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THE EFFECT OF GAME-BASED LEARNING VIA KAHOOT AND QUIZIZZ ON THE ACADEMIC ACHIEVEMENT OF THIRD GRADE PRIMARY SCHOOL STUDENTS

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Abstract. *The application of student response systems could have a lesser effect on the science education of younger students compared to the effects achieved with older students in language and social science courses. The aim of this research was to determine the effect of the application of Kahoot and Quizizz on the academic achievement of third grade primary school students (9 years old) in a natural sciences course. A total of 113 third grade primary school students participated in this research. During the experimental phase which lasted 4 weeks, the participants were divided into three groups. Out of two experimental groups one group used Kahoot as a learning aid, while the other used Quizziz. The third group was the control group. At the beginning and at the end of the experimental phase, the participants were given an academic achievement test. The results of this research showed that the experimental group which used Kahoot for learning the content of the natural sciences course achieved significantly higher results in the post-test than the control group. There were no significant differences in the academic achievement of the group which used Quizizz and the other two groups. This result indicated that Kahoot could be used effectively as a learning aid in third grade primary education in the field of natural sciences.*

Keywords: *game-based learning, Kahoot, Quizizz, primary education, pre-test-post-test research design, science education*

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Introduction

There are various factors which influence the effects of the learning process on academic achievement. Besides innate abilities, students' motivation is one of the most important factors (Lambić & Lipkovski 2012). Lack of motivation of students for learning (Lee & Hammer, 2011) represents a significant problem in contemporary education (Kiryakova et al., 2014) which can reduce learning outcomes due to the fact that it is very hard for teachers to foster student motivation over time during teaching (Wang & Tahir, 2020).

The problem regarding the lack of motivation for learning cannot be easily resolved by conventional methods (Goksün & Gürsoy, 2019). One of the approaches which can solve this problem is the application of student response systems (SRSs) in the classroom (Wang & Tahir, 2020) which have a positive impact on learning performance (Caldwell, 2007). Another good approach is the gamification of the learning process which can lead to the improvement of students' motivation and engagement (Goksün & Gürsoy, 2019). Game-based learning is very efficient because students are motivated to play a game and, in this process, they are learning without even being aware of it (Gee, 2003).

Several applications combine these two approaches (SRS and game-based learning) to resolve the concern of the lack of student motivation for learning. Each of these SRSs have a set of characteristics which is different from other software of the same type and thus it is reasonable to assume that the effects of the application of various software on student academic achievement can be different. Unlike most of SRSs which introduce a certain type of game experience, Kahoot is the first SRS developed from the ground up as a video game based on the game design principles which are related to intrinsic motivation and game flow (Wang & Tahir, 2020). Also, Kahoot is a very popular application used more frequently in game-based learning than other applications of that type (Goksün, Gürsoy, 2019). Another popular tool is Quizizz, whose application in education is compared with Kahoot in a number of research studies (Basuki

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& Hidayati, 2019; Cadieux Bolden et al., 2017; Chaiyo & Nokham, 2017; Goksün & Gürsoy, 2019; Halim et al., 2020).

Kahoot and Quizizz differ to some extent in the presentation of the questions, feedback, progression speed and method of questions, technical requirements, etc. Each of these differences can be considered as an advantage (Goksün & Gürsoy, 2019). Moreover, it is important to bear in mind that the application of educational software needs to be adapted to the learners' age, abilities (Lambić et al., 2021) and to the subjects which are studied (Đorić et al., 2021). Therefore, the effects of the application of different educational software on the academic achievement of students, of a specific age, in specific subjects, need to be explored.

