Introducing Gamification into e-Learning University Courses

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Abstract - Research on educational e-courses that contain only a series of motivating elements of computer games but do not include playing computer games has intensified since 2010 [1] [6]. This field of research is called *gamification* and represents the *use of game elements* (mechanics, dynamics and aesthetics) in a field (education, marketing etc.) that is not a computer game. A review of literature related to the field of teaching with online courses in information technology (e.g. programming, software engineering) shows that the topic of *gamification* has so far been inadequately explored, with the lack of theoretical and empirical research that would involve gamification methodology. Previous studies have shown that gamification can have a positive impact on the pedagogical and psychological aspects of e-learning. In this paper empirical research is presented regarding the use of gamification in online teaching of programming. A gamified e-course was designed for the lectures in programming, and a possible positive effect was examined on the usage of learning materials in an experimental group of students who will use a gamified e-course (online system).

I. INTRODUCTION

The idea of using an e-learning system with the attributes of a computer game, but without game playing, has been a rapidly growing trend since 2010 [2][5][6]. Recent research on a similar topic of *serious games* confirms a positive attitude of subjects (learners) who used interactive dynamic systems (with an emphasis on learning) like computer simulations (economic, political, military etc.) where a student plays according to a predefined scenario and monitors the outcomes of his/her decisions on goal realization and learning outcomes. For this purpose commercial games can be used, as well as specialized educational games designed for specific fields of study.

The term "gamification" represents the use of elements (mechanics, dynamics and aesthetics) of computer games in the field that is not a computer game [2][5][6]. Gamification as a rising trend has been recognized by many researchers and institutions like *Gartner Research* [8][14][19][24][25].

In 2013 gamification was positioned as a technological innovation whose development should be followed with the exceptional importance (see: [4][9][15]). Previous studies have focused on proving that this approach gives positive results in various fields like business, marketing and education [12][17][20]. A simple search using the scientific literature search engine *Google Scholar* (http://scholar. google.com; February 2017) reveals that in the documents related to the year 2010 the term "gamification" appears only 173 times, while in those for the year 2013 and 2016 it appears 3,780 times and 8,410 times, respectively.

About a decade ago it was demonstrated that the use of elements of computer games can have a positive impact on the psychological characteristics of students and learning behaviour (for instance, see: [22]). A review of literature related to the field of teaching information technology (e.g. programming, software engineering) revealed that, until recently, there have been very few empirical studies related to gamification of respective online courses. Also, it has not been clearly defined what all the elements of computer games are that should be specifically taken into account when designing online courses, as well as how they can be effectively implemented in the (re)design of existing online learning systems.

In our study experimental research methodology will be used. A *traditional* (for the *control* group) and *gamified* (for the *experimental* group) online course will be designed to investigate the influence of the use of elements of computer games on learning outcomes in an online environment.

When creating a gamified online course, according to Iosup and Epema [11], teachers, designers and/or administrators of gamified online courses are expected to ensure at least *one week* for the consideration of the computer game elements which are included in the e-course, and at least *one day* for creating educational content. Furthermore, Iosup and Epema [11] state that it is necessary to set aside at least *two hours* to analyze questions for each teaching unit as well as *two days* for entering the results of each knowledge assessment. Finally, it is important to ensure one week for analysis of the transition to gamification.

II. RESEARCH BACKGROUND

With today's pervasive use of technology in everyday life, there is a growing need for technological advancement in the use of online education that would be based on pedagogical and psychological processes which positively influence the student's perception of the teaching content and their motivation for active participation, research and cooperation [1][6][7]. An earlier example is the use of 3D virtual worlds in online learning where *Second Life* was the most commonly used product.

Second Life enables online connectivity and teaching/training in 3D virtual space with the use of educational methods/metaphors that can be used in many other technological forms in the future.

A turning point for the use of gamification was the "GSummit 2014" conference held in San Francisco with numerous speakers, investors and members of the world's leading companies presenting and seeking gamified solutions

for their products and systems [7]. Another conference entitled "Gamification World Conference 2016" was held in Madrid, Spain, with the presence of the most famous researchers of gamification methodology and technology in the world, such as [3], [13], [16], [26], [29].

