Game Experience of Primary and Preschool Pedagogy Students in a Gamified Mathematics Class

Iuliana Zsoldos-Marchiș
Professor, Faculty of Psychology and Educational Sciences, Babes-Bolyai University, Cluj-Napoca, Romania, email address: iuliana.marchis@ubbcluj.ro

Edina-Timea Opriș
PhD Student, Doctoral School of Didactics. Tradition, Innovation, Development, Babes-Bolyai University, Cluj-Napoca, Romania, email address: edina.erdei@ubbcluj.ro

Magda Illyés
Lecturer, Faculty of Psychology and Educational Sciences, Babes-Bolyai University, Cluj-Napoca, Romania, email address: magda.illyes@ubbcluj.ro

Abstract: The paper presents a quasi-experimental study using gamification in Seppo during a mathematics course for primary and preschool pedagogy students. The aim of the investigation was to examine students' game experience and their motivation during the game. The research tools were the Gameful Experience Scale [GAMEX] and the Game Experience Questionnaire (developed by the authors). The participants were 32 second-year students. The results show that students' enjoyment and the feeling of creativity was high, but their activation, absorption in the game and feeling of dominance were low. Students' self-reports show that they liked the game's story, the teamwork, and the diverse nature of the assigned tasks. The perceived stress during the game was also relatively low. There was a strong negative correlation between enjoyment and perceived stress. The elements that contributed most to perceived stress were the difficulty of the tasks, the lack of time, and the competition between teams. The motivating elements mentioned frequently by the students were teamwork, collecting game money, and reaching higher levels of the game. A prevailing pattern among the students involved being influenced by both internal and external motivation throughout the course of the game. For one-third of the students, motivation increased at the beginning and decreased at the end of the game, while nearly another third's motivation increased at the end of the game. Students preferred the

https://doi.org/10.24193/JRHE.2023.2.3

version of the game with physical movement in the building and enjoyed the freedom of selecting the difficulty of the tasks when the game did not restrict the advancement to a higher level.

Keywords: gamification, game experience, motivation, teaching mathematics, primary and preschool pedagogy students, pre-service teachers

Introduction

Developing problem-solving skills is one of the most important goals of teaching mathematics (Liljedahl, 2016). This competency should be developed starting with the early years (Varol & Farran, 2006). Thus, the primary school period is crucial to cultivate pupils' problem-solving skills, and in this process, the primary school teacher has a decisive role. Teachers should have adequate problem-solving competency to be able to develop their pupils' skills. If the teachers' problem-solving skills are not on a higher level, and for this reason, they usually only address routine problems in the classroom, pupils also remain on this routine level of problem-solving (Näveri et al., 2011). A significant percentage of primary school pedagogy students do not possess adequate mathematical problem-solving skills (Marchiş, 2013b); therefore, it is essential to improve their competencies. Mathematical problem-solving competence can be developed only by solving non-routine problems and by spending a significant amount of time on mathematical problems (Leppäaho, 2018). Solving non-routine problems can be demanding and practicing repeatedly can become boring. Problem-solving competence is in correlation with the attitude towards mathematics, especially with the feelings towards this subject (Marchiş, 2013a). The majority of preservice primary school teachers don't like mathematics (Marchiş, 2013a). Thus, preservice teachers' attitude towards mathematics should be changed into a more positive one and they should be motivated to solve problems. It is important to use teaching methods that increase and maintain students' motivation to solve mathematical problems, and gamification can be an adequate tool for this.

Gamification is "the use of game design elements in non-game contexts" (Deterding et al., 2011, p. 10). In the case of education, gamification can play the role of turning the learning process from a serious activity into a game (Rauschenberger et al., 2019). Gamification is used in higher education mostly for blended learning courses (Dicheva et al., 2015; Dichev & Dicheva, 2017), most often in computer science related subjects, as shown also in the reviews made by Dicheva et al. (2015), Ortiz et al. (2016), and Dichev and Dicheva (2017). There are not many studies regarding the application of gamification in teaching mathematics at university level (some examples: Faghihi et al., 2014; Cadavid & Gómez, 2015; Molnar, 2019; Lanuza, 2020; Zsoldos-Marchis, 2020; Zsoldos-Marchiş & Opriş, 2021; Egri et al., 2022; Opriş et al., 2023). However, the number

of these studies is increasing, as in the review by Dicheva et al. (2015) there was only one mathematics related gamification mentioned out of the 34 included in the study, while in the review by Dichev and Dicheva (2017) there are already five mathematics-related papers included out of 51.

In this research, gamification is used during a university level mathematics course for motivating students and for turning the problem-solving activities into an enjoyable game-like experience. The aim of the research is to experiment with a 10-week-long gamification designed in Seppo (https://seppo.io) to solve mathematical problems. The study tries to find answers to research questions related to game experience and motivation, such as how different gamification elements contribute to the motivation of the students or how students' motivation changes during the gamified problem-solving. In a previous experiment (Opriş et al., 2023) with gamified problem sheets designed in Seppo, students played individually. The results show no change in intrinsic motivation, as students were intrinsically motivated by the satisfaction of a successful solution. Students' extrinsic motivation increased, the most motivating gamification elements being points and the leaderboard. Students reported a decrease in motivation by the end of the semester due to many other activities and assignment deadlines. The present research experiments with a gamification in which students work in teams and are physically present in a classroom.

