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The effect of using personal response system on 6th grade students' achievement and attitudes towards science and technology

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Abstract

This study examines the effect of using a personal response system (PRS) on students' academic performance and attitude towards science and technology. The study is conducted during the spring semester of the 2018-2019 academic year in a secondary school in northwestern Turkey. The study is designed as a pre-test and post-test control group design, with 21 in the control group and 23 in the experimental group. The Science Achievement Scale and the PRS Attitude Scale were administered to 92 students in the pilot study during the scale development process. The study is conducted on one unit in the course syllabus called "The World of living things and indispensable part of our lives: electricity." The researcher worked with the group two hours a week for six weeks. Every week after the lecture, the class teacher made their students solve multiple-choice questions with PRS in the experimental group and paper-based in the control group. The quantitative section of this study included three tools: the Achievement Test, the Attitude Toward Science Scale, and the Attitude Toward PRS Scale. Although results showed no difference in achievement between pre-test and post-test scores in both groups, the experimental group showed a promising difference in their attitudes toward science. In addition, boys were more positive about PRS than girls based on the PRS attitude scale. The qualitative component involved focus group discussion with a random sample of six surveyed students and an interview with the class teacher. Students provided positive feedback regarding the use of PRS. They appreciated peer discussions that instructors facilitated while using PRS. The teacher was likewise enthusiastic about implementing PRS in his class.

1. Introduction

Depending on the technology, the methods, techniques, and materials used in learning and teaching environments are constantly updated. Because the innovations and changes that the 21st century brought to people's lives also affect their learning and teaching styles. The courses can be delivered using various methods, applications, environments, and materials. Sometimes, a course environment is tried to be created within a specific curriculum framework and sometimes independently of the curriculum. However, the fact that only the course subject, course material, or instructor is effective does not create a sufficient learning environment on its own (Clark & Feldon, 2014). It is stated that such learning environments do not center students, do not provide effective learning, and do not offer active learning (Açıkgöz, 2011; Çubukçu, 2012). Studies have shown that methods and techniques that encourage student participation make the lesson more involved and support learning. Hamouda and Tarlochan (2015) state that active learning

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necessitates a high level of student participation in the learning process, which includes not only reading and listening to information, but also student participation in class meetings, presentations, and promoting real-life experiences and other events. According to the generative theory of learning, students learn more effectively when they engage in an active cognitive process (Prince, 2004). Gainor, Bline and Zheng (2014) state that active learning improves students' incorporation, behavior toward the course, and commitment to their education and academic institute, lowering dropout rates and creating a competitive learning environment. In their study, Qureshi et al. (2021) discovered that active learning through collaborative learning is related to student engagement.

The Turkish Ministry of National Education (MONE) has expanded its attention on technology integration in schools to create more student-centered classrooms and satisfy the demand for 21st-century skills throughout the previous decade. Secondary schools have access to the Internet and interactive smartboards through the FATIH project. Interactive technologies are encouraged to be used by both instructors and students to enhance the teaching/learning process. Learning is proven to benefit from teaching techniques that promote interaction and debate. Therefore, Personal Response Systems (PRSs) are a type of sophisticated interactive technology that may be utilized in the classroom to enhance active learning. PRSs (Chan and Knight, 2010), also known as Student Response Devices (SRSs) (Anthis, 2011), Classroom Response Systems (CRSs) (Graeff et al., 2011), Electronic Question Voting System (Electroy) (Fidan and Debbağ, 2014), or clickers (Hunsu, Adesope, and Bayly, 2016), are electronic voting systems used in class to gather student replies to a specific question. Teachers may use PRSs to show multiple choice questions on a screen or interactive smart board, and students can answer instantaneously with their PRSs.