According to Souza-Concilio and Pacheco [23], the implementation of elements of computer games is getting more visible in various fields including education, health and fitness, task management, environmental sustainability, science, user generated content and others. About 40 years ago Malone et al. [15] emphasized the need to make learning more interesting. As a confirmation of their claim, it must be noted the value of gamification market had risen to 513 million dollars by 2013, with its value increasing to 980 million dollars in 2014, amounting to as much as 2.8 billion dollars in 2016 [19][27][28].

The importance of gamification can also be illustrated by the recent EU project call in the Horizon 2020 funding scheme (ICT-21-2014) for research of gamification technologies with funding opportunity of eight million euros in total [9]. A more recent call was launched in 2016 for proposals that could be funded with up to one million euros (ICT-24-2016) [10].

The previously presented market value and research funding opportunities indicate the relevance of gamification research. In this paper the authors will focus on the context of online education, especially in the field of informatics and software engineering. Therefore related theoretical and empirical analyses are presented as well as a proposal for standardization of elements of computer games that might come into consideration for implementation with the learning management system (LMS) Moodle.

According to Nielson [18] and Schonfeld [21], the following 24 types of **gamification mechanisms** that are currently recognized and accepted in practice have been most frequently cited in the literature (see *Table 1*).

TABLE 1. MECHANICS AND AESTHETICS IN A GAMIFICATION SYSTEM

Achievements	Bonuses	Countdown	Endless duration of the game
Duties / Challenges	Introduction with the information	Uncertainty / Detection	Levels
Behavioural momentum	"Combo" effect x3	Epic meaning	Loss of aversion
Productivity	Joint collaboration	Surprise	Conscious risk
Ownership	Regular rewarding	Advancement	Optimism
Points	Status	Tasks and challenges	"Addiction" / Commitment to the game

Each element in Table 1 can be categorized according to three attributes: (1) the *mechanics* of a game, (2) *benefits* and (3) *personality*. Mechanics of the game can be divided into *behaviour, feedback* and *promotion*. According to the categorization by Bartle [3], personality can be divided into *winner, wordsmith, collector* and *researcher* subtypes, all of which represent basic types of users or players in a game.

The components of computer games (i.e. *mechanics*) shown in Table 1 are not new. It is the use of information and communication technology to support a more effective and visually attractive creation/application of a game that represents today's novel modality for gamification. In that respect, it should be noted that not all of the *elements* of computer games are appropriate for all *types of players*. However, most of those elements can find some application in business or education systems.

III. RESEARCH HYPOTHESIS

For this research paper only one directional hypothesis is defined:

• **H**: *An online course which is pedagogically designed with the application of the elements of computer games (i.e. gamified) will have a greater effect on the amount of use of online teaching materials in comparison with a course with the same educational content, but without the presence of elements of computer games.*

To confirm the hypothesis H1, first a research of literature was conducted focusing on the topic of *motivation of the participants in gamified online courses* and other related positive effects. The focus was also placed on online courses related to information and communication technologies in higher education institutions. In the *empirical phase* of our research an investigation was performed of the influence of gamification on the use of e-learning materials. In the analysis of empirical data the log report of participants' activities in the Moodle LMS was used for both the *experimental* and the *control* group of subjects.

IV. CURRENT STATE OF THE USE OF ELEMENTS OF COMPUTER GAMES IN E-LEARNING

The research that is presented in this paper began by collecting the views of teachers in two higher education institutions (HEI) from two Central European universities. A total of 43 correctly completed survey forms were collected from the HEI teachers. All of the subjects/respondents used the Moodle LMS in their academic teaching. Their courses were mostly delivered in the second or third year of an undergraduate study.

