

# STUDENTS' ACCEPTANCE OF GAMIFICATION IN SECONDARY SCHOOL COMPUTER SCIENCE CLASSES

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## Abstract

One of the increasingly used approaches in education that addresses the problem of lack of student engagement and motivation during the learning process is gamification.

The concept of gamification is usually described as the application of game elements and principles of game design in a non-game context. The application of gamification is not about designing a serious digital game or incorporating existing games into the learning and teaching process, but about gamifying activities in which students participate using game-based elements. This includes elements such as avatars, badges, virtual points, and levels that can be easily implemented with simple digital tools or in learning management systems. Although elements of gamification can be introduced into the teaching process without digital tools, advances in technology have facilitated the broader application of gamification in education.

Gamification can be used in a variety of contexts and at different levels of education. The application of gamification elements increases student motivation and active participation in the learning process and, in turn, the achievement of learning outcomes. Gamification elements can be used in a traditional learning environment (face-to-face learning), but also in online learning or in hybrid learning that combines face-to-face and online learning. Due to the COVID -19 pandemic, it is especially important to introduce innovative approaches to online and hybrid learning models to address the lack of student engagement and motivation. Gamification can also be used at different levels of education: in elementary schools, secondary schools, higher education, and lifelong learning programs. Although one might expect game elements to be used more often in activities for younger students, analysis of the literature shows that gamification is being introduced to a much greater extent in higher education than in elementary and secondary education.

This paper presents the results of a study of student acceptance of gamification in secondary computer science classes. Students used Kahoot! quizzes, Escape Room games, Moodle quizzes and games. The study aims to contribute to the field by highlighting the need to understand how students perceive gamified activities, as this can help teachers in their attempts to design effective gamification. According to the results of the questionnaire, students were very satisfied with the use of different game elements such as points, badges, leaderboards, and stories.

The presented study is the first step in developing a more comprehensive model for designing gamified activities in secondary education to improve the quality of teaching and students' motivation.

Keywords: Gamification, game-based elements, digital tools, secondary education, student motivation.

## 1 INTRODUCTION

Today's students are often referred to as members of the so-called "digital generations" or "Generation Z" because they are growing up with a new digital technology such as computers and the Internet, smartphones, and video games [1]. They are characterized by rapid information processing and multitasking in their learning process. Thus, Generation Z is able to use different learning tools and play video games at the same time. These characteristics should be taken into account in the educational process by using Game Based Learning (GBL), Serious Games and Gamification among other modern approaches and digital technologies ([2], [3]).

The goal of gamification in education is to increase the interest and motivation of students and to involve them more intensively in the teaching process [4]. Gamification can include the use of various game design elements such as avatars, points, virtual badges, levels, leaderboards, etc. ([5], [6]).

While it is important to motivate students in classroom or face-to-face (f2f) instructional models, it is even more important to motivate students in online or hybrid instructional models. Nowadays, online

and hybrid models are increasingly needed and used due to the COVID-19 pandemic [7]. Furthermore, the importance of gamification is increasingly emphasized. Although gamification can be used in education at different levels, from elementary and secondary schools to universities and lifelong learning programs, the analysis of literature on the use of gamification has shown that it is more present in higher education and less in elementary and secondary schools ([5], [8]).

Since there is a paucity of data on gamification in schools, this work was primarily conducted to address the lack of scientific data and to present new important data on gamification in secondary schools. Secondly, this paper aims to determine the acceptance of gamification in secondary school computer science classes. Finally, gamification tools such as Kahoot! quizzes, Escape Room games, Moodle quizzes and games, and game elements such as points, badges, leaderboards, and stories will be evaluated.

In summary, the main contributions of this paper are to determine: 1 - what students' attitudes are towards the use of gamification in computer science courses; 2 - which of the digital tools and gamification elements are most motivating to students. This research will be continued within the scientific project "Digital games in the context of learning, teaching and promoting inclusive education" (Degames), so the possibilities of using gamification in schools will be further explored to support teachers in their attempts to design effective gamification.

## 2 METHODOLOGY

The purpose of this study is to determine the level of student satisfaction with the use of gamification in teaching. The research focuses on the implementation of gamification in computer science teaching at secondary level. For this purpose, some digital tools and game-based elements are included in the computer science course curriculum.

The research methodology is based on a quantitative research method supported with a questionnaire among secondary school students.

In order to investigate the students' acceptance of gamification, the following research questions (RQ) were explored:

- RQ1. What are the students' attitudes toward the use of gamification in computer science education?
- RQ2. Which of the digital tools and game-based elements used were most motivating to students?