1. *Gameplay experience and motivation*

The gamification of education is an "approach for increasing learners' motivation and engagement by incorporating game design elements in educational environments" (Dichev & Dicheva, 2017, p. 1). Some of the most important gamification design principles are goal setting, customised learning environment, fast feedback, progress, freedom of choice and storytelling (Dicheva, et al., 2015). These principles can be applied by adding some gamification elements to the course, such as points, levels, stories, unlocked content, etc. (Nah et al., 2014).

Gameplay experience can be defined as "an ensemble made up of the player's sensations, thoughts, feelings, actions and meaning-making in a gameplay setting" (Ermi & Mäyrä, 2005, p. 91). But the term game experience can be used in a nongame setting as well, where it "refers to the positive emotional and involving qualities of using a gamified application" (Eppmann et al., 2018, p. 100). The game experience is multidimensional

(Elson et al., 2014). Eppmann et al. (2018) establish six dimensions in their game experience scale: enjoyment, absorption, creative thinking, activation, absence of negative affect, and dominance. In the scale developed by Högberg et al. (2019) there are seven dimensions: accomplishment, challenge, competition, guided immersion, playfulness and social experience. The dimensions are not precisely determined, there are differences among various studies.

In the following, some of the dimensions mentioned above are discussed. Immersion in the game is realized when the player loses awareness of time and their real environment (Jennett et al., 2008), a cognitive state in which the player feels "in the game" (Cairns et al., 2014). It is a state close to flow, but not the same (Högberg et al., 2019), because flow is seen as a positive state, but immersion can also have negative aspects, such as anxiety (Jennett et al., 2008). Absorption also appears in some studies, yet it is not the same as immersion. Absorption is "directing attention to an experience", while immersion is becoming part of that experience (Ermi & Mäyrä, 2005, p. 94). When comparing the elements of the immersion dimension from the GAMEFULQUEST scale (Högberg et al., 2019) with the elements of the absorption dimension of the GAMEX scale (Eppmann et al., 2018), the absorption dimension on the GAMEX scale can be considered immersion.

Motivation is one of the criteria for evaluating gamification. While a meta-analysis by Sailer and Homner (2020) shows that there is a significant but small effect of gamification on motivation, yet there is a considerable level of heterogeneity among different studies. In another meta-analysis study, Zhang and Yu (2022) show that gamification has a positive effect on motivation, both intrinsic and extrinsic. Gamification has a more stable effect on intrinsic motivation than on the extrinsic one, as in the case of extrinsic motivation the heterogeneity is significant, despite the effect size being higher. The higher stability of intrinsic motivation in comparison to extrinsic motivation can be explained by the fact that gamification can increase intrinsic motivation by internalizing high extrinsic motivation (Vansteenkiste et al., 2006). Even if meta-analysis studies show a positive effect of gamification on motivation, not all experiments lead to the conclusion that gamification increases motivation (Dicheva et al., 2015; Dichev & Dicheva, 2017). Another question, which should be addressed when studying the effect of gamification on motivation, is related to the influence of different game elements used. A difficulty in this study is that usually during gamification various game elements are

used in combination, therefore the effect of each element cannot be precisely identified (Hamari et al., 2014). Studies in which the effect of different elements of the game on motivation was measured based on the responses of the participants report different effects on the same element (Leitão et al., 2022).

Methodology

Quasi-experimental research was carried out during the second semester of the 2022-2023 academic year at Babeş-Bolyai University, Romania. Gamification was used during a mathematics course for second year primary and preschool pedagogy students.

1. Research questions

This research tries to find the answers to the following questions:

1. What was the students' game experience during the Seppo game?
2. What do students like about gamified mathematics problem solving using Seppo?
3. What is students' stress level during the Seppo game and what are the factors responsible for the perceived stress?
4. How did students' motivation change during the Seppo game?
5. Which gamification elements motivated students to problem-solve?
6. What are the correlations between students' game experience, perceived stress level, and motivation?

2. Participants

32 primary and preschool pedagogy students have participated in the research. They were in their second year of study. The age of the participants was between 19 and 24, with an average of 20,65 and mode 20. Only one participant was male, the other participants were all female. 56.25% of the participants were from rural areas.

3. Description of the game in Seppo

In this experiment a game with mathematical tasks combined with travel organization tasks was developed by the researchers and played by the participants. The game was designed on the Seppo platform. The story created to frame the game was the following: The world of fairy tales is in great trouble, because streaming platforms have

kidnapped the characters of fairy tales and hidden them so that children would no longer read fairy tales but watch cartoons and movies. Since students are aware of the role of fairy tales in personality development, they know that fairy tale characters must be freed. In addition to these, the weed multicompanies also burnt all the fairy tale books, so players should also collect money to republish these. Fortunately, two invented companies (Grimm & Andersen Kft., together with Népmese Zrt.) support them in this task with a substantial amount. Of course, as in all fairy tales, nothing falls into their laps, they have to work for everything, but with a little cunning and ingenuity, they easily obtain the amount needed to search for the characters of the fairy tale and to publish the books.

