GAME-BASED LEARNING IN PRIMARY SCIENCE AND SOCIAL STUDIES

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Abstract

Play is a natural form of learning that contributes to a child's development. Previous research on the effectiveness of game-based learning has found that using games in teaching leads to greater activation of students in the learning process and contributes to creating a positive classroom environment. Game-based learning increases students' attention and thus more effectively contributes to the achievement of educational learning outcomes and the development of students' competencies. As a teaching strategy with elements of cooperation, game-based learning is essential at all levels of education, especially in primary grades. In primary classes, games can be used to learn new teaching content, practice specific social skills, socialize students, or improve the classroom environment. By applying methodically designed games, students often achieve better results in the learning process. As a form of formative evaluation, the game enables discovering students' abilities and giving quality feedback on their learning process. Didactic games can be applied in all segments of primary science teaching to motivate students, learn new content, practice skills, formative and summative assessment of student achievements, or riching high levels of learning outcomes. This paper presents the results of research whose main goal was to determine the attitudes of primary school teachers (N = 349) on the possibilities of applying game-based learning in Science and Social studies classes, advantages and possible disadvantages of gamification in this school subject in the first four grades of primary school in Croatia, and the frequency of application of different forms of games during teaching. Research has found that teachers generally use game-based learning once to twice a month to motivate students and practice skills, but rarely for formative assessment. Although they expressed positive attitudes on the game-based learning strategy, there is a weak correlation between their attitudes on using this teaching strategy in Science and Social studies teaching and the frequency of their application. They are more likely to use games that are easier to implement and those that achieve lower levels of cognitive learning outcomes such as memorization and less likely to use more time-consuming games or games that require higher levels of cognitive learning outcomes, analysis, and evaluation, and creation. Therefore, in the future, the teachers should be sensitized for more frequent and purposeful use of game-based learning, contributing to the complete development of student competencies, especially for formative assessment, and achieving a higher level of learning outcomes.

Keywords: Game-based learning, learning outcomes, Science and social studies classes, teachers` attitudes.

1 INTRODUCTION

Game-based learning is a teaching strategy that includes educational games in the teaching process [1]. Jan [2] highlights three areas of using game-based learning: 1) content mastery, which includes content practice; 2) motivation such as fantasy, challenge, and engaging curiosity; 3) higher-order thinking (problem-solving, synthesis, and evaluation) and social skills (collaboration). Many researchers have reported the positive impact of educational games on fostering students' science learning [3, 4, 5, 6]. Research showed that educational games encourage students` ability to communicate and interact with their peers during the game, increase students' knowledge about the science content presented in the game, that primary students could acquire scientific concepts during game-based learning, and that students demonstrated positive attitudes toward the use of the educational card game in science learning. Learners' active participation can be facilitated through competitive and collaborative concept of games that support guided exploration, assisting with applying and learning concepts [7]. The great advantage of educational games is that they can connect scientific knowledge and real-life contexts [8].

Schaaf [9] concluded that game-based learning is most effective when it aligns with students' needs and curriculum content. In Liu and Chen˙s study [5], elementary school students learn science-related concepts by participating in games with educational card. The students demonstrated positive attitudes toward the use of the educational card game in science learning. This study shows that game-based learning improved students' scientific knowledge, enhanced students' social skills, and improved their

skills in understanding and solving problems. Papp [10] investigated students' opinions, experiences, and perceived outcomes of the game-based learning process and concluded that students found game-based learning to be engaging, motivating, and a preferred learning approach.

Considering the pedagogical approaches in game design and its purpose, there are three generations of educational games. The first generation of educational games is mostly drill-and-practice games that occur by conditioning the link between the correct response and the stimuli with a reward system. In second-generation games, learning occurs through scaffolding, exploration, and problem-solving. In the third generation belong educational games influenced by socio-cultural and constructivist perspectives that consider meaningful social interaction and cultural elements as important considerations in game design [11, 12]. Today is recommended the use of third-generation educational games that contribute to the development of complex key competencies.