### 2.1 Study design and procedure

The intervention took place on a sample of 62 secondary school freshman. The study was conducted for 8 weeks on students aged 14-16 years in three different classes at the Civil Engineering Technical School, Rijeka. These classes covered three different fields of study: Architectural Technician, Civil Technician, and Geodesist.

Gamification was implemented in the form of face-to-face classes, according to the curriculum, and through various online platforms such as Kahoot! [9], Escape Room games [10], and Moodle (called Loomen) in Croatian schools [11].

The first topic of the curriculum was computer science fundamentals, and students had the opportunity after the lesson to take a gamification test on the Loomen platform (Fig. 1) instead of the usual textbook test. This test was formative assessed, which means that the results of the test were not included in the official school report.

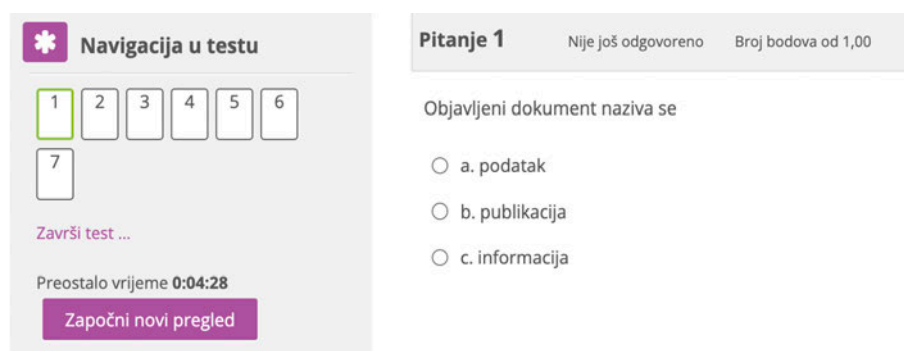


Figure 1. Quiz on the platform Loomen.

Due to the very positive atmosphere and the students' desire to use more frequent game-based activities, new activities were created on the Loomen platform [11]. The Millionaire quiz game (also known as TV show, in which participants have to answer 15 questions) was created on the Loomen platform (Fig. 2). The quiz included topics about storage media. Instead of answering textbook questions, students had the opportunity to play the online quiz to answer the questions quickly but accurately. Unlike previous activities that served for formative purposes, the goal of this game was to test students' knowledge in a more modern and fun way, but for summative purposes as an assessment of what they had learned. Depending on the number of questions answered correctly, the student is assigned a grade in the official school record.

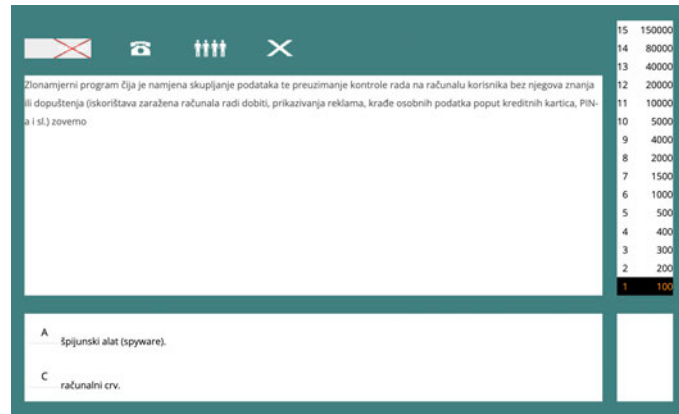


Figure 2. Millionaire quiz.

The research took place during the Christmas season, so the digital platform Genially offered a Christmas theme for the Escape Rooms game story (Fig. 3). The educational game was designed to motivate students to collect Christmas decorations by answering questions correctly. The Escape Rooms story contained computer hardware topics, and the goal of the game was to revise the hardware topic before a written test.



Figure 3. Escape Room game.

After gamification was introduced, a survey was conducted among the students to answer the research questions. A questionnaire was developed for the survey and used as an assessment tool. The questionnaire consisted of four parts.

The first part included questions about the students' previous experiences using digital devices and playing video games, such as: How many years have you been using computers, tablets, and other digital devices? How many hours per week do you use a computer, tablet, or other digital device? How many hours per week do you play video games?

The second part of the questionnaire included a survey of student satisfaction with the use of gamification in teaching, in which student satisfaction was rated using a series of twelve statements on a 5-point Likert scale. The following Likert scale of attitudes was used: 1 - strongly disagree, 2 - disagree, 3 - neutral, 4 - agree, 5 - strongly agree.