The game had 10 stages. Each stage was played in a 2-hour seminar. In the first stage students had to get the seed money they used in order to start their adventure. The tasks were hidden in the building where the course was organized and they had to find them using the online map (Figure 1) and solve them to get money. The more tasks they successfully solved, the more starting capital they could earn. The next stages were played in the classroom on virtual maps in Seppo (Figure 2, A & B). Each stop had a short story that tied into the frame story. These contained a description of where they should travel, where they would find the next writer and his fairy tale characters, and what means of transport they could use to get there. They had to organize the trips using real travel information from the internet. The hiding places of the characters were marked on the maps, where different tasks had to be done to free them. The text of each task was formulated to be part of the story. All stages were organized into levels. There were stages where the players could freely choose to move between levels, but there were also stages where the advancement to a higher level was conditioned by the completion of certain tasks on the previous level. The last stage was also played in the building, using the map of the building as a gameboard in Seppo (Figure 1).

The game was played in teams. Each team had its own spreadsheet in which they kept track of their incomes and expenses. The amount left at the end of the mission was spent on book publishing. Throughout the whole game teams had to move together, they were not allowed to split up.

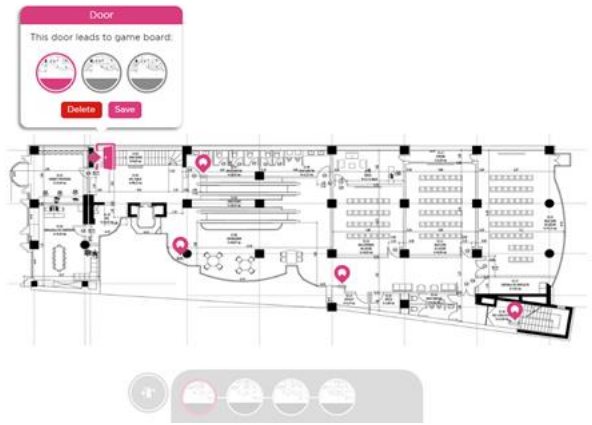
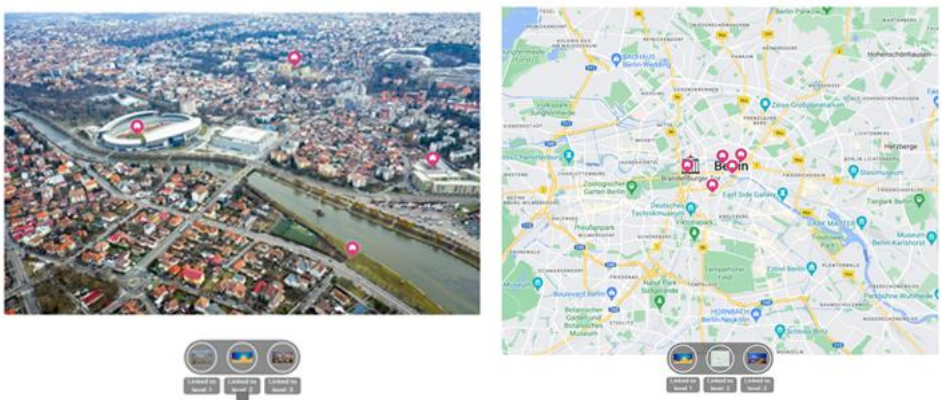


Figure 1. Board (map) of the game in the building



A B

Figure 2. Boards (maps) of the games

4. Instruments

As a first step, students were asked to provide some demographic data (e.g., age, gender, etc.), after which they completed two questionnaires measuring game experience. The instruments were filled in by the participants after the intervention.

The **Gameful Experience Scale [GAMEX]** developed by Eppmann et al. (2018) was translated into Hungarian by the authors. This scale contains 26 items grouped into six factors: *enjoyment* (e.g., Playing the game was fun.), *absorption* (e.g., Playing the game made me forget where I am.), *creative thinking* (e.g., Playing the game sparked my imagination.), *active participation/activation* (e.g., While playing the game I felt motivated to participate actively.), *absence of negative affect* (e.g., While playing the game I felt upset.), and *dominance* (e.g., While playing the game I felt influential.). Participants had to rate their level of agreement regarding each item on a 5-point Likert scale.

A **Game Experience Questionnaire** (GEQ) was developed to evaluate the experience of students during the game used in the current experiment. It contains 17 items, from which 13 are closed (scale, multiple choice, and checkboxes) and 4 are open-ended. The questions refer to the satisfaction offered by the game, the elements and mechanisms of the game that the students enjoyed the most (e.g.: "What did you like in the game?"), the type of motivation during the game and its changes (e.g.: "How did your motivation change during the game?" with the options: increased by the end of the game/ increased at the beginning of the game and decreased at the end of the game/ decreased at the end of the game/ decreased at the beginning of the game and increased at the end of the game/ didn't change during the game), the elements which assured the maintenance of motivation and the perceived stress level (e.g.: "On a scale from 1 to 5 evaluate the stress you felt during the game.").

5. Data collection and analysis

Students completed these two instruments online in June 2023 at the end of the 10-week long game. The data obtained were quantitatively (closed questions) and qualitatively (open-ended question) analyzed. For quantitative analysis, frequencies, percentages, means, and standard deviations were calculated. For comparisons, the Wilcoxon signed-rank test and the ANOVA test were used. Pearson's correlation coefficients between the subscales of the GAMEX scale were calculated. For qualitative analysis, the MAXQDA program was used. To analyze the answers given to the open-ended questions, codes and subcodes were identified, and frequencies for these codes and subcodes were calculated.

