

Computer Game Elements and its Impact on Higher Education

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Abstract: This review paper analyses authors who used gamified e-learning systems in higher education. Their thoughts, problems and conclusions are accompanied and observed. Positive guidelines are provided for the inclusion of computer game elements in the education system. Review paper includes a comparison of the gamified and traditional education system with an incentive to conduct further research activities. The list of researchers is provided who had experiments on students in the higher education system. Duration of those experiments is shown as well as the number of used game elements for their gamified systems. The list of survey questions for teaching staff (N=98) is provided as well as their thoughts on gamified systems and its use. The conclusions are that it is necessary to pay attention to the visual appearance and environment in which teaching materials are presented and studied.

Keywords: e-learning; game elements; gamification; higher education; teachers

1 INTRODUCTION

This article lists the authors of papers from gamified e-learning systems, and their research that is accompanied by observed problems and conclusions. Positive guidelines are provided for the inclusion of computer game elements in the education system. Manuscript concludes with a comparison of gamified and traditional education systems with an incentive to conduct further research activities. There are several keywords that should be familiar to the reader such as gamification, e-learning, game elements and flow theory. Strmecki et al. [1] explains that gamification is not so new trend of including video game elements into non-game environment such as education systems. Bernik et al. [2] examines best video game elements for implementation into e-learning systems such as score, feedback loops, collaborations, badges, levels, etc. Most of them are available within Moodle CMS system and are free to use. Furthermore, Bernik et al. [3] states that E-learning represents digital (both synchronous and asynchronous) approach where teaching and tutoring materials are online and users are connected with internet connection. If the E-learning system is designed correctly, the student creates a sense of comfort that can lead to a state of flow in which the learning process is optimal. This is one of the conclusion by Bernik [4] within the manuscript where gamification framework was described.

2 RESEARCH OVERVIEW

Landers and Callan [5] explore techniques for motivating students through the development of a one-semester educational social network. The study included 385 students who accepted an invitation sent via e-mail. Introduction to the aim and purpose of the research was conducted through a five-minute lecture. Landers and Callan have included in their e-learning system, in addition to teaching materials, the possibility of using a profile picture and posting public announcements about own achievements. The system supports asynchronous communication as well as badge and certificate assignment. Their system contained several knowledge tests with closed-ended questions for which certificates were awarded. The knowledge test

contained 10 questions for the answers of which the student had 10 minutes. Access to the knowledge test was provided every four days. Particularly interesting in their approach is the mentoring system, which, based on the certificate, enables the pairing of students with regard to individual achievements and learning needs. A student who has difficulties mastering a teaching unit may request the assistance of a proposed student who has successfully mastered a certain teaching activity and justified knowledge through the previously mentioned 10-minute knowledge test. Landers and Callan point out that at the end of the study, 113 out of a total of 385 students had won a total of 546 certificates. They also point out that internal (university) social networks can have a positive effect on student motivation. Rewarding students should be explicit and recognized in the social network, because the clearer the reward and the more valuable it is to students, the greater the motivation. The reward should be matched to the difficulty of the desired activity or knowledge test. Difficulty should be built gradually. Feedback for activities and knowledge tests should be current. It is necessary to pay attention to visual appearance and the environment in which the teaching materials are studied. Muntean [6] links the state of flow with the research of B. J. Fogg who proposed the so-called Fogg's Behavior Model, which is based on (a) motivation, (b) abilities and (c) drivers of certain activities. According to Muntean, motivation can be caused by feelings of comfort or pain, fear or hope, and social status, which can be acceptance or rejection. If a student has a high level of motivation, but lacks a certain level of ability, a change in behavior and / or an effective learning process will not be achieved. In addition to the above, it is necessary to include the triggers of certain activities, i.e. elements that suggest the student to do a certain activity at a certain time. Triggers can be simple signalling, all the way to a narrator who reacts at a crucial moment and directs student's activity. A pre-requisite for this is the level of education of a student in which a student is able to recognize, learn and reason based on the information presented. The state that occurs when all three elements are activated is called the flow state. It is pointed out that there is a problem in working with an e-course when conveying stimulus or emotion that is present in the interaction between

a teacher and a student. It is for this reason that e-learning systems need to be expanded with technological solutions that affect motivation and encourage students to engage in teaching activities.

The elements of mechanics from computer games that can be used to stimulate intrinsic motivation (IM) are listed as follows: Points (IM: Status, Achievement, Competition, Altruism), Levels (IM: Achievement, Competition), Challenges (IM: Rewarding, Status, Exploration, Competition, Altruism), Virtual currency (IM: Rewarding, Status, Achievement, Competition), Top list (IM: Status, Achievement, Altruism), Gifting (IM: Status, Achievement, Competition).