The games used in teaching science are most commonly divided into five categories: 1) training games designed to develop individual skills for solving single problems or a class of problems; 2) inquiry games structured around players conducting an inquiry; 3) professional simulation games, where players simulate being part of a professional context; 4) embodied system games, where players explore scientific phenomena by manipulating simulations or models of them; and 5) research collaboration games, where players generate data for scientific research by manipulating simulations of the research object [13]. Magnussen et al. [14] claim that games can create narrative frameworks or simulations that allow students to gain first-hand experience on scientific contexts or phenomena.

Training games are drawn on behaviouristic learning models based on laws that strengthen a specific response through rewards and stimuli [15]. Inquiry games include solving complex problems by conducting specific investigations. Professional simulation games also include inquiries, but their key elements are the simulation of authentic professional values, tools, and processes. Inquiry games and professional simulation games can potentially be based on cognitivist models of learning and motivation as the players' mental model of the inquiry process can be a central aspect of these games [13]. Socio-cultural theories can be visible in the foundation of these two types of games, including the understanding that learning is situated in the specific context in which the skills are practiced and that a focus of the games is to simulate this environment. Learning through experimentation, exploration and construction are central elements of embodied system games and research collaboration games. In both types of games, the gameplay is based on manipulating natural phenomena and potentially constructing new structures [13].

Al-Tarawneh [16] investigated the effectiveness of educational games on first-grade students' scientific concepts acquisition. Results showed statistically significant differences in students' scientific concepts acquisition in favour of the experimental group exposed to game-based learning. Based on these results, Al-Tarawneh [16] recommended using educational games in teaching science in primary education.

In recent times the term gamification has been increasingly used. In the scientific and professional literature, gamification is most often defined as the use of game design elements in non-game contexts [17] to improve students` cognitive engagement in learning [18, 19, 17]. Nicholson (2012) define gamification as the use of game elements to help someone find meaning in a non-game context, and therefore a tool to help people learn by changing their perspectives on life [20]. Tulloch [21] suggests that gamification is "an alternative framework for training and shaping participant behavior that has at its core the concepts of entertainment and engagement" [21, p. 317]. In this view, gamification can be understood as an alternative form of pedagogy, incorporating the sophisticated mechanics of gameplay.

Unlike gamification, game-based learning is a teaching approach, which integrates games into teaching for educational goals and emphasizes the application of games in helping to achieve learning objectives [22]. It is being used to encourage students to participate in learning while playing and make the learning process more interesting by adding fun to the learning process [23]. It designs learning activities that can incrementally introduce concepts and guide students towards the end goal [24]. Setting clear learning objectives in line with curriculum requirements with student-centered implementation makes game-based learning more efficacious [25]. The application of game-based learning to the constructivism approach can form students' basic scientific concepts and skills. Specific educational games in science classes can encourage students to solve problems and develop essential scientific competencies [26].

Some researchers compared gamification to the game-based approach [23] which can be seen in Table 1. Although both make teaching more interactive, gamification focuses more on applying games that have design elements in non-game contexts [27], where their role is more to support students' learning. The primary purpose of gamification is to stimulate students` interest [28] by making rewards as the

essential medium for encouraging students to play. Gamification is the practice of using game design elements, game mechanics, and game thinking in non-game activities to motivate participants.

Table 1 Comparative analysis of educational games, game-based learning, and gamification [23].

