester. The figure presents the percentage of students who fill out the survey each week. We need to use percentages for the data to be comparable between the years. The control group and the experimental group in academic year 2015/2016 showed a clear gap between them, which states that a higher percentage of the students in the experimental group were willing to give feedback if they were rewarded.

In academic year 2016/2017 students dropped out in the middle of the semester so we calculated the percentage for the first five surveys with 108 students and the last five surveys with 105 students.

There were peaks and saddles regarding filling out the surveys in every line in Figure 2. One can conclude that students fill out one survey and then some of them skip the next one. In addition, some students told us that at the beginning they did not know how or could not find the survey, so some changes were made related to that at the beginning.

The most interesting part of Figure 2 are the last five weeks where gamified students were more motivated to fill out the surveys than non-gamified ones. In the last five weeks for academic year 2016/2017 values are all above the 2015/2016 curve.

We can conclude from Figure 2 that gamification can improve the students' motivation to fill out the surveys. It cannot be stated clearly by how much, because there is one problem. Some students may fill out these surveys just to get the points and there is no way to tell in most cases who such students are.

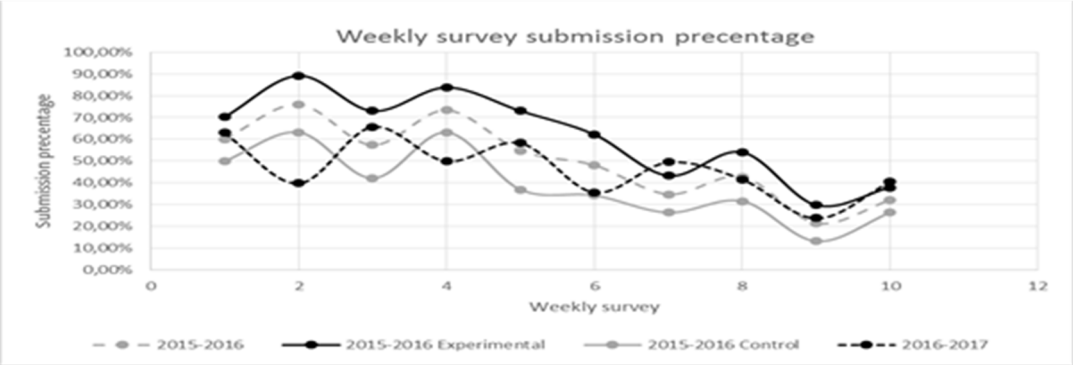


Figure 2. Percentage of weekly survey submission

D. Levels

One of the most recognized goals in computer games is getting the highest level. Table V shows the number of students per gained level and its percentage. In academic year 2015/2016 more students from the experimental group gained the highest level (7) than from the control group.

36.3% of students in the experimental group and 25.7% in the control group had two highest levels (6, 7). Unexpectedly, in academic year 2016/2017 only one student (1.3%) gained the highest level. However, 30.8% of students gained two highest levels, which was very close to the same levels for all students (30.9%) in the previous year.

On the other hand, we must examine three lowest levels in academic year 2016/2017 gained by five students. These students passed the course so we have to ask ourselves about the reason for their poor achievement. Two of them earned many points and got good grades (3 and 4 in a scale 2,3,4,5 where 5 is the best). The other three had more than enough points to pass the course and they earned the passing grade (2). The only reason why they achieved lower levels is that they earned some experience points but did not want to collect them.

There is no doubt that some students would like to climb on the ladder of levels in the gamified course especially if they got a good reward. For others, that is not "their game" and they thought their path is in the usual academic system.

TABLE V. SUDENTS PER LEVELS

Level	2015/2016 – E		2015/2016 – C		2015/2016 – A		2016/2017 – A	
	No	%	No	%	No	%	No	%
1							2	2.6
2							2	2.6
3							1	1.3
4	1	3.0			1	1.5	2	2.6
5	20	60.6	26	74.3	46	67.6	47	60.3
6	8	24.2	7	20.0	15	22.1	23	29.5
7	4	12.1	2	5.7	6	8.8	1	1.3

A–All students, E–Experimental group, C–Control group

E. Academic achievements

The course is organized in a way that students can acquire knowledge and skills in the area of Web technologies through earned points in the following categories: homework assignments, midterm exams, project, and total number of points. Table VI shows points (average, maximum and standard deviation) for three groups in each category.