Muntean states that for the correct gamification of e-learning it is necessary to gradually discover teaching content, and put emphasis on repetition, practice, and knowledge testing. For correct solutions, a student needs to be provided with points. The goal to be achieved by gamifying e-learning is to ensure higher motivation among students as well as the involvement of students in teaching activities that are available in a gamified system. Muntean states that if students stay in the system longer, it is very likely that they will achieve a better result on the knowledge test. As a result, students will master teaching activities in the future faster with better results. In traditional e-learning systems, a teacher, administrator, or e-course designer should include some of the following elements of computer games: avatar, notification, separate chapters, and separate teaching levels. It is concluded that a student, after mastering certain teaching units, progresses to higher teaching levels where the process of mastering new teaching units is repeated with difficulty corrections of repetitive tasks and the correction of abstraction of teaching materials.

The e-course should reward students not only for their academic achievements, but also for a certain type of behavior, such as helping and communicating with other e-course participants. In addition, it is important to ensure that students know what their responsibilities are and what awaits them in the next course. In addition, it is important to create a sense of surprise and anticipation in order to influence motivation of the participants at the time of discovering new elements of the gamified system. Barata et al. [7, 8] conducted the research for two years. Elements of computer games (points, levels, top lists, challenges, and badges) are included in the Moodle system with the aim of positively influencing the interest of higher education students. The research was focused on motivation and learning outcomes, but due to the duration, there are significant differences in the implementation of the experiment: unequal number of respondents in groups, unequal teaching materials, and unequal conditions in which classes were held. The result of the research was a greater interest of students for lectures and for participation in the e-course, proactivity, and greater use of teaching materials. Barata et al. state that the research does not show a direct impact of motivating elements of computer games on the achieved course grades, and that is suggested for future consideration and additional research.

Jayasinghe and Dharmaratne [9] explore learning through educational computer games and learning through elements of computer games without the presence of a game in the field of programming. The research was conducted on

60 students who previously had no education in the field of programming, more precisely program-sorting algorithms. The experiment lasted 60 minutes and contained points and feedback on the correct answers that the students received. Students were divided into 4 groups of 15 respondents. Two groups were experimental, while the other two were control. The statistical significance of point difference between the groups was not calculated, but the groups were divided according to previously obtained grades in mathematics. The sorting algorithms used in the research were sorting by replacing adjacent elements (Bubble sort) and segmental sorting (Bucket sort).

The results of the study show that both of their experimental groups had higher average scores. In the case of sorting by replacing adjacent elements, the average score of both experimental groups was 21.3% higher compared to both control groups. In the case of segmental sorting, the average result in both experimental groups was 25.3% higher compared to both control groups. In addition to average points, the time in which students studied teaching materials in the field of programming was also measured. The conclusion is that both experimental groups mastered teaching materials in almost twice less time than both control groups of respondents, which concluded the research.

Ortega-de-Marcos et al. [10] developed a gamified add-on for Black Board LMS system that allowed tracking teaching activities of a total of 371 students, as well as mutual collaboration, but also competition. Teaching activities are related to four areas: word processing, spreadsheets, presentations, and databases. Each activity was presented as a challenge and was divided into several levels to help students achieve a sense of progress. The e-course was open to students for one semester. It was active 6-10 hours a week. After each level, a student is awarded a badge in the form of a trophy. Several badges were hidden to keep students surprised and further motivated. In the research, collaboration and sharing of achievements was ensured in the form of a forum. In addition to a gamified supplement for monitoring teaching activities, a web platform was developed that provided students with access to video materials and blogs. Students were able to follow other users through the so-called follow function. Students had the opportunity to post short messages, mark agreement with other people's opinions through a like function, as well as commenting on other activities.

The research uses three research groups, where the first group (consisting of 114 respondents) was exposed to a gamified e-course, the second group (consisting of 184 respondents) was exposed to a social network, and the third group (consisting of 73 respondents) was a control group which used a classic e-course. The experiment was conducted during 2012. The place of research were various university centres depending on the group of students. de-Marcos et al. used a pre-test and post-test methods to test student knowledge and a survey questionnaire (consisting of 10 questions) that was presented only to the first and second groups of respondents.