The efficiency of formative assessment tools is significantly influenced by the characteristics of learning content and the way in which these tools are used (Đorić et al., 2021). Such tools have less of an effect in natural sciences education compared with other fields (Kingston & Nash, 2011). A lesser effect can be caused by the volume of feedback which is often much bigger in natural scientific fields (Maier et al., 2016). The intellectual abilities of students, required for learning science education content, depend on their working memory capacity (Gathercole et al., 2004). The development of the working memory capacity in primary school students (grades 1-4) is closely related to their problem-solving skills (Swanson et al., 2008) which is important for science education. For this reason, it is important to examine the effects which can be achieved by using Kahoot and Quizizz in those aspects of primary education related to the natural sciences.

In the previous literature, there were only a few research studies regarding the application of Kahoot or Quizizz in science education in primary and secondary schools. In one of these studies in which 39 students participated, the application of Kahoot in an earth science course reduced the anxiety level of 9th grade students (Lee et al., 2019). The students in the 12th grade expressed a positive opinion regarding the use of Kahoot in the classroom for learning mathematics and science (Curto Prieto et al., 2019). In another research, Kahoot was used to improve the motivation and engagement in lower secondary school science course (de Sousa, 2018). None of these studies dealt with students involved in primary education. Despite the fact that the subjects dealing exclusively with science content, such as physics, biology and chemistry, were usually studied from the fifth grade of elementary school, science content was also studied in the first four grades. For example, the science content in primary education in some countries was studied in the subject "nature and society" (Diković & Gergorić, 2020).

In a literature review regarding the application of Kahoot in education (Wang & Tahir, 2020) it was determined that only four percent, out of 93 papers, dealt with primary education. One research study regarding the application of Kahoot, Quizizz and Socrative in social science classes included 23 second grade primary school students (Cadieux Bolden et al., 2017), but the results of this study were invalid due to many technical problems (Wang & Tahir, 2020). Another research dealt with the application of Kahoot, in which 23 fourth grade primary school students participated, but Kahoot was used in social science classes (Çetin, 2018) and therefore the results of this research do not give us an insight about the applicability of this tool in science education.

Other studies on the application of Kahoot and Quizizz in education in which primary school students participated dealt with the learning of the English language (Tivaraju et al., 2017; Yunus & Tan, 2021). Both Kahoot and Quizizz were used in research in which 60 primary school students participated (Halim et al., 2020), but there was no comparison of the effects achieved by these two tools because all the items in the instrument used to measure the students' attitudes towards these tools were related to both Kahoot and Quizizz and therefore these tools were not separately examined. There were also a few research studies dealing with the comparison of the effects achieved by Kahoot and Quizizz in university and adult learning studies (Basuki & Hidayati, 2019; Chaiyo & Nokham, 2017; Goksün & Gürsoy, 2019), but with inconsistent results.

A wider review of the literature showed that the application of Kahoot and Quizizz is beneficial in several ways for students in secondary education and older (Curto Prieto et al., 2019; Goksün & Gürsoy, 2019; Lee et al., 2019; Wang & Tahir, 2020). The previous research also showed that the application of Kahoot and Quizizz in social sciences and English courses has multiple positive effects on primary school students (Cadieux Bolden et al., 2017; Halim et al., 2020; Tivaraju et al., 2017; Yunus & Tan, 2021). However, none of these studies deals with the learning science content in primary school. Because of the difference in intellectual abilities between students in primary school and those older (Gathercole et al., 2004; Lambić et al., 2021; Swanson et al., 2008), plus specific characteristics of natural science content which limits the effects of tools of this kind (Kingston & Nash, 2011; Maier et al., 2016), there is a possibility that the application of Kahoot and Quizizz in natural science education for primary school students (grades 1-4) can have lesser effects on the academic achievement in comparison with the results of the previous studies dealing with the older students' learning in language and social content. For this reason, research on the effect of the application of these tools for learning science content in primary education is undertaken. The aim of this research is to investigate

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the effects of game-based learning, via Kahoot and Quizizz, on the academic achievement of primary school students in natural science classes. Based on this aim the following research questions are formulated:

1. What is the effect of game-based learning using Kahoot on the academic achievement of primary school students in natural science education?
2. What is the effect of game-based learning using Quizizz on the academic achievement of primary school students in natural science education?
3. Is there a difference in the effects of game-based learning using Kahoot and Quizizz on the academic achievement of primary school students in natural science education?