PRSs are a type of instructional technology that has grown in popularity in recent years (Liu, Sands-Meyer, & Audran, 2019). PRS has been demonstrated to provide several advantages for both students and instructors. It allows teachers to ask questions in large courses, collect real-time replies from students, and deliver fast feedback to them, according to Preis, Kellar, and Crosby (2011). This cutting-edge educational technology enables ubiquitous teaching and learning, allowing many students to participate in active learning and achieve better learning outcomes (Berry, 2009, Ares et al., 2018; Dolezal et al., 2018). Because of the anonymity and simplicity of usage, Heaslip, Donovan, and Cullen (2014) discovered that when students utilize PRS, they become more involved, engaging, and interactive. Students that utilized PRS had increased motivation, self-efficacy, involvement, and engagement, according to Liu, Sands-Meyer, and Audran (2019). Wang, Ran, Huang, and Swigart (2019) added more game-based aspects to PRS and discovered that students like it. Personal response systems (PRS) have been widely employed to increase teaching and learning effectiveness by encouraging students' active participation and engagement in various classroom situations (Ma, Steger, Doolittle & Stewart, 2018). PRSs may completely engage students in the classroom, allowing instructors to assess students' grasp of (or misunderstandings about) subjects in real-time and assisting instructors in identifying students who may need more support.

PRSs are becoming increasingly popular in education, and research has focused on their emotional effects, such as improved student involvement, attention, and debate (Trees and Jackson, 2007; Muir et al. 2020). Active learning is supported by activities such as discussion, debate, inquiry, and explanation through PRS. Gauci et al. (2009) claim that superior learning results result from a shift in pedagogical focus from passive to active learning rather than the employment of a specific technology. Numerous studies have shown that students who actively engage with things they are learning and create their knowledge achieve deep and enduring learning.

There are various self-report studies on students' perceptions of PRSs, such as how much they enjoyed using them or how beneficial they found them in terms of learning or engagement (Ares et al., 2018; Dolezal et al., 2018; Draper & Brown, 2004). Experiential studies with control groups, on the other hand, are very limited (Gök, 2011; Mayer et al., 2009; Wang & Lieberoth, 2016). Gök (2011) used PRS with an experimental study in a physics course for a semester. According to the research results, it was revealed that the students in the experimental group were more successful in conceptual learning than the students in the control group. In addition, it was observed that there was a positive increase in the level of interaction of the students in the experimental and control groups based on individual and class wide. Kim and Dopico (2014) looked at the consequences of secondary school science curriculum revisions. The study found that students who were taught through an inquiry and negotiation-based curriculum had a more favorable perception of the classroom environment than those led through an academic-centered scientific curriculum. They also discovered significant links between students' perceptions of their classroom environment and their attitudes, concluding that appropriate student attitudes could be promoted in constructivist classes where students shared responsibility with teachers, discussed topics with peers and instructors, and perceived content and instruction to be relevant to them.

In Turkey, science is a compulsory subject throughout compulsory school. As a result, engaging pupils in scientific classrooms can be difficult. Students in regular lecture classes take notes passively and struggle to maintain their attention until the end of the lesson. Baltaci-Goktalay (2016) states that students frequently believe they are the only ones who don't comprehend the topic and are hesitant to raise inquiries. Furthermore, students often express their dissatisfaction with class lectures and the lack of opportunities for engagement. Students claim that it is not the instructors' fault but rather the provided material (Baltaci-Goktalay, 2016). PRSs were used to make classrooms more learner-centered, interactive, and enjoyable in order to keep students engaged with the subject being given. They also support enhancing active learning in large courses by incorporating it into lectures and delivering feedback. According to previous research, studies switched the focus of lecture engagement from understanding to higher cognition in application and analysis at the level of the questions being asked

Although earlier studies on the benefits of the PRS have been done, given the advancements in technology and their favorable effects on student performance, further research is needed to understand how the PRS might increase active learning (Wong & Yau, 2020) and support students attitudes toward science and technology. The growing use of the PRS necessitates pedagogical guidance on its application and consideration of aspects such as the quality of PRS-based instruction and the educational practice's appropriateness. The PRS was widely used in the disciplines of arts, social science, and scientific education, according to the findings of Wong and Yau (2020). However, it is seen that the studies are generally carried out with university students (Akkuş, Özkan & Çakır, 2021; Ares et al., 2018; Ayebi-Arthur & Owusu, 2020; Chaiyo & Nokhan, 2017; Muir et al., 2020, Özüdoğru, 2020, Ranieri, Raffaghelli & Bruni, 2021; Taşkın & Bahadir, 2021), and very few studies are carried out with secondary school students (Baltaci-Goktalay, 2016; Shyr, Hsieh & Chen, 2021). Besides, experimental studies are minimal at the secondary school level. The current study fills this gap in the literature through empirical research.