A pre-test was used to test knowledge between all three groups. The results of the pre-test indicate that there was no statistically significant difference between the groups. Based on the post-test knowledge test, it was determined that both

experimental groups achieved better results in the practical part of the knowledge test compared to the control group in all four teaching units (word processing, spreadsheets, presentation, and data bases). The group that used social networks achieved better results in the first two teaching units (word processing, spreadsheets) compared to the group that used a gamified supplement within the Black Board environment. Other results did not differ statistically.

Interestingly, control group students scored better than both experimental groups in terms of written knowledge testing, where the group that used social media scored better than the group that used the gamified supplement. Within the written test, all three results provide a statistically significant difference. It is concluded that both experimental groups place more emphasis on practical skills, where theoretical knowledge is neglected. The authors (de Marcos) [10] noted a problem where both experimental groups showed very little interest in teaching materials. Approximately 20% of students actively participated in this research, which puts emphasis on the design of the research. It is necessary to repeat this research, which would focus on the social component instead of achievements, badges, and competition.

Iosup and Epema [11] created two courses that were conducted over four semesters on over 450 students. In addition, gamification is considered as a set of tools that can influence the motivation and behavior of users. The researchers list seven gamification elements that are divided into two categories: mechanics and dynamics. Mechanics defines how a game functions as a system, while dynamics defines the interaction of a game and a user. Within the mechanics of computer games are points, levels, and scales of success. Within the dynamics of computer games, badges, an explanation for beginners, social loops and gradual unlocking of content are included. It was observed that over 75% of students passed the knowledge test in the first exam period. A positive correlation was also observed between students who passed the knowledge and satisfaction test attributed to the gamified elements. It was observed that almost 100% of students accessed bonus teaching materials even though those materials did not score for the overall grade. Students who have not successfully passed the knowledge test retake the test in 90% of cases. Students who have passed the knowledge test reapproach the test in 5% of cases with an aim of achieving even better result.

Laskowski and Badurowicz [12] conduct research within the first year of graduate study lasting one semester. The sample of respondents consists of 62 students who are divided into four groups. Two groups are experimental, while two are control. The experimental groups were in a system that assigns points and badges to participants for achievements and allows for a ranking scale. When analyzing the results, at the end of the semester, the following indicators were taken into account: the number of attendances at regular classes, the number of completed assignments, the average grade and similar information such as homework and project assignments collected during the semester. The aim was to examine the impact of using elements of computer games, without the presence of a game, on student motivation. The results of the research show that the experimental groups of respondents have a higher rate of attendance at classes (97%)

compared to the control groups of respondents (85%) as well as the number of solved individual tasks (1.7) compared to the control groups of respondents (1.37). However, the average grade at the end of the semester in the experimental group is 3.83 out of 5, while in the control group it is 4.53 out of 5. Laskowski and Badurowicz [12] confirm that gamification can be used to motivate students but cannot find a link between higher grades in the control group of respondents and lower attendance at teaching activities. They conclude the research with a remark that the research should be repeated with a larger number of respondents, with a pre-test and post-test of knowledge.

González and Carreño [13] research which elements of computer games can be used in traditional education, e-learning and hybrid learning in terms of student involvement in educational process. González and Carreño cite Werbach's 6D model as well as the individual elements of dynamics, mechanics, and aesthetics used within this paper. The sample used in the research numbers 100 third-year undergraduate students of computer engineering. The research activities were conducted for a total of four weeks. The research methodology is reduced to observation method, interview method and a survey questionnaire. All three instruments were taken from other researchers. For research purposes, they create their own platform within which points, ranking scale, user groups, avatars, virtual objects, etc. are implemented. Moodle platform was rejected because it did not meet the software architecture of the server used in the research. There are no more detailed explanations for rejecting the Moodle platform. They conclude that gamification or elements of computer games without the presence of the game itself can satisfy basic human desires or needs such as: identity, reward, achievement, competition, collaboration, self-expression, and altruism. Students showed how these elements are important to them in everyday life as well as in the virtual environment in which they are presented with teaching materials. The social component is particularly important, distinguishing between cooperation and competition as well as independent and teamwork. In addition, gamified solutions encourage students to a higher level of involvement whether it is formal or nonformal education, due to a phenomenon that is described as a state of flow.