Research Methodology

General Background

This research was conducted during the September and October of the school year 2021/2022. In this period, for the students from the 3rd grade of primary school, the natural sciences content was taught through the subject "nature and society". In this study a pre-test–post-test research design was used to assess the students' knowledge of natural science before and after the experiment. The study began about two weeks after the beginning of the school year.

Participants

It was planned that 118 third grade primary school students from six classes in Serbia had to fully participate in this study, but 5 students were not able to participate in all the required activities (pre-test, post-test, or experimental phase). For this reason, one hundred thirteen students (63 boys and 50 girls; 9 years old) actually participated. A simple random sampling technique was used to divide the participants of this research into two experimental and one control groups. The first experimental group used Kahoot as a learning aid (n=43; 24 boys and 19 girls), the second experimental group used Quizizz (n=41; 23 boys and 18 girls), while the control group learned the content of natural sciences without using any tool of this type (n=29; 16 boys and 13 girls). Based on ANOVA, no significant differences between the achievement of different groups in the pre-test were found ($F(2, 110)=3.079$, $p=.677$, $p>.05$).

Instrument and Procedures

The academic achievement test initially consisted of 15 questions from the natural sciences content of the "nature and society" course (related to the biology content), which were used in schools for several years to assess the students' knowledge of this field at the beginning of the school year. The test was reviewed by a panel of 5 teachers and experts from the field of education, and a pilot test was conducted involving 27 students. Questions with a distinctiveness limit below the 0.20 were excluded from the final version. The final version of the test consisted of 13 questions and the maximum of 42 points having a mean difficulty of .5975 percent. The reliability of the achievement test was determined using Cronbach's alpha. For the pre-test, Cronbach's alpha was .75 while for the post-test it was .77. Both values exceeded the acceptable level of .70 (Nunnally, 1978).

Before the experimental phase, all the students who participated in the research were tested using the pre-test. The students from all three groups learned the content in the same way except for one difference. The students from the experimental groups had the opportunity to participate in the game-based learning sessions which were provided at the end of each class. The first experimental group used Kahoot in which the content was presented in the form of a quiz or presentation, while the second experimental group used Quizizz in the same manner. The game-based learning sessions in the experimental groups were used for revising the content, which the students learned in class. In the control group, revising the content was conducted in the traditional way without using any software. All the students participated in this research voluntarily with the signed consent from their parents. All personal data collected in this research were treated anonymously and confidentially.

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Data Analysis

After four weeks of the experimental phase, the students were tested again to determine the effects of the applied learning strategies. A one-way independent-samples analysis of covariance (ANCOVA) was used for the analyses of the results. The independent variables were the three strategies used in natural sciences classes, while the dependent variables were the results of the post-test. The results of the pre-test were the covariate.

Research Results

The results of the pre-test and post-test are shown in Table 1. The value of the coefficient $F(2,107) = 1.17$, $p = .314305$ ($p > .05$) confirms the hypothesis of the homogeneity of the regression coefficient.

Table 1
Means and Standard Error Values of Pre-test and Post-test Results

Group	*N*	Pre-test		Post-test	
		M	σ_M	***M***	σ_M
Experimental group Kahoot	43	19.42	1.35	30.07	1.24
Experimental group Quizizz	41	19.41	1.19	27.83	1.18
Control group	29	18.07	1.12	24.52	1.49

In order to eliminate the influence of the pre-test (covariate) on the results of the post-test (dependent variable), ANCOVA was used. The results of this test showed significant differences between the academic achievement of the three groups after the experiment ($F(2,109) = 4.43$, $p=.014$, $p < .05$) (Table 2). For this reason, the students' academic achievement was taken to be influenced by the experimental treatments. The effect size of 0.42 was considered to be large for Cohen's f test (Cohen 1988).

