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STUDENTS' OPINIONS TOWARD USING ONLINE PLATFORM SOCRATIVE IN CHEMISTRY EDUCATION

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Abstract. *With the development of technology, various new applications are increasingly used in schools. Their implementation often creates a stimulating environment for learning and leads to an increase in student performance. Due to their effectiveness, student responder systems (SRS) and similar mobile applications are increasingly used in teaching. The aim of the research was to examine students' opinions on application of Socrative online platform as a SRS in chemistry classes during formative evaluation. The sample included 77 primary and secondary school students from the Republic of Serbia. Online Socrative quiz was applied to evaluate their knowledge about mixtures (in primary school) and about antibiotics (in secondary school). After the quiz students filled out a questionnaire on their opinions towards the Socrative platform. The questionnaire consisted of 26 items organized in five subscales: advantage, belief, engagement, usability, and satisfaction. The obtained results showed that students had a positive opinion on the application of Socrative in chemistry education. As the positive features, students pointed out real-time feedback and increased engagement and motivation in class. Based on the obtained results, it can be concluded that students enjoy the use of online platform Socrative, so it is recommended for further use in chemistry classes in order to increase student participation and to develop a more efficient evaluation methodology.*

Keywords: *chemistry education, mobile learning, student response system, Socrative quiz*

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Introduction

The student response system (SRS) is widely used in teaching because empirical studies have shown that their application increases the engagement and involvement of students during the class (Heaslip et al., 2014). Responder systems are reliable and convenient (Dervan, 2014), very effective for both students and teachers. It makes learning easier for students and teaching for teachers (Aljaloud et al., 2015; Awedh et al., 2014). It has been confirmed that the application of SRS contributes to better student achievement and causes less mental effort in solving tasks compared to the conventional approach (Radulović, 2021).

In a review paper (Aljaloud et al., 2015), the researchers have explained that the future of the responder systems is in applications for cell phones and already existing mobile devices (tablets, laptops). One such application is Socrative - user-friendly online SRS. Unlike the 'clickers' – special handheld remote responder devices, Socrative is web-based and requires no additional software or setup. A smartphone (or other mobile device) with a web browser and internet access is all that is needed (Balta & Tzafilkou, 2019). There are a free Socrative version and a commercial Socrative Pro version (Socrative, n.d.). They are both fully functional, and the only advantages of a pro version are the unlimited number of quizzes, unlimited number of rooms and a larger group of students who can simultaneously access the application.

Socrative enables formative assessment of students and offers instant feedback (Roman et al., 2021). Based on students' responses, teachers can assess their progress. If students identify themselves during the accessing the application, it is possible to grade them and save their answers. This feature is very useful for teachers who are used to assessing students' knowledge on a regular basis using short tests. Socrative provides the possibility to view results as a file in tabular form (Balta & Tzafilkou, 2019).

One of the main reasons for using Socrative platform is the fact that it supports the application of various types of questions (Dakka, 2015), so teachers can organize various exercises and activities for students. As student responses can be presented immediately, a stimulating atmosphere is created

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(Kaya & Balta, 2016), student engagement is increased (Dakka, 2015; Dervan, 2014; McKenzie & Ziemann, 2020) and cooperative learning is encouraged (Awedh et al., 2014; Dervan, 2014). The application of Socrative in chemistry teaching provides a solution for maintaining student engagement whether the courses take place live - face to face, online or in blended learning. The application of Socrative in online teaching of general chemistry during COVID-19 managed to maintain a certain continuity and active learning even in a separate classroom (Christianson, 2020).

Also, it was shown that most students have an easier understanding of material concepts and ambiguities during learning (Dervan, 2014; Roman et al., 2021). It has been found that the application of Socrative in Chemistry courses increased class attendance, academic performance, student satisfaction and motivation, and helped create a more pleasant learning environment (Roman et al., 2021). Similar findings were observed in the teaching of physics (Mendez-Coca & Slisko, 2013; Radulović, 2021). The application of Socrative has proven to be very effective when carried out before an experimental session in chemical engineering (García-Fayos et al., 2021). By solving tests via cell phones, students can easily assess their level of knowledge. Feedback on test errors before experimental work also provides them with information on the parts of the material in which they received poorer results and to which they should pay more attention.