Stokes [14] warns that the education system, in its present form, operates on the principle of a kind of "deduction of points" given the number of mistakes. A student must not make mistakes, which leads to stress and additional pressure, which negatively affects his/her motivation. The education system should recognize the degree of motivation and guide students on the right path through the elements of computer games. Deterding [15] points out that elements of computer games directly affect motivation and a sense of inclusion, which is widely used by marketing companies and employees working in the field of human resources. Ortega de-Marcos et al. [10] confirm a positive attitude and better motivation of respondents, with the achievement of better learning outcomes during the presence of elements of social networks in the educational system. Hamari et al. [16, 17, 18] come to a conclusion that confirms the research of Deterding and partly the research of de-Marco et al. Within academic education, researchers

Smole, Diniz and Milani [19] announce that in working with elements of computer games. Students can learn and develop their self-confidence in various ways, such as interaction and collaboration, critical and problem-oriented thinking, self-analysis of work and activities, and current feedback on success or failure, where failure is approached as a basis for new guidance and learning.

Dicheva et al., [20] within the FP7 project, investigate which teaching content can gamification be applied to, and which are the most commonly used elements of computer games in the education system. The analysis by Dichev et al. includes 34 empirical papers found within some of the leading scientific databases (ACM Digital Library, IEEE Xplore, ScienceDirect, SCOPUS, Springer Link, ERIC, and Google Scholar). Dicheva et al. state that points, badges, levels, rankings, progress status, virtual currencies and avatar are the most used computer game mechanisms used in the education system, of which points, badges, levels, and top rankings are much more common elements than the others are. The design of a gamified system is based on visual status, social inclusion, and social media, as well as freedom of choice, a positive approach to failed attempts and constant feedback.

The educational style that is most covered within the above 34 empirical papers refer to Blended Learning Courses. In second place are courses with or without online support, in third place are massive open online courses (MOOC), followed by educational websites, and gamified customer support platforms. In addition to the above, the most frequently covered educational areas are computer science and IT, computer game programming and STEM areas.

In addition, it is stated that clear indicators explaining the impact of computer game elements on motivation are still lacking. There are no reports on the sensitivity of computer game elements and the implementation of practical educational gamified solutions. There are no reports on the need for teachers to effectively conduct, monitor and evaluate students within the gamification approach. There is also a negative experience in which students were not ready for autonomy, and the project approach was not taken seriously enough, as was the approach to knowledge testing, which concludes the paper.

Schreuders and Butterfield [21] explore opportunities to increase student involvement in the teaching process and increase motivation, and to improve the experience that students have when going through the educational process. The research was conducted within the university course on computer security. The research lasted two years and involved 32 students. For the purposes of the research, a special open source software solution was created that ensured the transparency of points, the allocation of various points for student activities as well as providing feedback on the success of student activities.

The results of the research indicate positive indicators in terms of qualitative and quantitative results in knowledge tests. There was an increase in the satisfaction that students had when going through the educational process, but the results were not statistically significant. It is concluded that the research, despite the small number of respondents, is in line with other research that speaks about the positive effects

of gamification on increasing motivation and improving the experience that students have when using e-learning systems. Further research is needed to make the higher education system more receptive to computer game elements at all levels.

The conclusions that can be summarized from these studies are that it is necessary to pay attention to visual appearance and environment in which teaching materials are presented and studied, and that gamified systems could include avatars, news reminders, separate teaching units as well as separate teaching levels. These mechanisms will be taken into account when selecting elements of computer games to be included in the gamified pre-study system as well as in the first and second main surveys. The problem observed in the research of de-Marcos et al., in which the experimental groups of respondents showed very little interest in teaching materials and where approximately 20% of students actively participated in the study, will be particularly monitored in this study in order to avoid repeating the same. Also, the seven elements of computer games (points, levels, success scale, badges, explanation for a beginner, social loops, and gradual unlocking of content) that Iosup and Epema list, were considered for inclusion in the gamified system, along with other elements described in Bernik [4], with the aim of confirming the results cited by Iosup and Epema [11].

Special emphasis will be placed on the situation seen in Laskowski and Badurowicz [12], where the control groups of respondents at the end of a semester achieved higher average grades than the experimental groups of respondents, where the control groups of respondents had lower attendance at teaching activities. Laskowski and Badurowicz [12] could not explain such a result and emphasize that the research should be repeated with a larger number of respondents, which was done in Bernik [4] with a significantly larger number of respondents (309 in total) and a larger number of included computer game elements (24 in total)

3 DISCUSSION: IMPACT OF VIDEO GAMES ON TEACHERS

Parreno et al. [22] investigate the impact of the use of computer game elements, without the presence of the game, on teachers and list the following series of issues that are analysed through their research:

- 1) Do teachers in higher education show a positive attitude towards gamification?
- 2) Do teachers in higher education use gamification in their courses?
- 3) Does gender influence teachers' attitudes regarding the application of gamification in higher education?
- 4) Does gender of teachers affect the very application of gamification in higher education?
- 5) Does age affect teachers' attitudes regarding the application of gamification in higher education?
- 6) Does age of teachers affect the very application of gamification in higher education?
- 7) Does the type of educational institution influence the attitudes of teachers regarding the application of gamification in higher education?
- 8) Does the type of educational institution affect the application of gamification in higher education?