Table 2
Summary from ANCOVA Test

Source of variation	Type III sum of squares	*df*	*MS*	*F*	*p*	η_p^2
Pre-test	2616.962	1	2616.962	70.432	.000	.393
Group	329.525	2	164.762	4.434	.014	.075
Error	4050.003	109	37.156			
Total	78338.000	113				

In order to obtain detailed results, a post hoc test was used. The results were as presented in Table 3. The significant difference in the results of the post-test were only established between the academic achievement of the group which used Kahoot as a learning aid and the control group ($p < .05$). The post hoc test analysis did not show significant difference between the results of the groups using Kahoot and Quizizz ($p > .05$). Also, no significant difference was found between the results of the group which used Quizizz and the control group ($p > .05$).

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Table 3
Results from Post Hoc Test

(I) group	(J) group	MD (I-J)	σ_M	*p*	95% confidence interval for differencea	
					Lower bound	Upper bound
Kahoot	Quizizz	1.557	1.331	.244	-1.080	4.194
	Control	4.368*	1.469	.004	1.457	7.279
Quizizz	Kahoot	-1.557	1.331	.244	-4.194	1.080
	Control	2.811	1.483	.061	-.129	5.750
Control	Kahoot	-4.368*	1.469	.004	-7.279	-1.457
	Quizizz	-2.811	1.483	.061	-5.750	.129

**p<.05*
[a] Adjustment for multiple comparisons: Least significant difference (equivalent to no adjustment)

Discussion

The results of this research show that the group which used Kahoot as a learning aid has achieved significantly better results in the post-test than the control group. This result is in line with the previous research study, which demonstrated that game-based learning by using Kahoot increased the achievement and participation of 7th grade students in social studies classes (Turan & Meral, 2018). It is noted that other research papers, although dealing with positive effects of Kahoot on anxiety level (Lee et al., 2019), positive opinions of students (Curto Prieto et al., 2019; Çetin, 2018) and improved motivation and engagement (de Sousa, 2018), they did not deal specifically with the effect of Kahoot on the academic achievement of students. Nevertheless, they reported positive effects which could be suggested as facilitating the improvement of academic achievement after the use of this tool and therefore implicitly seen as supporting the results of this research study.

Although some research indicates that younger students are not able to use such tools for learning to the full extent, due to their limited intellectual abilities (Gathercole et al., 2004; Lambić et al., 2021; Swanson et al., 2008), the results of this study show that the application of Kahoot in the 3rd grade of primary school can significantly improve their academic achievement. Also, evidence from previous studies show positive effects for the application of Kahoot for learning language and social sciences, but such tools have questioned or limited effects when learning-science (Kingston & Nash, 2011; Maier et al., 2016). For the above-mentioned reasons, it is to be expected that the effects of the application of this tool on younger students is reduced to some extent. However, bearing in mind the sample in this study and the content learned during the experiment, there is evidence that Kahoot can be used effectively in the 3rd grade primary school for natural science education. Therefore, we can claim that the intellectual abilities of 3rd grade primary school students and the specific characteristics of science education content cannot significantly reduce the effects of the application of Kahoot.

The group which used Quizizz as a learning aid achieved better results than the control group, but the post hoc test analysis does not show a significant difference. This is in line with the results of the previous research study in which pre-service teachers participated (Goksün & Gürsoy, 2019). The lack of a significant difference between these two groups is unexpected to some extent, due to many advantages which learning with Quizizz offers. The reason for lesser effects of Quizizz on the academic achievement of students may lie in the limited visual feedback capacity of the Quizizz application and the manner in which the questions progress (Goksün & Gürsoy, 2019).