Research Problem

Scientific literacy and critical thinking are key components of science education, and chemistry education in particular, that aim to prepare students to think and function as responsible citizens in a world increasingly affected by science and technology (Vieira & Tenreiro-Vieira, 2016). According to the official results of the Ministry of Education, Science and Technological Development of the Republic of Serbia of student achievement for 2018 on the international PISA test, the average achievement in scientific literacy amounted to 440 points and was below average. Compared to the achievement of students from other countries in the region, the achievements of Serbian students were better than Montenegro, Northern Macedonia and Bosnia and Herzegovina, and lower than Croatia, Slovenia, and Hungary (Videnović & Čaprić, 2018). In order to improve learning of chemical content and chemical literacy in students, new methods of teaching have to be applied in Serbian schools, and the solution could be the application of SRS.

Striving to create a stimulating environment for students, the application of ICT in education has become an essential element of the educational environment (Hernandez, 2017). Based on the review of available literature, it can be concluded that the application of Socrative and generally SRSs increases student engagement in class (Balta & Tzafilkou, 2019; Dakka, 2015; Dervan, 2014; Santos et al., 2019). However, very few studies have examined the effectiveness of Socrative in chemistry education, and no such research was conducted in the Balkan countries. Therefore, the significance of this study is even greater and is reflected in the perception of the affective domain of student learning after the application of Socrative in the primary and secondary chemistry education in the Republic of Serbia.

Research Aim and Research Questions

The aim of the research was to examine students' opinions on application of Socrative online platform as a SRS in chemistry education in order to improve chemistry teaching during classes of evaluation - to increase student participation and to develop a more efficient evaluation methodology. A research question that arose from the aim of the research was: What are the opinions of students of different age and gender and different achievement in chemistry toward the application of Socrative in chemistry teaching?

Research Methodology

General Background

Since there is no published research on the application of Socrative platform as a SRS during chemistry classes in the Balkan countries, this research was aimed at obtaining students' opinions on Socrative online quizzes during review of chemical content. This quantitative research was designed to be conducted in two parts: review

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of content via cell phones using Socrative quiz, followed by filling out an online Google form with questions on students' satisfaction with this form of formative assessment. A research instrument was designed according to the results from the research by Balta and Tzafilkou (2019). The research was conducted with students of primary and secondary school after the application of Socrative quiz during one review chemistry class in the second semester of 2020/2021.

Sample

The sample comprised two classes of students of the primary school "Dr Jovan Cvijić" (in Zrenjanin) and two classes of the secondary school (Zrenjanin Grammar School) from Serbia. These classes were chosen because they were taught by the same chemistry teacher to avoid the interference factor in the research. The total number of students in these classes was 113, but 77 respondents completed the questionnaire. Of the total sample, 68.8% were seventh grade primary school students (aged 13-14), while 31.2% were fourth grade secondary school students (age 18-19). The sample consisted of 48.1% male and 51.9% female participants.

All students participated in the research on a voluntary basis, and informal consent from parents, teachers and the school pedagogue/principal was obtained. The research was conducted anonymously to ensure student privacy. The students were informed about the goal of the research and that the results will be used exclusively for scientific purposes. The students could give up at any time.