The research was conducted through an online survey, and the teachers were encouraged to forward the survey to their colleagues via a web link. A total of 98 teachers participated, with an average age of 44 years. In the sample, 56.25% of teachers were males.

Research shows that teachers who participated in the research (Q1 and Q2) had a positive attitude regarding the use of gamification in teaching, but only 18 out of a total of 98 teachers (11.30%) apply gamification in practice. The result is expected given that the term is quite new and insufficiently documented in the professional and scientific literature.

The answer was also negative to the third question: "Does age affect teachers' attitudes regarding the application of gamification in higher education?", as well as to the fourth question: "Does the gender of teachers affect the very application of gamification in higher education?" Gender does not affect attitudes regarding gamification as well as the application itself. The answers are based on the analysis and calculation of a t-test in which there was no statistically significant difference between participants.

Regarding the fifth question: "Does age affect the attitudes of teachers about the application of gamification in higher education?" As well as to the sixth question: "Does the gender of teachers affect the very application of gamification in higher education?", the answer was negative. Age is not related to attitudes or the application of gamification. In the analysis, the authors did not find a significant positive correlation regarding respondents' age.

Regarding the seventh question: "Does the type of educational institution influence the attitudes of teachers regarding the application of gamification in higher education?", the answer was positive. It has been shown that teachers of private higher education institutions have a more positive attitude towards the application of gamification, in contrast to teachers of public higher education institutions. Regarding the eighth question: "Does the type of educational institution affect the application of gamification in higher education?", the answer was negative. The results indicate the absence of statistically significant differences in responses between private and public educational institutions.

It is stated that there is a positive impact of the use of computer game elements on teachers of higher education institutions, but the application of this approach in practice is missing. Only 11.30% of respondents used gamification methods or educational computer games in their work environment. It is concluded that the age, gender, and type of educational institution do not statistically significantly affect the attitudes of teachers. The main problems that teachers face are related to information and communication technology and IT solutions that exist in a particular work environment, as well as the possibility of proper and timely teacher education. This is due to the lack of time for education and the lack of financial resources. Additional research in this area is suggested.

Good to mention is the relationships between the most common mechanisms of computer games and players

(system users) that serve teachers, designers and / or administrators of gamified education systems as recommendations in the planning phase. This topic mentions the types of players where the division cited by Richard Bartle is most used [23, 24]. If users are accessed through the Bartle matrix, then there are four groups of players to which system users can belong, and these are Winner, Collector, Socialite, and Explorer. It is necessary to know that not every one of the listed players is interested in every activity that is in the system, and accordingly, one should take care of mechanisms of computer games that are built into the educational system.

4 CONCLUSION

This paper presents a number of studies that include research of the higher education population in an online or offline environment. Guidelines are provided on how teaching staff should adapt their teaching material. Teachers should ensure the use of badges and points and enable the realization of certain achievements and the display of status. It is advisable to use a leader board, but also a top list of the top scoring students. Feedback to students must be available at all times. It is also useful to include occasional virtual meetings in the e-course to get students back into the system independent of the teaching materials. The gamified system should be as socially oriented as possible. Sociability is important for the type of players seeking recognition from other e-course participants. It is good to include in the e-course additional teaching and non-teaching elements (bonus) that are made available to students in special circumstances. The reward should be aligned with activity difficulty and activity difficulty should be built gradually.

An average teacher, who uses elements of computer games in educational process, should have advanced knowledge of computer tools for managing elements of computer games, especially if working with large groups of students. It takes a lot of energy to explain a new system to students, as well as getting approval from an organization that is used to working differently. An additional obstacle may be the lack of technical support of a higher education institution, which is not offered until the stated approach shows positive results in a certain situation and is accepted by a larger number of teachers.

When creating a gamified e-course, teachers, designers and / or administrators of gamified education systems should provide a minimum of one week for reviewing the elements of computer games included in the e-course, and one day for creating teaching materials of one teaching unit. It is necessary to set aside two hours for question analysis for one teaching unit, two days for entering the results of each knowledge test, and one week for pass rate analysis. Educational systems supported by elements of computer games will be increasingly used in the years to come due to the growing number of researchers and users of gamification around the world, especially considering the situation with the global health situation. Limitations of this study lies within one STEM field. It would be interesting to see how gamification could enhance similar university courses.

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