	Educational game	*Game-based learning*	*Gamification*
Definition	A game designed specifically with some learning goal in mind. Designed to help students to learn about a particular subject, expand the concept, and to reinforce development.	The process and practice of learning using games. Use of games to enhance the learning experience.	The use of game elements in a non-game context. They reward users for certain behaviors.
Description	Lesson content is adjusted to fit the game.	Lesson content is adjusted to fit the game.	Game-like aspects are adjusted to fit the lesson content.
Purpose	Connected with some educational goals.	Approach to learning with specially designed games to teach specific learning objectives.	To drive motivation and to make something more playful and game-like.
Reason for implementation	To learn something.	To improve learning.	Depending on how it's implemented, it can tap into extrinsic or intrinsic rewards (or both).
Focus	Content/Message	Content/message	User experience.
Main question	Is it effective?	Is it effective?	Is it effective?
Concept catalyst	Performance or knowledge gap.	Game is the lesson, or it is used as a part of the lesson.	In learning usually impacts how things are taught and administered rather than what is taught.

2 METHODOLOGY

2.1 Research aim

The study aimed to determine how often and for what purpose primary school teachers use educational games during primary science and social studies classes and their beliefs on game-based learning of science and social studies concepts.

- H1 - Teachers often use educational games in primary science and social studies classes.
- H2 - Teachers believe that educational games are an effective learning strategy in primary science and social studies classes.
- H3 - Teachers mostly use educational games in primary science and social studies classes for formative assessment.
- H4 - There is a positive correlation between teachers' beliefs on the application of educational games in primary science and social studies classes and the frequency of their application.

2.2 Research instrument

The first version of questionnaire for teachers was developed within the master thesis [29] which was a pilot research on this topic on a smaller sample of teachers, but for the purpose of this research the questionnaire was expanded, adapted and significantly modified. The questionnaire consisted of three parts. The first part collected socio-demographic data. The second part consisted of two questions in which teachers declared themselves about the frequency of using educational games in primary science and social studies classes and the part of the class when they use them most often. On the Likert type scale with five degrees (1 = never, 2 = rarely (1-2 times in a semester), 3 = occasionally (1-2 times a month), 4 = often (once a week), 5 = always (at every science class) they indicated how often they use

a specific educational game (a list of 19 educational games was offered). The third part of the questionnaire consisted of 11 items on using game-based learning in primary science and social studies classes. On the Likert scale, teachers were assessed to what extent they agree or disagree with the stated statements (1 = in completely disagree, 2 = mostly disagree, 3 = neither agree nor disagree, 4 = mostly agree, 5 = agree entirely). The last question in the teacher questionnaire was an open-ended question that asked to list the advantages and disadvantages of game-based learning in primary science and social studies.

2.3 Data processing methods

The results of the research were processed using the statistical package SPSS. Descriptive statistics of each variable for the whole sample were calculated. For qualitative variables, the results are presented in the form of frequencies, and for continuous variables, the range of results, arithmetic mean, and standard deviation are shown. The last open-ended question in the teacher questionnaire was addressed by a qualitative analysis of the respondents' answers. The statistical procedure of calculating the correlation was also used, where the consistency between the teachers' beliefs on the application of educational games in primary science classes and the frequency of their application was examined.

2.4 Research sample

The study was conducted on a sample of 356 primary teachers. Most of them have a master's degree (72%), 28% have a bachelor's degree. Most of the teachers have 11-20 years of school work experience (35%), 23% have 0-10 years of school work experience, 17% have 21-30 years of experience, while the rest (25%) have more than 30 years of experience in school work.

3 RESULTS

In the second part of the questionnaire, teachers expressed how often and in which part of the lesson they use educational games. 18% of teachers expressed that they use game-based learning once or twice a week. Most teachers (70%) stated that they use educational games once or twice a month, 9% use them only once or twice in a semester, and 3% once or twice in a school year. From the obtained results it can be concluded that most teachers occasionally use educational games in primary science and social studies classes (once or twice a month). Hypothesis 1, which assumes that teachers often use educational games in and primary science and social studies classes, is rejected since only 18% of teachers use educational games once or twice a week. It was also found that teachers rarely use educational games listed in Table 2 in primary classes (M_{total} = 2.31).