It must be noted that our survey respondents were not using the customization functionality of the Moodle LMS and their answer to the question "Do you use a special custom graphics template?" was "No" or "We have no choice". Also, most of the respondents (53%) were not familiar with the learning systems of *Khan Academy*, *Duolingo* or similar learning systems. This was not a positive indicator of how broad their knowledge of e-learning was since the aforementioned systems had received prestigious awards as well as introduced some innovative approaches to knowledge transfer via e-learning. Furthermore, in their response to the survey question regarding the use of external links (plugins/functionalities) that can be added into the Moodle LMS system *(Facebook, Twitter, Yahoo, YouTube, Gmail, G-search, Wiki)* as many as 58% of respondents chose the response "none of the above".

Other questions in our survey among academic teachers were related to the mode of presentation of learning materials in an online course. Our survey revealed that the majority of respondents preferred traditional *(offline)* teaching materials, but in their online course material they also frequently used static text that is accompanied with a PowerPoint presentation

or a PDF document/article. In the Moodle LMS system the most widely used functionalities by our respondents were the following:

1. Forum (86%)
2. Achieved current points (67%)
3. Questionnaires (65%)
4. Multimedia (58%)
5. Bonus teaching materials (49%)
6. Editing of profile & avatar (28%)

According to the surveyed teachers, the most frequent activities that their students performed in the LMS environment were:

1. Use of quizzes and assignments (53%)
2. Feedback from students to the professor (53%)
3. Student cooperation on problem solving tasks (26%)
4. Individual voluntary casual tasks (26%)
5. Personalization of user interface (14%)

Most of the teachers agreed that story and motivational elements visible in computer games can have a positive impact on the interest of students regarding the teaching subject. Also, a considerable percent of respondents (49%) stated that they were not familiar with the *flow theory*, which is important in interpretation of *gamification* of e-learning, while only 37% of them replied that they were partially informed about flow theory.

Our survey of teachers at two academic institutions in Croatia revealed that the variety of their implementation of pedagogical elements related to computer games in their e-learning courses was, on average, rather low. As it is previously listed, the most widely used pedagogical features were discussion forums, questionnaires, quizzes, assignments, multimedia, bonus teaching materials, as well as feedback from the instructor to students, and *vice versa*. The surveyed teachers were not familiar with e-learning systems and products for e-learning like *Khan Academy* or *DuoLingo*. It would be of great value to the teachers to be included into an online course covering the possibilities of e-learning and digital networking tools which are more game-oriented.

In the continuation of this paper the authors will try to demonstrate that the use of elements of computer games (i.e. *gamification*) can positively affect the use of teaching and non-teaching material that is available to students within an e-learning system like Moodle.

V. Procedure and Subjects

For the purpose of our study a new installation of Moodle 2.7. LMS was used with additional gamification components. The gamification elements were added in form of plugins because they were not available in the initial version of Moodle 2.7 system. A conceptual model with potentially useful gamification elements was created on the basis of a survey of academic teachers who used e-learning, available plugins for Moodle 2.7 system, and *Octalysis Gamification Framework* [http://yukaichou.com/gamification-examples/octalysis-complete-gamification-framework/]. For the *experimental group* of students a *gamified* e-learning course for teaching computer programming (on the topic "Batch and Stack") was designed in Moodle with the use of selected elements of computer games. Conversely, for the *control group* of students, a traditional *non-gamified* online course was developed in parallel and with equal content in the Moodle system that was located on a separate physical server. The traditional non-gamified course had only three elements that were set besides the educational materials: profile and avatar area, use of forums, and nonlinear access to educational materials.

To complete the development of both e-learning courses (*gamified* and *traditional*), the teaching content and teaching materials of all the basic teaching material that was adapted for this research was standardized (made equal) for both e-learning courses and reduced to HTML text accompanied by pictures or videos. In other words, identical basic educational content and materials were placed in both e-learning systems. Also, the teaching materials and topics that were used *online* in both e-learning courses were *not used* for lecturing in *traditional classroom* face-to-face environments, including exercises in computer laboratories. Students were instructed to use online teaching materials in the gamified and non-gamified course completely alone, without any intervention from the teacher in the physical environment. In this manner, the subjective influence of teachers on students in both the *experimental* and the *control* group was considerably reduced, increasing the credibility and reliability of the experimental procedure. It must especially be noted that the teaching materials used in the course did not differ in its content or in the order in which they were listed the Moodle system. After the two weeks during which the students were involved with the online course materials their log entries were analysed to draw conclusion regarding hypothesis H1.