Instrument and Procedures

The applied instrument consisted of 26 items on the 5-point Likert-type scale (Strongly Disagree = 1, Strongly Agree = 5). The items were divided into five subscales that referred to the advantages of using the Socrative application compared to other knowledge evaluation methods, opinions on its application, on student engagement during classes, ease of use and general impression after using the application. The questionnaire consisted of 26 items organized in five subscales: advantage (questions 1-6), belief (questions 7-12), engagement (questions 13-16), usability (questions 17-21), and satisfaction (questions 22-26). The applied instrument was adapted from a questionnaire originally created by Balta and Tzafilkou (2019) for examining students' opinions on the application of Socrative in teaching physics. The questionnaire was translated to Serbian and modified to suit the purpose of this research. The reliability coefficient of the instrument in this survey was .79.

Free Socrative platform was used in chemistry classes during 2020/2021 with seventh grade primary school students and fourth grade secondary school students from Serbia. Socrative quiz was applied to primary school students during the reviewing the topic on homogeneous and heterogeneous mixtures (in primary school) and on antibiotics (in secondary school). Review of the teaching content was conducted using the online Socrative platform in the form of multiple-choice quizzes designed to facilitate understanding and to provide instant feedback to students. After class, the students filled out an online questionnaire provided as a Google form, in which they expressed their opinion on the application of Socrative in chemistry teaching by selecting one of the given answers.

Data Analysis

The collected data were processed using the IBM SPSS software (version 20). In addition to the calculation of descriptive statistics using t-test for independent samples and one-factor analysis of variance (ANOVA), the differences between the given research variables were also tested.

Research Results

Students' Opinion on the Application of Socrative in Chemistry Teaching

In the first step, the descriptive statistics of all subscales were calculated (Table 1). It is observed from the table that the participating students have a highly positive opinion on the application of Socrative in chemistry in all five dimensions: advantage, belief, engagement, usability, satisfaction.

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Table 1
Descriptive Statistics of Student Responses

Subscales	Min	Max	*M*	*SD*	Skewness	Kurtosis
Advantage	18	28	23.21	1.86	0.066	0.487
Belief	14	30	26.32	4.09	-1.191	0.588
Engagement	7	20	16.79	3.39	-0.968	0.410
Usability	12	25	16.40	3.26	0.996	0.698
Satisfaction	9	25	23.44	3.22	-0.669	0.485
Total	77	122	106.17	9.64	-0.953	0.958

The results of the correlation between the subscales are presented in Table 2. Among the scales, Engagement has the highest correlation with Belief, while Advantage has the least statistically significant correlation with Usability.

Table 2
Pearson Correlation Analysis of the Subscales

Subscales	Advantage	Belief	Engagement	Usability	Satisfaction
Advantage	1	-.064	-.047	.257*	-.013
Belief		1	.691**	.020	.602**
Engagement			1	.054	.545**
Usability				1	–.119
Satisfaction					1

Note: *$p < .05$; ** $p < .01$

Table 3 shows the arithmetic means and standard deviations for each statement. Four statements (3, 18, 20, and 21) were negatively worded and values for M and SD were presented without transforming the response.

Table 3
Descriptive Statistics for All Items

Subscales	Items	*M*	*SD*
Advantage	1. Chemistry classes are more interesting when Socrative is applied.	4.78	0.50
	2. Answering questions using Socrative platform is faster compared to tests in paper form.	4.79	0.47
	3. Checking chemistry knowledge is less objective when applying Socrative	3.47	1.32
	4. Reviewing of the material in chemistry is more interesting with the application of Socrative.	4.75	0.57
	5. Answering questions using Socrative platform is easier compared to tests in paper form.	4.46	0.87
	6. Compared to the tests in paper form, using Socrative helps me find out faster whether I answered the question correctly.	4.82	0.51
Belief	7. Socrative will be increasingly used in chemistry education.	4.39	0.81
	8. Socrative should be used in primary school.	4.57	0.83
	9. Socrative should be used in secondary school.	4.57	0.77
	10. Socrative should be used in university.	4.22	0.95
	11. Socrative should be used in other courses as well.	4.68	0.73
	12. If my chemistry teacher used Socrative more often in classes, I would probably have higher grades.	3.90	1.24