In the case of the GAMEX scale, the *absence of negative affect* subscale items had to be reverse scored, as suggested by the scale. In the data analysis instead of reverse scoring the scores the subscale name was changed to *negative affect*.

Results and discussion

1. Game experience measured with the GAMEX scale

The mean (M) and standard deviation (SD) were calculated for each of the factors on the GAMEX scale (Table 1). The highest mean was obtained for the *enjoyment* subscale (M = 3.91), meaning that students enjoyed the game. As the mean for *creative thinking* is

also quite high, it can be assumed that the tasks required a significant amount of creativity from the students. It is supposed that the tasks related to travel planning, which were taken from real life with real data from the internet, required creativity especially because there were always some restrictions the students had to work around, such as finding the cheapest or fastest way to travel, at the same time taking into account the amount of money the group owned. There is a quite low mean for the *absorption*, *activation*, and *dominance* subscales.

Table 1. Descriptive statistics for the factors on the GAMEX scale

	Enjoyment	Absorption	Creative thinking	Activation	Negative affec	Dominance
M	3.91	2.54	3.52	2.82	1.63	2.75
SD	0.77	0.90	0.95	0.68	0.84	0.97

Table 2 reports Pearson's correlation coefficients between the 6 factors of the GAMEX scale. There was a strong positive correlation between *creative thinking* and *absorption*, *creative thinking* and *activation*, respectively, *activation* and *absorption*.

Table 2. Pearson's correlation coefficients

		Enjoyment	Absorption	Creative thinking	Activation	Negative affect	Dominance
Enjoyment	Pearson's r	–					
	p-value	–					
Absorption	Pearson's r	0.113	–				
	p-value	0.531	–				
Creative thinking	Pearson's r	0.414*	0.502**	–			
	p-value	0.017	0.003	–			
Activation	Pearson's r	0.097	0.454**	0.569**	–		
	p-value	0.590	0.008	<.001	–		
Negative affect	Pearson's r	-0.437*	-0.030	0.005	0.373*	–	
	p-value	0.011	0.869	0.980	0.033	–	
Dominance	Pearson's r						
	p-value						

* p < .05, ** p < .01, *** p < .001

2. Motivation and its change during the game

The questions analyzed in this subsection are from the Game Experience Questionnaire. As one of the goals of gamification is to increase motivation (Dichev &

Dicheva, 2017), it is important to know which game elements helped to maintain motivation. Students had to select a maximum of two elements from a given list. According to student reports, teamwork was the most motivating game element; it was selected by 23 students (71.88%). Teamwork was followed by collecting money (18 students – 56.25%), reaching higher levels of the game (12 students – 37.50%), and the frame story (10 students – 31.25%). The points awarded which went towards the students' final evaluation in the discipline were less motivating (6 students – 18.75%).

In the case of a question regarding the types of motivation, the results indicated that the students experienced higher levels of motivation during the game, of whom 14 students (43.74%) felt equally internal and external motivation, 12 (37.50%) were more externally motivated by the frame story, earning money, points awarded for evaluation in the discipline, etc., while only 6 students (18.75%) were intrinsically motivated by the joy of a successful solution, by developing their problem-solving and self-regulation skills, etc. There were more students whose extrinsic motivations increased than whose intrinsic motivation increased, which result is in line with previous studies (Deci et al., 2001; Zsoldos-Marchis, 2020).

Based on the students' responses to the previous question, they were divided into three groups: those intrinsically motivated, those extrinsically motivated, and those experiencing both types of motivation. ANOVA was used to see if there are differences between the means on the factors of the GAMEX scale of these three groups of students. The results are displayed in Table 3. There was no significant difference in the case of any factor. Analyzing the means, it can be observed that students with extrinsic motivation have the highest mean for the *enjoyment* category, while students with intrinsic motivation have the highest mean for the *absorption* and the lowest mean for the *negative affect* category.

Table 3. Comparing means with ANOVA on the factors of the GAMEX scale of the students reported different types of motivation

	Extrinsic motivation		Intrinsic motivation		Both types of motivation		F	p
	M	SD	M	SD	M	SD		
Enjoyment	4.13	0.88	3.89	0.87	3.73	0.65	0.847	.441
Absorption	2.14	0.99	2.94	0.62	2.71	0.87	2.156	.134
Creative thinking	3.21	1.08	3.67	0.63	3.73	0.96	1.043	.365
Activation	2.71	0.52	2.83	0.30	2.91	0.93	0.263	.770
Negative affect	1.69	0.99	1.11	0.17	1.79	0.86	1.410	.260
Dominance	2.61	1.09	2.94	1.06	2.79	0.92	0.232	.754

Another question was related to the change in motivation during the game. Students had to choose from a list of 5 patterns the one which was most suitable to describe the change of their motivation. In the case of 11 students (34.38%), motivation increased at the beginning of the game and decreased at the end, for 9 students (28.13%) motivation increased at the end of the game, for 6 students (18.75%) motivation did not change during the game, for 4 students (12.50%) motivation decreased at the end of the game, and for 2 students (6.25%) motivation decreased at the beginning of the game and increased at the end. Similarly to the present results, Hanus & Fox (2015) also found that students' motivation decreases with the long-term application of gamification. It seems that 10 weeks were long enough to produce a decrease in motivation in the case of one third of the students, even if their motivation increased at the beginning.