The results of this research show that there is no significant difference in the academic achievement of the groups which use Kahoot and Quizizz as a learning aid, although the group using Kahoot achieve better results on the post-test. The absence of a significant difference can be explained by the many similar features between Kahoot and Quizizz. On the other hand, the group using Kahoot indicate significantly better results on the post-test compared with the control group, while the group using Quizizz do not achieve the same. This fact indicates that Kahoot may have a greater impact on the academic achievement of students than Quizizz. The results obtained in

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this research are in line with the previous study (Goksün & Gürsoy, 2019) in which no significant difference between the effects of Kahoot and Quizizz on the academic achievement of pre-service teachers is found. Other studies show that the application of Kahoot contributes to higher concentration, engagement, enjoyment, perceived learning, motivation, and satisfaction than the use of Quizizz (Chaiyo & Nokham, 2017). These can be seen to support the results of this research study indicating that to some extent, Kahoot is more effective than Quizizz.

Research by Basuki and Hidayati (2019) showed that Quizizz is more preferable than Kahoot for participants learning the English language. Although students' preferences can influence the efficacy of some tools, other characteristics can have a greater effect on the learning outcomes. Also, the content presented by some tools can have a major impact on its effectiveness (Kingston & Nash, 2011; Maier et al., 2016). Therefore, it is possible that some features of Quizizz are more convenient for learning languages, while the features of Kahoot better support the demands of science studies. For this reason, the effects of Kahoot and Quizizz on the academic achievement of students from different fields of study, can be examined in future research.

Future research can also give more attention to the age of students. The results of this research study show that students from the 3rd grade of primary school can use Kahoot effectively for learning natural sciences. However, due to the development of the working memory capacity of primary school students, there can be differences in the ability of students of different ages to effectively use different tools (Lambić et al., 2021). For this reason, future research can explore the ability of students, from the first two grades of primary education, to effectively use Kahoot in their learning.

This research study has some limitations. Although the majority of research papers dealing with the application of Kahoot in education have a smaller number of participants than this study, there are research studies which include a few hundred or even a thousand participants (Wang & Tahir, 2020). Also, this research is conducted only with the participants from one country which could influence the generalizability of the obtained results to some extent. For these reasons, research with a larger international sample is needed for higher validity.

Conclusions and Implications

In this research study, the effects of game-based learning by using Kahoot and Quizizz in the third grade of primary school education were examined. Bearing in mind the importance of learners' age when the application of software in learning was being considered and the specific characteristics of natural science education, it was seen as important to determine the effects which could be achieved by these tools with learners of a young age. The intellectual abilities of 3rd grade primary school students and the specific characteristics of science education content could be a cause for the reduction of the effects of the application of such tools.

The results of this research study showed that there were no significant differences in the academic achievement of the group which used Quizizz and the other two groups. On the other hand, the experimental group, which used Kahoot as a learning aid in the natural science course, achieved a significantly better result on the post-test than the control group. This result showed that Kahoot had a significant effect on the academic achievement in the field of natural science of the third grade primary school education. For this reason, we were able to conclude that the intellectual abilities of 3rd grade primary school students (and older ones) and the specific characteristics of science education content did not reduce significantly the effects of the application of Kahoot. Therefore, Kahoot could be recommended as a learning aid in primary education starting from the 3rd grade. It is further recommended that future research should explore the ability of students, from the first two grades of primary education, to effectively use Kahoot in order to close the knowledge gap regarding the usability of this tool in elementary school. Another recommendation for future research was that the effects of Kahoot and Quizizz on the academic achievement of students from different fields of study should be examined and compared.

Based on the results of this research study it could be recommended that teachers in primary school use Kahoot as a learning aid for revising the content which the students learn in class. Also, learners from the 3rd grade of primary school and older can use this tool as a learning aid because of its proven positive effects on academic achievement. Furthermore, consideration needed to be given to the professional development of teachers including some training on how to use this tool in the classroom and how to present learning content by using Kahoot in order to achieve the best effects on the students' learning process.

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Declaration of Interest

Authors declare no competing interest.

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