The subjects in this study were students of an informatics college in the Republic of Croatia. All of the students attended the course "Programming 2" at the undergraduate level of study of informatics in the winter semester of the academic year 2015/2016. The total number of subjects who were voluntary participants in the study was 201. The subjects were divided into two groups: the *experimental* group and the *control* group. Of the total number of subjects, 44 (or 21.9%) were female and 157 (or 87.1%) were of male gender. Their average age was 20 years. Information on our convenience sample of subjects is presented in more detail in *Figure 1*. The permission for students' participation in the study was requested and obtained by the relevant higher education institution authorities.

VI. Results and Discussion

The analysis of the initial written test of prior knowledge (pre-test) in *Table 2* provides insight into the distribution of the subjects/respondents in the *control* and *experimental* group. The data presented in *Table 2* indicate that there was no statistically significant difference between the *experimental* (G_E) and the *control* (G_K) group regarding the results of *prior knowledge* testing (pretest). The value of the *t-test* was 0.57, with $p>0.56$. Also, there was only a slight difference between the mean results of the two groups (about 5% of the standard deviation). It can be concluded that the two groups were suitable for performing the subsequent experimental research procedure.

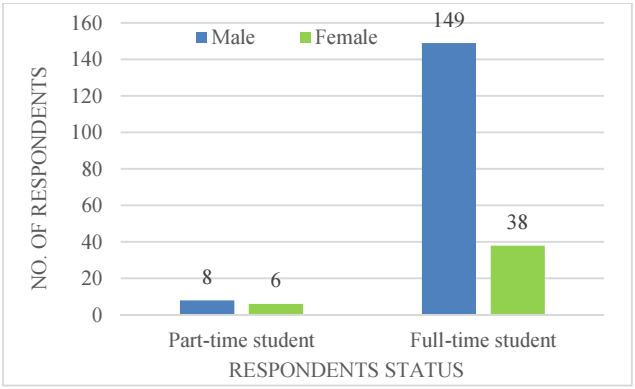

FIGURE 1. STATUS OF THE COURSE RESPONDENTS

TABLE 2. TESTING OF THE STATISTICAL SIGNIFICANCE OF DIFFERENCE IN *PRIOR KNOWLEDGE* (PRETEST RESULTS) BETWEEN EXPERIMENTAL (G_E; N=99) AND CONTROL (G_K; N=102) GROUP

Group	N	Mean	SD	t	p
G_E	99	15.57	4.17	0.57	0.5658
G_K	102	15.25	3.72		

In the continuation of this paper a report is presented on student activities that was generated based on the log entries from the Moodle system. This represents the final part of our data analysis which will enable the confirmation or rejection of our research hypothesis H1.

TABLE 3. REPORT ON THE NUMBER OF REGISTERED ACTIVITY INSTANCES (LOG ENTRIES) IN THE MOODLE SYSTEM FOR *EXPERIMENTAL* (N=88) AND *CONTROL* (N=102) GROUP OF STUDENTS

Activity name	Sum	Mean	
Learning outcomes	342	3.89	**Activity of the *experimental* group**
Forum	1214	13.80	
List of terms	838	9.52	
Learning outcomes	41	0.40	**Activity of the *control* group**
Forum	252	2.47	
List of terms	22	0.22	

* Mean is calculated as Sum/N

Table 3 provides a list of activities that were accessed by students within the *gamified* and *non-gamified* online course. For the *experimental* group of students, the average number of 9.07 access attempts was registered in log entries for all of the activities listed in *Table 3*, while for the students in the *control* group the average number of registered instances of access was only 1.03. The results in *Table 3* indicate a significant difference in favor of the *experimental* group. It can be concluded that the *experimental* group showed a much greater average interest in the available activities in the online course such as "Forum" (5.6 times greater), "Learning outcomes" (9.7 times greater) and "List of terms" (43.3 times greater).