The following part of the questionnaire investigated the satisfaction with the digital tools and game design elements used with the multiple-choice questions, and the last part of the questionnaire included open questions about the general impression of the activities and suggestions for future improvements.

### 3 RESULTS

#### 3.1 The students' answers to the questionnaire

The first part of the questionnaire contains general questions about the participants' gender and course of study, as well as some open-ended questions about the students' previous experiences with using digital devices and playing video games.

Of the n=62 students who participated in gamified activities in computer science, 35.48% of the respondents identified as girls and the rest of 64.52% identified as boys. Tab. 1 shows the ratio of girls and boys by gender and also provides information about the field of study that these students are attending at the Civil Engineering Technical School (Architectural Technician, Civil Technician, or Geodesist).

Table 1. Number of students who solved questionnaire by gender and class.

	<i>Architectural Technician</i>	<i>Civil Technician</i>	<i>Geodesist</i>
Boys	12	16	12
Girls	9	7	6
Total	<b>21</b>	<b>23</b>	<b>18</b>

The results of the first part of the questionnaire showed that most students started using digital devices (mostly mobile phones) at a very early age (age  $\leq 6$  years) in preschool or early elementary school. The results of the questionnaire also showed that more than 60% of the students use digital devices on a daily basis. The questionnaire revealed that the time spent on this activity is more than 4 hours per week. More than 65% of students reported that they play video games at least 2 hours per week.

##### 3.1.1 The students' attitudes towards the use of gamification

The second part of the questionnaire was conducted to determine students' attitudes towards the use of gamification. Tab. 2 shows the results.

Table 2. Satisfaction with gamification in Computer Course.

		1	2	3	4	5	AVG	SD
<b>S1</b>	Using gamification in the subject of computer science was fun for me.	2%	0%	11%	55%	32%	4,161	0,745
<b>S2</b>	Using gamification encouraged me to learn computer science material.	3%	5%	37%	45%	10%	3,532	0,856
<b>S3</b>	I find that using gamification helps me learn more quickly.	2%	2%	23%	47%	27%	3,968	0,842
<b>S4</b>	I find the use of Kahoot! quizzes fun.	5%	0%	8%	50%	37%	4,145	0,931
<b>S5</b>	I look forward to seeing my name on Kahoot! podium.	0%	3%	13%	40%	44%	4,242	0,797
<b>S6</b>	I find using Loomen quizzes fun.	3%	2%	23%	52%	21%	3,855	0,877
<b>S7</b>	I look forward to seeing the results of my answers right after solving the Loomen quiz.	3%	2%	23%	45%	27%	3,919	0,921
<b>S8</b>	I find using Escape Room fun.	3%	2%	21%	53%	21%	3,870	0,921
<b>S9</b>	It makes me happy when I get to the end of the Escape Room game.	2%	5%	15%	60%	19%	3,903	0,817
<b>S10</b>	I find the Millionaire quiz fun.	2%	5%	15%	48%	34%	4,113	0,825
<b>S11</b>	I would like gamification to be used more in teaching computer science.	2%	2%	13%	52%	32%	4,113	0,805
<b>S12</b>	I would like gamification to be used in teaching other subjects.	2%	0%	11%	48%	39%	4,226	0,771

To answer question RQ1, which is the objective of this study ("What are the students' attitudes toward the use of gamification in computer science education"), questions S1-S3 and S11-S12 were included in the questionnaire. The results show that 87% of the students think that they enjoy the use of gamification in the computer science classes. Furthermore, 84% of the students indicated that they would like to use gamification more in computer science classes and 87% of students indicated that they would like to use gamification in other school subjects. In addition, 74% of the students felt that they learn the course material faster than usual by using gamification. Finally, 55% of students said that gamification encourages them to learn computer science material better than usual.

To answer question 2 ("Which of the digital tools and game-based elements used were most motivating for students?"), questions S4-S10 were included in the questionnaire. In the study on Kahoot! it was found that 87% of the students had a lot of fun while using the Kahoot! platform. In addition, 88% of the students reported that they felt pleasure when they noted their own name written down on the Kahoot! board. Compared to the Loomen quiz, the results are similar, but not the same. It appears that a smaller number of students (73%) felt enjoyment when using Loomen quiz and similarly, 72% of students felt satisfaction when they received the answers to the test immediately after solving it. The third section of the questionnaire was about feedback on the Millionaire quiz game and the results showed that 82% of the students felt that the Millionaire was fun. When using the Escape Room game, 74% of the students indicated that they enjoyed this learning model and 79% of the students were satisfied when they completed the Escape Room game.