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Subscales	Items	*M*	*SD*
Engagement	13. Time passes faster when Socrates is used in chemistry classes.	4.60	0.76
	14. Applying Socrative in chemistry classes increases my motivation to learn.	3.96	1.13
	15. Applying Socrative in chemistry classes increases my engagement in chemistry class.	4.30	1.00
	16. Applying Socrative on my cell phone increases my interest in learning chemistry.	3.94	1.27
Usability	17. Socrative is easy to use.	4.86	0.42
	18. Socrative platform is difficult to access via cell phones.	1.64	1.22
	19. The percentage of correct answers can be seen in real time.	4.49	0.90
	20. It bothers me that I don't have enough time to think while answering questions in Socrative.	2.35	1.41
	21. It bothers me that at the end of the test in Socrative, I can't check my answers one more time.	3.06	1.44
Satisfaction	22. I have a positive opinion on Socrative platform.	4.75	0.46
	23. I like to apply Socrative in reviewing chemistry content.	4.77	0.60
	24. I would like to apply Socrative in chemistry classes in the future.	4.74	0.73
	25. I would like to apply Socrative in chemistry classes more often.	4.65	0.79
	26. I wish we had used Socrative before.	4.53	0.95

Differences in the Opinion of Students of Different Gender about the Application of the Socrative Platform in Chemistry Education

In order to test the differences in the opinions of male and female students on the application of Socrative in chemistry teaching, a t-test for independent samples was applied. The obtained results showed that the differences were not statistically significant (Table 4).

Table 4
T-Test Results for Independent Samples

Subscales	Gender	*M*	*SD*	*t*	*df*	*p*
Advantage	M	22.91	1.63	-1.318	75	.190
	F	23.47	2.02			
Belief	M	26.54	3.71	0.443	75	.659
	F	26.12	4.45			
Engagement	M	16.54	3.22	-0.624	75	.534
	F	17.02	3.55			
Usability	M	16.13	3.69	-0.690	75	.493
	F	16.65	2.83			
Satisfaction	M	23.70	2.42	0.682	75	.498
	F	23.20	3.83			

Differences in the Opinion of Students of Different Levels of Education on the Application of the Socrative Platform in Chemistry Education

Using the t-test for independent samples, differences in the opinions of students of different ages were tested and the obtained results showed that there are statistically significant differences in students' opinions (Table 5). The differences proved to be significant on the Belief, Satisfaction and Engagement dimensions, while the differences on the Advantage and Usability dimensions were not statistically significant.

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Table 5
T-Test Results for Independent Samples

Subscales	School	*M*	*SD*	*t*	*df*	*p*
Advantage	1	23.00	1.78	-1.469	75	.146
	2	23.67	1.97			
Belief	1	27.30	3.42	3.312	75	.001*
	2	24.17	4.67			
Engagement	1	17.37	3.14	2.315	75	.023*
	2	15.50	3.62			
Usability	1	16.07	3.19	-1.314	75	.193
	2	17.12	3.37			
Satisfaction	1	24.17	1.85	3.111	75	.003*
	2	21.83	4.76			

Note: school: 1- primary school; 2- secondary school

Differences in the Opinion of Students with Different Grades in Chemistry on the Application of the Socrative platform

To check the existence of differences in the opinion of students who have different grades in chemistry, students were divided into three groups. Group 1 consisted of students who had grades 2 and 3 in chemistry (9 students); group 2 consisted of students who had a grade 4 in chemistry (14 students) and group 3 consisted of students who had a grade 5 (53 students). Using one-factor analysis of variance, the differences between students' responses were examined. The obtained results are given in Table 6 and show that the differences are not statistically significant.