Based on the students' choices from the 5 options given in the previous question, they were divided into 5 groups: those whose motivation increased at the end of the game, those whose motivation decreased at the end, those whose motivation increased at the beginning and decreased by the end, those whose motivation increased at the beginning and decreased by the end, those whose motivation did not change during the game. Comparing with ANOVA the means obtained on the GAMEX subscales for the students of these five groups with different motivation change patterns, no significant differences are obtained in any of the factors, as the results presented in Table 4 show.

Table 4. Comparing means with ANOVA on the factors of the GAMEX scale of the students reported different change pattern of the motivation

	Decrease, then increase		Increase, then decrease		Decrease		Increase		Doesn't change		F	p
	M	SD	M	SD	M	SD	M	SD	M	SD		
Enjoyment	4.08	0.59	3.86	0.90	3.46	0.57	3.93	0.89	4.19	0.57	0.538	.709
Absorption	3.08	0.25	2.53	0.83	2.17	1.67	2.46	0.91	2.75	0.64	0.407	.802
Creative thinking	4.25	0.35	3.46	1.07	3.06	1.53	3.53	0.92	3.71	0.49	0.551	.700
Activation	3.63	0.88	2.98	0.73	2.38	0.78	2.83	0.64	2.54	0.43	1.580	.208
Negative affect	2.17	0.24	1.79	1.16	1.42	0.63	1.59	0.80	1.33	0.52	0.504	.733
Dominance	2.83	1.18	2.61	1.22	3.33	1.05	2.63	0.90	2.78	0.69	0.412	.799

3. Students' opinion about the Seppo game

In a multiple-choice question students had to choose which type of game they liked more: one played moving around in the building to find the tasks or one played on the virtual map. 21 students (65.63%) preferred the version with physical movement. They explained their choice by the enjoyment felt when walking around the building and the excitement to find the tasks hidden in the physical world. 8 students (25%) liked both versions equally, and 3 students (9.38%) preferred the version with the virtual map. The game on the virtual map was liked by the students due to its design and its ability to transport them into a fairytale world. Some of the students mentioned that they preferred the virtual map version, because it took too much time to find the tasks in the physical movement version.

Students were also asked to rate on a 5-point scale how much they liked the two versions of the game (one played moving around physically in the building to find the hidden tasks, guided by the map from Seppo, and the other played on a virtual map on the same platform). Students liked most the game with movement in the physical world (Table 5). As the Shapiro-Wilk test showed deviation from normality (W = 0.871 and p = .001), the Wilcoxon signed-rank test was used to compare means. The results indicated that the difference between the means for the two versions of the game was significant (z = 3.014 and p = .002).

In the game, there were three types of tasks: mathematical tasks, travel planning tasks, and questions related to students' self-regulation. The mean and standard

deviation for each type of task is presented in Table 5. Repeated-measures ANOVA was performed to compare the three types of tasks given in the game. The Mauchly test indicated that the assumption of sphericity had been met ($\chi 2(2) = 0.822$, $p = .663$). The differences in enjoyment for the three types of tasks are statistically significant ($F(2) = 3.976$, $p = .024$). The Holm post-hoc test shows that the mean for travel planning tasks is significantly higher than the mean for math tasks (t = -2.354 and p = .044) and for questions related to self-regulation (t = 2.522 and p = .043).

Regarding the organisation of the levels, students were asked in a multiple-choice question which variant they liked more: where the advancement to a higher level was restricted by the program or where they could choose the level freely. 15 students (46.88%) preferred to choose the level of the tasks they solved, motivating their choice by the feeling of freedom when selecting the tasks and the order in which they solve them. They also reported better time management and work sharing in the team, and a lower level of stress. 9 students (28.13%) preferred the version where access to a higher level was restricted by collecting a given number of points. Students who liked this version more felt a higher level of motivation to solve a problem and to find the correct solution. 8 students (25%) liked both versions equally.

Table 5. Descriptive statistics to evaluate different aspects of the game by students.

	Games played in the building	Games played virtually	Story	Teamwork	Mathematical problems	Travel planning tasks	Self-regulation questions
M	4.50	3.81	4.41	4.31	3.50	3.93	3.46
SD	0.71	0.69	0.91	0.96	0.71	1.07	0.84

Students valued the story of the game and teamwork; these two elements received a high score in their evaluation (Table 5). To find out more about what students liked about the game, an open-ended question was formulated. The responses were analysed using the MAXQDA program. Codes and sub-codes were identified. Three codes were

found: task, game design, and game involvement. The subcodes for each code can be consulted in Figure 3 and Table 7.