### 3.1.2 The students' preferences about digital tools and game-based elements

The third part of the questionnaire was designed to explore participants' preferences for digital tools and game design elements to complete the response to RQ2. Preferences were based on students' entertainment level and motivation. As shown in Fig. 4, Kahoot! seemed to be the most entertaining digital tool among those offered. The results show that 71% of the students would primarily choose Kahoot! as the most entertaining tool. 22% of students indicated that they thought the Millionaire quiz would be the most entertaining. Only 5% of the students found the Escape Room story to be the most entertaining tool and the rest (2%) of the students would choose the Loomen quiz as the most entertaining tool.



Figure 4: Preferences about digital tools.

When examining student preferences for the game-based elements used, it appears that leaderboards are the most popular among students. When comparing leaderboards, points, levels, and story, 47% of students primarily choose leaderboards as the most motivating element among the others. Points are also the second choice of students (27%). Levels were the most popular element of gamification for 18% of students. Finally, 8% of students indicated that story was the most popular element of gamification.

## Which of the following elements for gamification motivated you the most:

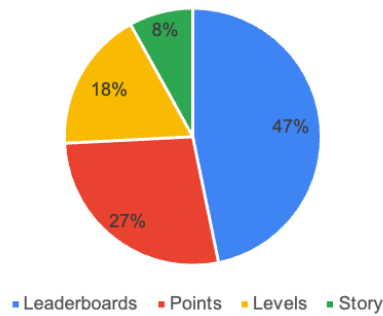


Figure 5: Preferences about game-based elements.

### 3.1.3 The students' comments

In the fourth part of the questionnaire, students gave their comments and recommendations about gamification in computer science classes. The comments were mostly positive: *"I like gamification because it is fun and educational, I learn in an entertaining way", "I like the fact that I learn a lot through fun and games, it is easier to remember the subject matter", "We were all actively involved in solving the tasks. We were like a team... It was a lot of fun", "It's much more fun than answering textbook questions."*

When it came to suggestions, students indicated that they would like to use gamification on a regular basis: *"More professors should use a more interesting learning method where students do not refuse to work and do not get bored", „Kahoot! and similar quiz games should be played more often in class", "I would like to see more gamification in other subjects as well".*

### 3.1.4 Discussion

Because there is a lack of information about gamification among secondary school students, this study was conducted to answer the research questions: RQ1 "What are students' attitudes toward using gamification in computer science education?" and RQ2 "Which of the digital tools and game-based elements used were most motivating to students?"

To summarize the results related to the research questions, we can conclude that after the gamification activities in the classroom, students were very satisfied with this teaching approach and believe that the selected digital tools and game-based elements allowed them to adopt new teaching content in an easier, more fun and interesting way.

These are students who belong to the digital generations or Generation Z. The results of this study show that they start using digital technologies as early as age 6, much earlier than previous generations. Most of the students surveyed currently use a mobile phone for more than 4 hours per day and frequently play video games. These findings support the fact that these students are eager to adopt new technologies and learning methods through games, including gamification, as confirmed in some other research on technology use among digital generations ([1], [8]).

That students accept the gamification introduced (RQ1) is evident from their responses, in which most of them agree or fully agree that the use of gamification in the computer science classes was fun and that they would like it to continue to be used not only in computer science but also in the teaching of other subjects. A slightly smaller number of students, but still more than half, agree that gamification has encouraged them to learn and therefore they have acquired the course content more quickly than otherwise. Adding to these results the comments from students, none of which were negative, confirms that student attitudes toward the use of gamification are extremely positive.

This research used some of the most popular publicly available and free digital tools Kahoot!, Loomen (for quiz and Millionaire quiz game), and Genially (for the Escape Room game), as well as the most commonly used elements of game design (leaderboards, points, levels, story). In response to RQ2 it can be stated that all of the games offered were fun for the students, but the results of this research show that Kahoot! is the most popular digital tool among the students. They were motivated by winning points and positions on the leaderboard and were very happy to see their name on the Kahoot! podium.

Compared to the other game activities, they found the Escape Room game the least fun, which involved collecting Christmas ornaments by answering questions correctly and eventually decorating Christmas trees. This could mean that teachers should work on stories as an element of game design when implementing gamification, i.e., prepare them in such a way that they are more attractive and motivating to high school students.

However, only a few different tools and game-based elements were used in this work. In future research, more tools will be included to give a better overview of digital tools and gamification elements.