Table 6
Results of One-Factor Analysis of Variance

Subscales	*F*	*df*	*p*
Advantage	2.747	2 (74)	.071
Belief	1.838	2 (74)	.166
Engagement	1.130	2 (74)	.328
Usability	1.140	2 (74)	.325
Satisfaction	0.202	2 (74)	.818

Discussion

The application of new technologies in chemistry teaching is an area of research in which there is a steady increase in number of published papers (Evans & Moore, 2011). The application of the Socrative and generally SRS in teaching has increased over the past decade (Balta & Tzafilkou, 2019), which requires feedback from students on the extent to which they like its application.

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In this research, the opinions of students on the application of Socrative in the teaching of chemistry in primary and secondary school were examined. The results showed that the students included in the research expressed a highly positive opinion on the application of Socrative (77% of students completely agreed and 22% mostly agreed with the statement that they liked using Socrative in chemistry classes). Findings from other studies have shown predominantly positive feedback in the teaching of biology (Liu & Taylor, 2013), sports management (Dervan, 2014), and pharmacy (Munusamy et al., 2019). Moderate attitudes were observed in teaching physics (Balta & Tzafilkou, 2019).

The surveyed students pointed out that the largest advantage of using Socrative platform during classes of reviewing educational content, in contrast to the traditional way of reviewing, was that they immediately received information on accuracy of their answers. Numerous studies have shown that direct timely feedback has significant positive results and helps improve student achievement (Juwah et al., 2004; Roman et al., 2021). It also keeps them engaged and promotes learning (Munusamy et al., 2019). When using Socrative platform, students receive instant feedback on their achievement in real time (McKenzie & Ziemann, 2020; Molloy & Boud, 2014).

Also, this research confirmed that reviewing is faster, more interesting and easier than using tests in paper form. The findings are in line with a recent study which confirmed that the advantage of this application is the ability to evaluate the knowledge acquired during the class in a very simple way (Santos et al., 2019).

Students agreed to a lesser extent with the statement which indicated that the knowledge test is more objective when applying Socrative. This result may be a consequence of a negatively formulated statement, so the students did not understand it well. The use of the SRS (Beatty et al., 2006) and Socrative in particular (Roman et al., 2021) has been shown to provide effective formative assessment.

The use of ICT in teaching, and the same applies to mobile learning which is becoming more and more present, is increasingly used in teaching. Numerous studies have shown that the use of computers and other electronic devices increases teaching and learning skills (Luu & Freeman, 2011). According to the surveyed students, Socrative should be increasingly used not only in the teaching of chemistry but also in the teaching of other subjects. Also, students believed that it should be applied in teaching at all educational levels – in primary and secondary schools and at the university. These perceptions are supported by the literature: Socrative has proven to be an effective software in teaching different subjects and different levels of education (Balta & Tzafilkou, 2019; Guarascio et al., 2017; Radulović, 2021; Roman et al, 2021; Santos et al., 2019).

Previous similar research has shown that the application of Socrative increases student engagement in class as well as improves students' understanding of the material (Dervan, 2014; Munusamy et al., 2019; Roman et al., 2021). This research confirms that the application of Socrative increases the engagement of students in review classes in chemistry. The students also stated that chemistry classes were more interesting when Socrative was applied and that their motivation to learn increased. This finding has also been confirmed in previous research (Awedh et al., 2014; Roman et al., 2021). According to the students, the interest in learning chemistry has increased because Socrative is applied on the cell phone. Santos et al. concluded similarly in the research related to the application of Socrative via cell phones during the experimental work in chemistry laboratory (Santos et al., 2019). In this research, it was shown that Socrative is suitable for the implementation of active learning strategies and for evaluation in chemical lab exercises. It also optimizes collaborative learning and student engagement in the laboratory and consequently improves academic achievement.