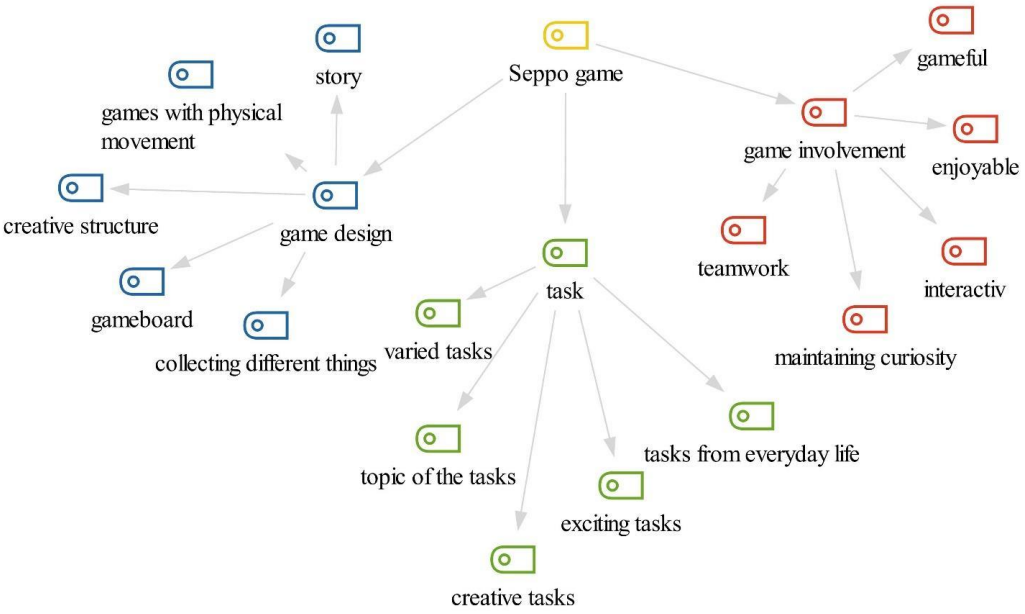


Figure 3. Aspects most liked by students about the Seppo game

Table 6 contains codes, subcodes, and the frequencies for sub-codes and codes. The code 'task' and 'game design' have the highest total frequencies. In the 'task' code, the most frequently used subcode was 'varied tasks'. In the 'game design' code, the most frequently used subcode was 'story'. In the code 'game participation', the most frequently used subcode was 'teamwork'.

Table 6. Student's most likeable things about the Seppo game

Codes	Subcodes	Frequency of the subcode	Frequency of the code
Task	thought-provoking	1	21
	creative tasks	3	
	tasks of everyday life	2	
	topic of the tasks	4	
	varied tasks	8	
	exciting tasks	3	
Game design	story	11	21
	gameboard	2	
	creative structure	4	
	collecting different things	2	
	games with physical movement	2	
Game involvement	teamwork	9	14
	interactive	1	
	enjoyable	1	
	maintaining curiosity	2	
	gameful	1	

4. Students' perceived stress and stress factors during the Seppo game

Students were asked to rate their stress level on a scale from 1 to 5. The mean obtained is 2.22 with a standard deviation of 0.98, indicating a low level of perceived stress during the game. Table 7 reports Pearson's correlation coefficients between perceived stress and the six factors on the GAMEX scale. There is a strong negative correlation between enjoyment and perceived stress.

Table 7. Pearson's correlation coefficients

		Enjoyment	*Absorption*	*Creative thinking*	*Activation*	*Negative affect*	*Dominance*
Stress	*Pearson's r*	*-0.482***	*0.225*	*-0.023*	*0.096*	*0.373**	*0.159*
	p-value	*0.005*	*0.2156*	*0.901*	*0.602*	*0.036*	*0.384*

* p < .05, ** p < .01, *** p < .001

In an open-ended question, students were asked to explain what influenced their stress level during the game. The answers were analyzed using the MAXQDA program. Codes and sub-codes were identified. The six codes identified are the following: task difficulty, teamwork, personal difficulties, time, competition, and student's competencies. The only code where no sub-codes were identified is the 'tasks difficulty'. In Figure 4 and Table 8 the subcodes for each code can be studied.