Teachers also expressed the purpose of educational games in primary science and social studies classes (motivation – engaging students in the learning process, learning new concepts, memorizing content and practice, determining learning outcomes and developing students` competencies, formative assessment). The data from Figure 1 show the obtained results. 47% of teachers declared that they use educational games mostly to memorize and practice the teaching content, and 10% to determine the learning outcomes and develop students` competencies in primary science and social studies classes. 34% of teachers use them the most often in the introductory part of the lesson for motivational purposes. Only 9% of teachers use educational games to learn new scientific concepts. None of the respondents use educational games for formative assessment of students' achievement, probably because teachers believe that formative assessment needs to be more complex and that there are more adequate strategies for its realization. Therefore hypothesis 3, which assumed that teachers mostly use educational games in primary science and social studies classes for formative assessment, is rejected because none of the respondents stated that they used the game for these purposes.

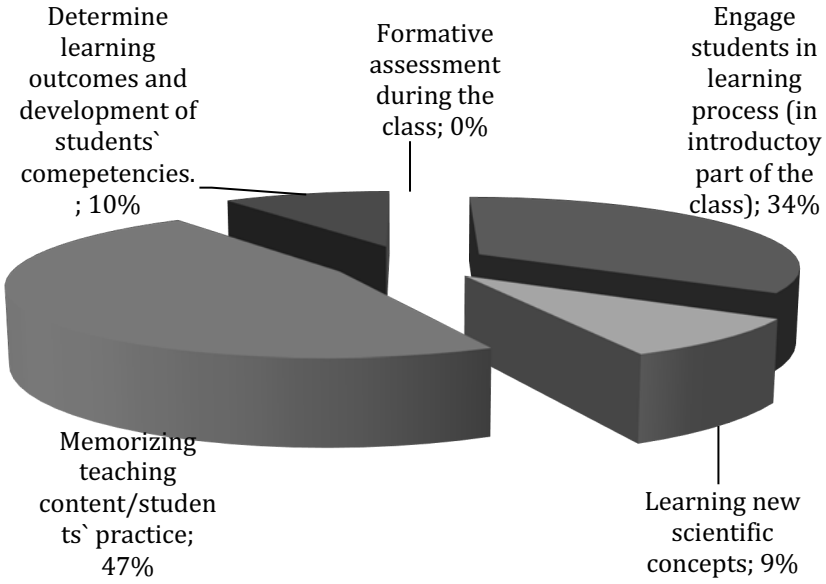

Figure 1 Purpose of application of educational games in primary science and social studies classes.

In the third part of the questionnaire on the offered list, teachers were assessed how often they use a particular educational game in primary science and social studies classes. The results are shown in Table 1.

Table 2 Frequency of use of different educational games in primary science and social studies classes.

Educational games	***M***	***SD***
Problem-solving games	1.54	1.08
Digital simulation games	2.36	0.85
Inquiry-based games	1.49	1.07
A game of guessing a hidden concept/object	2.68	0.95
Quizzes	2.81	1.06
Educational games with boards	2.26	1.09
Role-play	2.54	0.83
Puppet-stage play	2.96	1.08
Educational games with cards	2.96	1.05
Research collaboration games	1.51	0.75
Puzzle (merging images into a whole)	2.74	0.99
Pantomime	2.66	0.92
Game Tourist guide (making a flyer for tourists)	1.57	1.01
Game True / False	3.56	0.63
Problem-solving games	1.57	0.68
Games for development of creativity	2.15	1.28
Five senses scavenger hunt	2.13	1.13
Construction games	1.81	1.21
Online educational games	2.53	0.86
Total	2.31	0.92

Based on the result of the total value of arithmetic mean (M_{total} = 2.31), it can be concluded that teachers rarely use listed educational games in primary science and social studies classes. Surprisingly, teachers rarely applied problem-solving games in primary science and social studies classes (M = 1.54). On the other hand, the game True/false is most often used (M = 3.56). Some of the games are used occasionally: Educational games with cards (M = 2.96), Puppet-stage play (M = 2.96), Quizzes (M = 2.81), Puzzles (merging images into whole) (M = 2.74), Hidden concept guessing games (M = 2.68), Pantomime (M = 2.66), Online educational games (M=2.53) while the games Research collaboration

games (M = 1.51), Inquiry-based games (M=1.49), Tourist Guide (making a flyer for tourists) (M = 1.57), and Construction games (M = 1.81) are used very rarely. Possible reasons for the rare playing of these games may be the lack of time, materials needed for their realization, and the complexity of their preparation and realization. Also, Five senses scavenger hunt (M = 2.13), games for development of creativity (M = 2.15), digital simulation games (M = 2.36) are also rarely used.