TABLE 4. COMPARISON OF THE FREQUENCY OF ONLINE ACCESS TO BASIC EDUCATIONAL AND BONUS MATERIALS REGARDING THE LEARNING MATERIAL OF THE GENERAL E-COURSE TOPIC "BATCH AND STACK"

	Experimental group		Control group	
Activity name (learning content and bonus materials)	**Sum**	**Mean**	**Sum**	**Mean**
Teaching section 1a: Batch	430	4.89	184	1.8
Teaching section 2a: Charging and implementation of piles using fields	391	4.44	135	1.32
Teaching section 3a: Deleting a root and implementation of piles using integer fields	358	4.07	94	0.92
Teaching section 4a: Charging stacks	359	4.08	84	0.82
Teaching section 5a: Sequential deletion root piles (Heap Sort)	354	4.02	71	0.70
Bonus teaching content: Old and new names of standard C++ library	301	3.42	64	0.63
Teaching section 1b: Stack	251	2.85	108	1.06
Teaching section 2b: Adding (PUSH), reading and deleting the top of the stack (POP)	236	2.68	77	0.75
Teaching section 3b: Print whole and therefore deallocation	234	2.66	76	0.75
Bonus teaching content: The relationship between C and C ++	159	1.81	72	0.71
Total sum for all activities	**3073**	**34.92**	**965**	**9.46**

In case of this research, bonus learning materials were present in both e-courses. *Table 4* shows the access frequency / number of instances of access to course materials by respondents in the *experimental* and the *control* group with regard to *core learning content* and *bonus materials*. The *experimental* group of respondents used both the basic *teaching materials* and *bonus materials* which were added to the course to motivate students for additional learning and to access content more frequently. It can be seen in *Table 4* that the *experimental* group of respondents accessed the teaching and bonus materials on 34.92 occasions on average, while the same kind of materials were accessed by the *control* group only on 9.46 occasions on average. Therefore, it can be calculated that regarding the data in *Table 4* the summative indicators of frequency of access to all of the listed learning activities and bonus materials were 3.69 times higher in favor of the *experimental* group of respondents. In other words, the students of the *experimental* group, who were involved with the *gamified* e-course, used learning and bonus materials *3.69*

times more often than the *control* group, which was involved in the use of the conventional *non-gamified* e-course.

The data presented in *Figure 2* demonstrate that the *experimental* group of respondents had continuous access to learning materials with decreased motivation in subsequent topics and learning activities (also see *Table 4*) as the e-course was approaching its end. A similar trend in accessing learning materials is visible for the *control* group of respondents, but to a somewhat lesser extent. It must be emphasized that, at one moment, the *experimental* group of respondents had nearly 5 times higher access frequency to teaching materials in comparison to the *control* group, which is a substantial indicator of the effect of gamification on student activity and motivation in e-learning.

However, it must be noted that some of the results of comparison presented in *Figure 2* could be attributed to the greater visual quality of the *gamified* e-course, which had a more appealing appearance to the *experimental* group of respondents. Still, in other aspects the core learning materials for both the *experimental* and the *control* group were almost identical.

From the indicators that are presented in *Table 3* and *Table 4* as well as in *Figure 2*, it can be concluded that the *experimental* group of respondents, which used the gamified version of the online course in computer programming (on the topic "Batch and Stack"), had a significantly greater motivation to access and use the online learning material, which is visible by the analysis of the registered log entries.

In fact, the experimental group had a greater frequency of access within the Moodle e-course to all available teaching, non-teaching and bonus materials. The conclusion is that hypothesis H1 is confirmed and that *an online course which is pedagogically designed with the application of elements of computer games (i.e. gamified) will have a greater effect on the amount of use of online teaching materials in comparison with a course with the same educational content, but without the presence of the elements of computer games.*