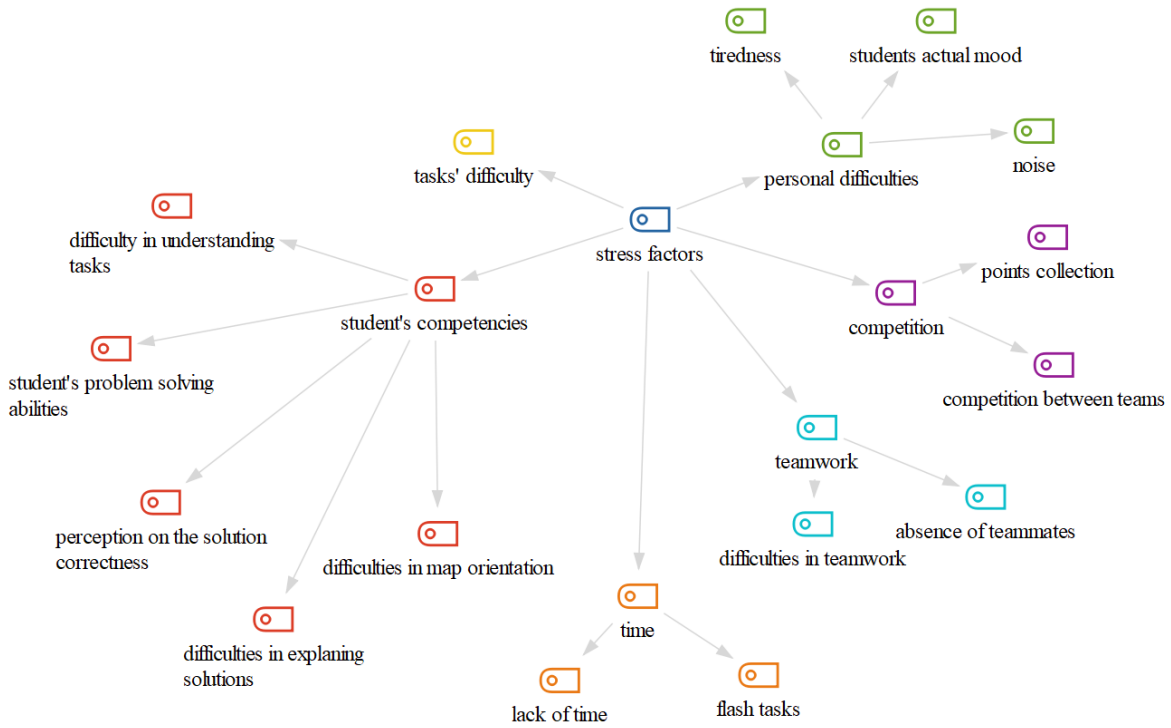


Figure 4. Students' stress factors in the Seppo game

Table 8 contains codes, subcodes, and the frequencies of subcodes and codes. The codes with the highest frequencies are 'task difficulty' and 'student competence'.

Table 8. Student's most stressful factor at the Seppo game

Codes	Sub-codes	Frequency of the sub-code	Frequency of the code
Tasks' difficulty	-	9	9
Teamwork	absence of teammates	2	6
	difficulties in teamwork	4	
Personal difficulties	students' actual mood	1	4
	noise	1	
	tiredness	2	
Time	lack of time	5	8
	flash tasks	3	

Codes	Sub-codes	Frequency of the sub-code	Frequency o the code
Competition	points collection	1	5
	competition between teams	4	
Student's competencies	difficulty in understanding tasks	3	9
	problem-solving abilities	2	
	difficulties in explaining solutions	1	
	difficulties in map orientatior	1	
	perception on the solution correctness	2	

Conclusions

Based on the results of the GAMEX scale, it can be concluded that students' enjoyment and the feeling of creativity were quite high, but their activation, absorption into the game, and the feeling of dominance were quite low. There was a strong positive correlation between creative thinking and absorption, creative thinking and activation, as well as activation and absorption. The students preferred the version of the game in which they had to move around the building and had to find hidden tasks significantly more. They enjoyed the story of the game, the teamwork, and the varied tasks. Regarding the tasks, students liked the travel planning tasks significantly more than the mathematical problems and self-regulation-related questions.

The perceived stress during the game was quite low. There was a strong negative correlation between enjoyment and perceived stress. The elements of the game that contributed the most to perceived stress were the difficulty of the tasks, the lack of time, and the competition between the teams.

Regarding motivation, the most motivating elements were teamwork, collecting game money and reaching higher levels in the game. The students were typically driven by both internal and external motivating factors during the game. Generally, motivation increased at the beginning and decreased at the end of the game, but there was a considerable number of students for whom motivation increased at the end of the game.

Students preferred the version of the game with physical movement in the building and they enjoyed the freedom of selecting the difficulty of the tasks when the game didn't restrict advancement to a higher level.

REFERENCES

Cadavid, J. M., & Gómez, L. F. M. (2015). Uso de un entorno virtual de aprendizaje ludificado como estrategia didáctica en un curso de pre-cálculo: Estudio de caso en la Universidad Nacional de Colombia. *RISTI-Revista Ibérica de Sistemas e Tecnologias de Informação, 16*(1), 1-16.

Cairns, P., Cox, A., & Nordin, A.I. (2014). Immersion in digital games: review of gaming experience research. In M.C. Angelides & H. Agius (Eds.), *Handbook of Digital Games* (pp. 339–361). John Wiley & Sons, Inc.

Deci, E. L., Koestner, R. & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review of Educational Research, 71(1), 1-27.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From Game Design Elements to Gamefulness: Defining "Gamification". In A. Lugmayr, H. Franssila, C. Safran, & I. Hammouda (Eds.), *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments* (pp. 9-15).

Dichev, C., & Dicheva, D. (2017). Gamifying education: what is known, what is believed and what remains uncertain: a critical review. *International Journal of Educational Technology in Higher Education, 14*, 9. https://doi.org/10.1186/s41239-017-0042-5

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in Education: A Systematic Mapping Study. *Journal of Educational Technology & Society, 18*(3), 75–88. http://www.jstor.org/stable/jeductechsoci.18.3.75

Egri, E., Opriş, E.-T. & Zsoldos-Marchis, I. (2022). Experimenting gamification for developing self-regulation skills during mathematical problem solving, *INTED2022 Proceedings*, 10155-10162. https://doi.org/10.21125/inted.2022.2671

Elson, M., Breuer, J., & Quandt, T. (2014). Know thy player: An integrated model of player experience for digital games research. In M.C. Angelides & H. Agius (Eds.), *Handbook of Digital Games* (pp. 362–387). John Wiley & Sons, Inc. https://doi.org/10.1002/9781118796443.ch13

Ermi, L., & Mäyrä, F. (2005). Fundamental Components of the Gameplay Experience: Analyzing Immersion. In *Proceedings of DiGRA 2005 Conference: Changing Views – Worlds in Play*.

Eppmann, R., Bekk, M., & Klein, K. (2018). Gameful Experience in Gamification: Construction and Validation of a Gameful Experience Scale [GAMEX]. *Journal of Interactive Marketing, 43*(1), 98-115. https://doi.org/10.1016/j.intmar.2018.03.002

Faghihi, U., Brautigam, A., Jorgenson, K., Martin, D., Brown, A., Measures, E., & Maldonado Bouchard, S. (2014). How gamification applies for educational purpose especially with College Algebra. *BICA, 182-187*.