Table 2 shows the teachers' beliefs on the application of game-based learning in primary science and social studies classes. Teachers express the greatest agreement that the use of educational games in primary science and social studies classes requires adequate teachers` preparation (M = 4.30) and that Game-based learning is efficient only if they are well structured and organized (M = 4.25). It can be assumed that they do this to avoid some of the shortcomings of game-based learning that they mentioned in the last question of the questionnaire (loss of structure of teaching content, time complexity, discipline). Teachers mostly disagree that educational games in primary science and social studies classes should be used only in the 1st and 2nd grades (M = 1.89). Teachers believe that game-based learning should be used in all four grades of primary school. There is a partial agreement that they often design their educational games (M = 3.40) and that competitive games in primary science and social studies classes are more valuable than collaborative games (M = 3.00). Teachers highlighted the problem of discipline in game-based learning. By analyzing their answers, it can be concluded that teachers recognize the excellent sides of game-based and are aware that it requires excellent preparation.

Table 3 Teachers beliefs on game-based learning in primary science and social studies classes.

Items	***M***	***SD***
Game-based learning in primary science and social studies classes is more efficient than traditional, frontal teaching.	4.09	0.62
Game-based learning is interesting for students.	4.15	0.52
Contents learned through game-based learning in primary science and social studies classes are more permanent.	4.15	0.72
Game-based learning is efficient only if they are well structured and organized.	4.25	0.67
Game-based learning in primary science and social studies classes positively affects students` socialization and collaboration.	4.21	0.75
In primary science and social studies classes, game-based learning should be used only in the 1st and 2nd grades.	1.89	0.91
Primary science and social studies classes are suitable for the application of many different educational games.	3.98	0.87
I often design my educational games for primary science and social studies classes.	3.40	0.95
Educational games can be applied in all parts of the primary science and social studies lesson.	4.04	0.83
The use of educational games requires adequate preparation of the teacher.	4.30	0.88
Competitive games in primary science and social studies classes are more valuable than collaborative ones.	3.00	0.83
Total	3.76	0.84

In order to check the correlation between teachers' beliefs on the application of educational games in primary science and social studies classes and the frequency of their use are related, Pearson's coefficient was calculated. The correlation coefficient (r) is 0.38, and p = 0.01, which shows a weak correlation between teachers' beliefs and the frequency of using game-based learning. Therefore, hypothesis 4, which assumed a positive correlation between teachers' beliefs on game-based learning in primary science and social studies classes and the frequency of their application during everyday teaching, is accepted. The more positive the opinion about the application of educational games, the more often teachers apply them.

The last question in the teacher questionnaire was an open-ended question at the end of the questionnaire that sought to investigate teachers' beliefs on the advantages and disadvantages of game-based learning (Table 4). 29% of respondents did not answer this question. Table 3 shows the advantages that teachers most often mention. 39% of them believe that game-based learning enables students to learn faster and that the permanence of their knowledge acquired by educational games is longer. This is the most common advantage of game-based learning highlighted by teachers. The most common teacher responses are: children are more interested and motivated (26%), games encourage

activity and participation in teaching (17%). 9% of teachers also think that game-based learning is more interesting for students than traditional learning strategies and that it encourages students` socialization skills. Several teachers pointed out higher efficiency, development of logical thinking, increased students` attention, and suitability for students with special needs. Hypothesis 2, which assumed that teachers believe that educational games are an effective learning strategy in primary science and social studies classes, is accepted because it was found that teachers are aware of many benefits of game-based learning. It can be concluded that teachers recognize the advantages of game-based learning.