Regarding the other limitations of this study, it was conducted with a small sample (n=62). A larger sample would improve the validity of this study, so it is planned for future research. The participants in this study were mainly boys, which could be another limitation of this study, as boys are often more interested in digital technologies than girls [12]. However, this study was conducted in Civil Engineering Technical School in Rijeka, where the majority of students are male. Future studies in Croatia should be conducted at other schools, such as medical schools, where most students are female, or other schools where both genders are represented.

Finally, students indicated that they would like to use digital tools in other courses and modules. However, the problem with using digital tools in Croatian schools is uneducated teachers and the lack of time needed to develop activities with digital tools ([6], [11]).

To conclude the discussion: gamification improves the quality of teaching and students are excited about digital learning. To this end, it is necessary to highlight the benefits of gamification in education and modernize teaching methods, as well as train teachers and motivate students to use digital tools.

## 4 CONCLUSIONS

The main contributions of the presented study were to determine students' attitudes towards the use of gamification in the computer science courses and which of the digital tools and game-based elements used were most motivating to students. The research methodology was based on a quantitative research method supported by a survey of secondary school students.

The results show that most students found gamification to be enjoyable. The majority of participants would like to use gamification in other subjects, as they indicated that they could learn the material faster than usual. The results of this study also show that Kahoot! is the most popular digital tool for gamification among students.

However, the study was conducted with a small sample of students and a limited number of gamified activities. A larger sample, as well as more game-based elements and digital tools for gamification, would improve the validity of this study, so the research will continue as part of the Degames project. Further work will continue with the goal of developing pedagogical-technological frameworks for gamification to help teachers design and implement gamified activities for their students.

## ACKNOWLEDGEMENTS

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## REFERENCES

- [1] W. Robertson and C. Evans, "The four phases of the digital natives debate," *Human Behavior and Emerging Technologies*, vol. 2, p. 269– 277, 2020.
- [2] J. Rugelj, "Serious computer games in computer science education," *EAI Endorsed Trans. Game-Based Learn*, vol. 2, pp. 1-7, 2015.
- [3] I. Franković, N. Hoić-Božić, M. Ivašić-Kos, and M. Holenko Dlab, "Supporting Learning Programming Using Educational Digital Games," *Proceedings of the European Conference on Games Based Learning (ECGBL 2019)*, pp. 999-1003, 2019.
- [4] F. Nah, Q. Zeng, V. Telaprolu, A. Ayyappa and B. Eschenbrenner, "Gamification of Education: A Review of Literature," *Lecture Notes in Computer Science*, vol. 8527, pp. 401-409, 2014.

- [5] C. Dichev and C. Dicheva, "Gamifying education: what is known, what is believed and what remains uncertain: a critical review," *International Journal of Educational Technology in Higher Education*, p. 14:9 (1), 2017.
- [6] D. Planatak Vukovac, M. Škara and G. Hajdin, "Korištenje i stavovi nastavnika o igrifikaciji u osnovnim i srednjim školama," *Zbornik Veleučilišta u Rijeci*, vol. 6, pp. 181-196, 2018.
- [7] F. Nieto-Escamez and M. D. Roldán-Tapia, "Gamification as Online Teaching Strategy During COVID-19: A Mini-Review," *In Frontiers in Psychology*, vol. 12, 2021.
- [8] A. Vrcelj, "Korištenje igrifikacije u osnovnoškolskom i srednjoškolskom obrazovanju: sustavni pregled literature (unpublished Ph.D. qualification paper)", University of Rijeka, 2022.
- [9] R. Dellos, "Kahoot! A digital game resource for learning," *International Journal of Instructional Technology and Distance Learning*, vol. 12, pp. 49-52, 2015.
- [10] A. Vrcelj, N. Hoić-Božić and M. Holenko Dlab, "Digital Tools and Platforms for Online Teaching Mathematics in Primary School," *Proceedings of the 11th International Conference on e-Learning Belgrade: Belgrade Metropolitan University*, 2020.
- [11] A. Vrcelj, N. Hoić-Božić and M. Holenko Dlab, "Using Digital Tools for Gamification in Schools," *44th International Convention MIPRO Proceedings (K. Skala eds)*. Rijeka: Croatian Society for Information, Communication and Electronic Technology- MIPRO, pp. 906-910, 2021.
- [12] M. Holenko Dlab and N. Hoić-Božić, "Effectiveness of game development-based learning for acquiring programming skills in lower secondary education in Croatia," *Educ Inf Technol*, vol. 26, p. 4433–4456, 2021.