A review of the available literature mostly states a number of positive effects while the negative sides are rarely mentioned. Some of the downsides cited are, for example, that teachers may focus more on technology than on teaching, the possibility of technical problems with software, problems with Internet access, or a lack of teacher experience. The results obtained in this study confirm that students find Socrative easily and reliably accessible via cell phones, which was stated in many previous studies (Balta & Tzafilkou, 2019; Dervan, 2014). However, some students also pointed out some negative aspects of the Socrative platform in reviewing chemical content. Namely, the students stated that they did not have enough time to think while answering the questions and that at the end of the test they could not check their answers once again. Such concerns are usually expressed by students who do not have a developed competitive spirit and do not enjoy this form of learning. Also, anxiety can occur when the grades obtained by applying the SRS are part of their overall grade (Dervan, 2014). Solving tasks often requires paper and pencil, which students cited as a downside of Socrative in physics teaching (Balta & Tzafilkou, 2019; Kaya & Balta, 2016).

Based on the results of this research, students have a positive opinion of Socrative and enjoy using it. They were also sorry for not applying the Socrative platform earlier and expressed the wish to apply Socrative not only in reviewing the content, but in other forms of work/classes. It is in accordance with previous studies in which

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students expressed satisfaction with using Socrative (Dervan, 2014; McKenzie & Ziemann, 2020; Munusamy et al., 2019). Similar to the findings of other authors (Balta & Tzafilkou, 2019; Kaya & Balta, 2016), it was established in this research that there were no statistically significant differences between students with different grades in chemistry, and also between opinions of male and female participants, so gender differences shouldn't be taken into account when applying Socrative.

However, statistically significant differences were recorded between primary and secondary school students on three subscales (belief, engagement, and satisfaction). Primary school students achieved higher scores on all three subscales. More specifically, primary school students have deeper beliefs that Socrative should be used at all levels of education (basic, secondary and tertiary). This difference is especially noticeable in the opinion that they would have a higher grade if they had used Socrative more often. It is in line with previous findings which agreed that Socrative platform improves learning (Rae & O'Malley, 2017) leading to higher academic achievement. There has been empirical evidence that after a period of adaptation to the application of Socrative in teaching, there is an increase in test results in students (García-Fayos et al., 2021).

It is an indisputable fact that the application of Socrative increases the engagement of all students in classes. However, it has been shown that primary school students are motivated and interested in learning chemistry to a greater extent. Primary school students have also shown higher satisfaction in using Socrative in chemistry education and greater desire to apply it more in the future. It was shown that there is a significant relation between classroom environment and students' motivation in learning (Lee et al., 2009). Due to their younger age, primary students enjoy playing games more, and the application of Socrative makes learning chemistry fun for them, giving them the feeling of self-efficacy and more control over the learning process. Reduced interest and motivation and lowered self-perceptions in secondary students has been recorded before (Yeung et al., 2011). It can be explained by the secondary students' perceptions of their own weaknesses which grow as they mature, as well as their lack of perception of relevance of academic work to their future (Wigfield & Eccles, 2000).

Conclusions and Implications

After application of online Socrative software during review of teaching content in primary and secondary school, students' opinions on its usage in chemistry classes were examined. It was found that reviewing with Socrative was quick, easy, and effective. Students believed that the biggest advantage was getting real-time feedback. Also, the use of Socrative on cell phones in class increases students' engagement and motivation to learn chemistry. Students enjoyed using Socrative and they would like to apply it more in the future, not only in chemistry classes, but also in other courses. Based on these findings, using Socrative can be recommended as a promising tool with excellent properties.

The results of this research implicate that learning chemistry with responder systems can positively affect students' interest for learning chemical content. However, regular use of Socrative in chemistry education requires the training of teachers, especially older teachers who are not familiar with mobile learning, for using it in the classroom, and the significant change in their approach to using methods of active learning in their teaching practice.

Despite the original scientific contribution of this research, the obtained results cannot be generalized due to certain limitations regarding the sample size and the duration of application of Socrative in teaching. For example, increasing the sample of students and teachers in future research, including students from different grades and educational levels, as well as longer application of Socrative in teaching different chemistry disciplines would give a more complete picture of the effectiveness of Socrative in chemistry teaching and of student feedback.

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Declaration of Interest

The authors declare no competing interest.

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