Table 4 Teachers' opinions on the benefits of game-based learning in primary science and social studies classes.

Advantages	*Percentage*
Students learn faster.	39 %
Students are interested and motivated.	26 %
Games encourage students` activity and participation.	17 %
It is interesting for students.	9 %
Encourages development of students` socialization skills.	4 %
Higher efficiency.	2 %
Development of logical thinking.	1 %
Students pay more attention to the learning process.	1 %
Participation of students with learning disabilities.	1 %

Table 5 shows the results of teachers' beliefs on game-based learning disadvantages. 29% of teachers state that the main disadvantage of game-based learning is the problematic maintenance of discipline and the structure of the teaching content, and 22% believe that game-based learning is time-consuming. Considering the subject-hour system with 40-45 minutes of class is difficult for teachers to fit educational games into the lesson due to lack of time. 19% of teachers state that some students cope hard with failure in educational games, and 15% critically commented on the lack of didactic materials for school game-based learning. Less common responses were: excessive playfulness, a problematic adaptation of children to the exclusively reproductive system in a higher level of education, and students' poor social skills.

Table 5 Teachers' opinions on the disadvantages of game-based learning in primary science and social studies classes.

Disadvantages	*Percentage*
It is difficult to maintain the discipline and structure of the teaching content.	29 %
Game-based learning is time-consuming.	22 %
Some students cope worse with failure.	19 %
Lack of didactic materials in schools.	15 %
It requires quality preparation of the teacher.	5 %
After the application of game-based learning, it is difficult for students to adapt to other teaching strategies.	5 %
The frivolity of student approach and playfulness.	3 %
Students do not respect the agreement and the rules; poor social skills.	2 %

4 CONCLUSIONS

Teachers are required to design teaching activities and situations that will encourage students to learn, to be creative, and one of the successful teaching strategies to achieve that is game-based learning. Therefore, educational games should be designed for children's interest and take advantage of its opportunities as a teaching method.

Based on the obtained results in this study, it can be concluded that teachers use educational games and game-based learning as a teaching strategy with elements of cooperation or competition, mostly occasionally, once or twice a month for motivation, practice, the realization of learning outcomes or development of students competencies and, rarely for learning new teaching content, and never for formative assessment in primary science and social studies classes. They are more likely to use games

that are easier to implement and those that achieve lower levels of cognitive learning outcomes such as memorization and less likely to use more time-consuming games or games that require higher levels of cognitive learning outcomes, analysis, and evaluation, and creation. Therefore, in the future, the teachers should be sensitized for more frequent and purposeful use of game-based learning, contributing to the complete development of student competencies, especially for formative assessment, and achieving a higher level of learning outcomes.

Although they expressed significant agreement with the statements that positively characterize game-based learning in primary science and social studies, a weak correlation was noticed between their opinion on the use of educational games and the frequency of its application. It was found that teachers consider game-based learning as an effective way of learning and are aware of its many advantages and disadvantages, such as discipline, excessive playfulness, lack of didactic materials for educational games, and time requirements. The discrepancy between teachers' beliefs of game-based learning and the frequency of its application needs to be analyzed more deeply. One of the reasons for that can be found in the lack of time to implement such learning strategies (in the Republic of Croatia, there are only 2 hours per week of Science and social studies classes in the first three grades of primary school) and burdening teachers with the need to fully achieve the curriculum learning outcomes, which is why they prefer to apply traditional methods of learning and teaching. This situation requires considering possible changes in teaching organization and the number of primary science and social studies lessons per week. Since previous surveys showed that students enjoyed such a way of learning, teachers should be aware of the advantages of that learning approach. Given its many advantages, it is crucial to encourage teachers to more frequent implementation of game-based learning in teaching primary science and social studies.

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