The Homework assignments category showed, as expected, that the 2015/2016 experimental group had higher values for average and maximum than the 2015/2016 control group. In addition, the 2016/2017 group had higher values for average and maximum than the 2015/2016 experimental group and the 2015/2016 control group.

In the Midterm exams category, the 2015/2016 experimental group again had higher values for average and maximum than the 2015/2016 control group. Contrary to that, the 2016/2017 group had lower values for average and maximum than the 2015/2016 experimental group and the 2015/2016 control group.

The Project category follows the Homework assignments category for average value but maximum value was the same for all three groups.

Finally, for the Total points category, the 2015/2016 experimental group had higher values for average and maximum than the 2015/2016 control group. The 2016/2017 group had equal values for average as the 2015/2016 experimental group and had higher values than the 2015/2016 control group. The 2016/2017 group had higher values for maximum than the 2015/2016 experimental group and the 2015/2016 control group.

F. Final questionnaire

One of the last activities on the course in each semester was to fill in the questionnaire. The questionnaire for academic year 2015/2016 consisted of questions divided in many categories, whereby one of them was about gamification, and it was given only to the experimental group. 76.9% thought they liked the gamified version of the course. The next question was "What was your curiosity level about the secret bonuses (awards)" and for 38.5% of students it was high, whereas 46.2% answered it was medium.

TABLE VI. POINTS IN CATEGORIES

HOMEWORK ASSIGNMENTS			
Ac. year group	Average	Max	St. dev
2015/2016 – E	14.8	23.0	3.6
2015/2016 – C	14.2	22.3	3.5
2016/2017 – A	19.1	29.0	4.1
MIDTERM EXAMS			
2015/2016 – E	9.3	13.1	1.7
2015/2016 – C	9.1	11.9	1.6
2016/2017 – A	7.8	11.7	2.0
PROJECT			
2015/2016 – E	31.1	45.0	8.8
2015/2016 – C	29.4	45.0	9.4
2016/2017 – A	31.6	45.0	7.0
TOTAL POINTS			
2015/2016 – E	66.3	91.4	12.7
2015/2016 – C	63.4	90.0	12.4
2016/2017 – A	66.3	94.7	11.8

A–All students, E–Experimental group, C–Control group

The next question was "Did you expect some special bonuses (awards) based on your success" and 84.6% answered yes. For question "Do you feel that the bonuses were appropriate in terms of the effort you have made" 61.5% answered yes. For question "If you knew about the bonuses (awards) in advance, would you make more effort to win them?", 53.9% answered they would make more effort, 43.3% would make equal amount of effort and 3.9% said they would make less effort. The last question for the analysis was "Would you recommend that the next year course uses the gamified version for all students" and 88.1% chose yes.

V. FUTURE WORK

Gamification is not an easy element to research. Many factors conceal the effect of gamification. To expose the effects of gamification thoroughly, extensive research is needed that should be conducted over several years of using gamification. We will continue using gamification and track the effects of different elements. Next, we plan to do a deep analysis of grades and try to see if there is any correlation between grades and other elements. With every academic year we will try to improve the gamification based on comments that we get from students' final questionnaire at the end of the semester.

VI. CONCLUSION

Some questions have arisen about the efficiency of gamification from the numbers presented in this paper. Is gamification responsible for the higher values or is this just a coincidence? The results show that gamification has some impact on simpler activities like surveys and self-assessment test. On the other hand, it seems that gamification does not have such a big effect on the quality of work. The authors think that students used the course materials more and performed the course activities better because of human curiosity and that is one of the elements of gamification. Both curves for the average number of weekly request per student and the percentage of weekly survey submission have similar falling trend towards the end of the semester, meaning gamification could not maintain the same interest in students throughout the semester. Most academic achievements were equal or higher in the second academic year than in the first academic year regardless of the groups we compared. That is not in direct connection to gamification per se, but mainly to the improvements we made in providing the information about possible awards, which had feedback effect on gamification.

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