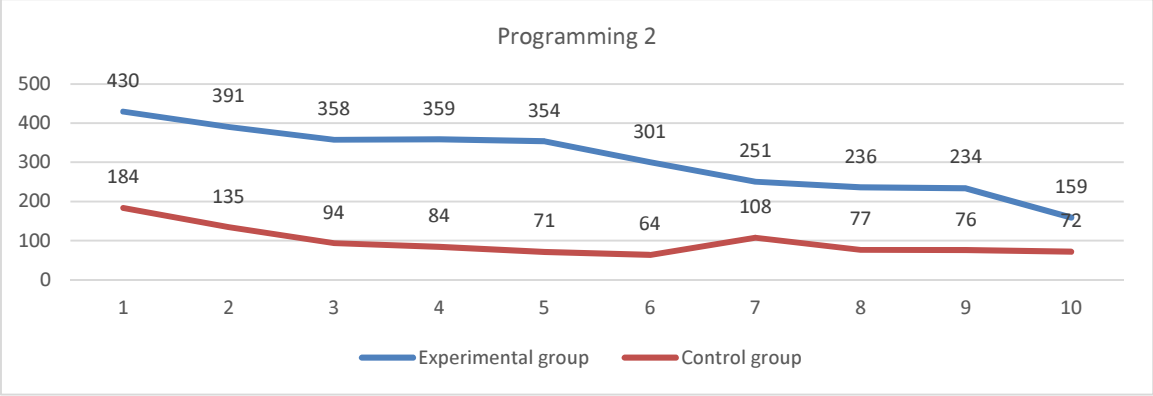

FIGURE 2. FREQUENCY OF ACCESSING EDUCATIONAL MATERIALS IN 10 SUBSEQUENT COURSE TOPICS (LISTED IN TABLE 4) FOR EXPERIMENTAL AND CONTROL GROUP

VII. CONCLUSION

Use of the elements of computer games (*gamification*) can be a meaningful way to increase student motivation and improve the educational effectiveness of online courses. The authors of this study conclude that the pedagogical design based on *gamification* places greater emphasis on student motivation in the learning process and makes an online course more interesting, as well as increases students' willingness to learn and their engagement with course materials.

In our study an *experimental research procedure* was used since two separate and equivalent groups of students were engaged in learning equal core learning material in two pedagogically different online learning environments.

At the beginning of our empirical procedure, the *experimental* and the *control* group of students were subjected to a written test of prior knowledge. Based on these results (average number of points) the students were assigned to either the experimental or the control group. Since the 'Programming 2' course has a total of 14 groups in computer labs, seven of them were treated as *control* and the other seven as *experimental* study groups. Online learning materials related to the topic "Batch and Stack" were created within the 'Programming 2' course with a total of 10 subtopics with teaching and bonus materials which were available to students for a period of 14 days.

The hypotheses H1 for our study stated the following: *An online course which is pedagogically designed with the application of elements of computer games (i.e. gamified) will have a greater effect on the amount of use of online teaching materials in comparison with a course with the same educational content, but without the presence of elements of computer games.*

In the central empirical part of our study it was confirmed that the e-learning course which is designed by applying elements of computer games (i.e. *gamified*) can have a positive effect resulting in greater frequency of use of teaching materials compared to the course with the same educational content, but without the presence of elements of computer games. Therefore, the hypotheses H1 was confirmed. This is clearly evident in the graphical analysis of objective indicators of online activity of *experimental* and *control* group of subjects regarding their frequency of access to learning materials placed in the Moodle system (see *Figure 2*).

The main contribution of this paper is related to the verification of the hypothesis that gamification can lead to greater usage of the gamified e-course educational materials measured by objective indicators that are present within the Moodle system in terms of participants' activity logs.

LIMITATIONS

The main limitations of our study are related to the following:

• **Students' obligations.** Our research was conducted during regular classes at the higher education institution. In addition to having to use the experimental e-learning system, students had obligations in other courses. It is important to emphasize that participation was voluntary. Conducting the experiment was planned at a time when students did not have a mid-term or final exam. Individual tasks and obligations at the level of the study program could not be included in the analysis of each student workload, but it is highly possible that students had other obligations related to other courses during the use of the experimental system.

• **Time period of the use of online courses.** Research activities for each course were planned with particular regard to the academic syllabus and other educational assignments. It was decided that the measurement should be carried out in a short time-period during the two to three weeks after the students had gained access to learning materials in the online courses that were designed for the experiment.

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