Hallifax, S., Altmeyer, M., Kölln, K., Rauschenberger, M., & Nacke, L. E. (2023). From Points to Progression: A Scoping Review of Game Elements in Gamification Research with a Content Analysis of 280 Research Papers. *Proceedings of the ACM on Human-Computer Interaction, 7*(CHI PLAY), 748–768, https://doi.org/10.1145/3611048

Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? - A literature review of empirical studies on gamification. *Proceedings of the Annual Hawaii International Conference on System Sciences*, 3025–3034. https://doi.org/10.1109/HICSS.2014.377

Hanus, M. D. & Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance, Computers & Education, 80, 152–161. https://doi.org/10.1016/j.compedu.2014.08.019

Jennett, C., Cox, A. L., Cairns, P., Dhoparee, S., Epps, A., Tijs, T., & Walton, A. (2008). Measuring and defining the experience of immersion in games. *International Journal of Human-Computer Studies, 66*(9), 641–661. https://doi.org/10.1016

Lanuza, M. H. (2020). Integrative Gamification Technique in Teaching Specialization Courses in Mathematics, *International Journal of Scientific & Technology Research, 9*(4), 1275-1281.

Leitão, R., Maguire, M., Turner, S., & Guimarães, L. (2022). A systematic evaluation of game elements' effects on students' motivation. *Educ Inf Technol 27*, 1081–1103. https://doi.org/10.1007/s10639-021-10651-8

Liljedahl, P., Santos-Trigo, M., Malaspina, U., & Bruder, R. (2016). Problem Solving in Mathematics Education. In *Problem Solving in Mathematics Education*. ICME-13 Topical Surveys. Springer, Cham. https://doi.org/10.1007/978-3-319-40730-2_1

Marchiș, I. (2013a). Relation between students' attitude towards Mathematics and their problem-solving skills, *PedActa, 3*(2), 59-66.

Marchiș, I. (2013b). Future Primary and Preschool Pedagogy Specialization Students' Mathematical Problem Solving Competency, *Acta Didactica Napocensia, 6*(2), 33-38.

Molnar, L. (2019). The Effect of Gamification Elements on Engagement and Achievement in Calculus 1 and 2. *The IAFOR International Conference on Education – Hawaii 2019 Official Conference Proceedings*.

Nah F.F.H., Zeng Q., Telaprolu V.R., Ayyappa A.P., & Eschenbrenner B. (2014). Gamification of Education: A Review of Literature. In F.FH. Nah (Ed.), *HCI in Business. HCIB 2014*. Lecture Notes in Computer Science, vol 8527. Springer, Cham.

Näveri, L., Pehkonen, E., Ahtee, M., Hannula, M. S., Laine, A., & Heinilä, L. (2011). Finnish elementary teachers' espoused beliefs on mathematical problem-solving. In *MAVI-17 Conference, Bochum, Germany* (pp. 161-171).

Opriș, E.-T., Zsoldos-Marchiș, I., & Egri, E. (2023). Impact of gamified problem sheets in Seppo on self-regulation skills, *Open Education Studies*.

Ortiz, M., Chiluiza, K., & Valcke, M. (2016). Gamification in higher education and STEM: a systematic review of literature, *EDULEARN16 Proceedings*, 6548-6558, https://doi.org/10.21125/edulearn.2016.0422

Rauschenberger, M., Willems, A., Ternieden, M., & Thomaschewski, J. (2019). Towards the use of gamification frameworks in learning environments. *Journal of Interactive Learning Research, 30*(2), 147-165. Waynesville, NC: Association for the Advancement of Computing in Education (AACE). Retrieved October 24, 2023, from https://www.learntechlib.org/p/181283

Sailer, M., Homner, L. (2020) The Gamification of Learning: a Meta-analysis. *Educ Psychol Rev 32*, 77–112. https://doi.org/10.1007/s10648-019-09498-w

Vansteenkiste, M., Lens, W., Deci, E. L. (2006). Intrinsic versus extrinsic goal contents in self-determination theory: another look at the quality of academic motivation. *Educational Psychologist, 41*(1), 19–31.

Varol, F., & Farran, D. (2006). Early Mathematical Growth: How to Support Young Children's Mathematical Development. *Early Childhood Educ J 33*, 381–387. https://doi.org/10.1007/s10643-006-0060-8

Qi, Z., Zhonggen, Y. (2022). Meta-Analysis on Investigating and Comparing the Effects on Learning Achievement and Motivation for Gamification and Game-Based Learning. *Education Research International, 2022*, Article ID 1519880, 19 pages. https://doi.org/10.1155/2022/1519880

Zsoldos-Marchis, I. (2020). Gamification of the mathematics course for pre-service preschool and primary school teachers, *Proceedings of 12th International Conference on Education and New Learning Technologies*, 6787-6794.

Zsoldos-Marchiș, I. & Opriș, E. (2021). Experimenting Seppo for Problem-Solving on a Mathematics Course for Future Preschool and Primary School Teachers. In R. Jugureanu, G. Albeanu, D. M. Popovici, O. Istrate, & A. Adăscăliței (Eds.), *Proceedings of the 16th International Conference on Virtual Learning*, 215-222.