This study aims to answer the questions about the effects of PRS on student achievement and students' attitudes towards the Science and Technology course, and what the perceptions of teachers and students are towards PRS. Depending on the purpose of the research, the following research questions were identified:

1. Does the use of PRS impact the science and technology achievement of secondary school students?
2. What are the secondary school students' attitudes towards PRS use in science and technology course?
3. How is PRS perceived by students and teachers of science and technology course?

2. Methodology

2.1. Participants and Procedure

The participants included 44 secondary school students (23 girls and 21 boys) in two science and technology course sections. The students were between 12 and 13 years old. There were 23 students (%52.3) in the experimental group and 21 students (%47.7) in the control group. In the study, an experimental design with a pretest-posttest control group was used. In the pretest-posttest control group design, two groups were formed on convenience sampling. One of them is used as the experimental group and the other as the control group. In both groups, pre-experimental and post-experimental measurements are applied. The presence of pre-tests in the model helps to know the degree of similarity of the groups before the experiment and correct the post-test results accordingly (Karasar, 1984). In this direction, the 6th-grade students, which constitute the subject groups, were determined by the convenience sampling method. While solving the questions, Electroy (PRS used in this study) was used in one of the groups, and worksheets were used in the other. On a technical level, Electroy is made up of software for creating and managing questions and three hardware components: interactive remote handheld devices (clickers), a receiver unit, and a classroom computer with a projection system. Students respond using remote handheld devices known as "clickers." Each clicker unit has a unique ID, allowing each student's response to be identified, recorded, and graded. PRS and worksheets used in the research were independent variables, and academic achievement and attitudes towards science and technology courses were dependent variables.

The research was conducted in the spring semester of 2018-2019. The course design was different for the two sections. One section used PRSs, and the other section used worksheets. While the students in the control group responded to questions by worksheets, the experimental group used PRSs. According to Technology-Enhanced Formative Assessment (TEFA) principles, a pedagogy developed for teaching with personal response system technology (Beatty & Gerace, 2009), the teachers prepared multiple-choice questions. PRS technology plays an essential supporting role in the TEFA. Students discuss a question with their peers or think about it alone before reporting their answer choice with clickers when the teacher asks a question. Following the display of the histogram of responses, a whole-class discussion usually follows, followed by the teacher presenting or presenting some type of closure. Following an iterative question cycle, the process is repeated with a new question (Beatty & Gerace, 2009). The four principles of TEFA are as follows: Instruction based on questions (Motivate and focus students with questioning), Dialogical discourse (Use dialogical discourse to improve pupils' comprehension), Formative evaluation (Inform and adjust teaching and learning decisions based on a formative assessment) and Communication on a meta-level (Help students develop higher-level skills and cooperate in the learning process). Questions were presented to both groups during the class for two hours a week over a period of six weeks. The research covers "Let's Travel and Get to Know the World of Living Things" and "Indispensable in Our Lives: Electricity" subjects. The experimental model of the research is shown in Table 1.

Table 1.

Research Model

Groups	Pre-tests	Experiment	Post-tests
Control Group	• Science Achievement Test • Science Attitude Scale	• Problem-solving using worksheets	• Science Achievement Test • Science Attitude Scale
Experimental Group	• Science Achievement Test • Science Attitude Scale	• Problem-solving using PRS	• Science Achievement Test • Science Attitude Scale • PRS Attitude Scale
The course teacher and 6 students selected from the experimental group			• Interview on PRS Attitude

The implementation phase was conducted as follows: two classes were determined by the convenience sampling method, based on the fact that it facilitates the experiment process in terms of the curriculum. The Science Achievement Test, which the course teacher developed, was applied as a pre-test to all students to measure their course success. The Science Attitude Scale was applied as a pre-test to determine the attitudes of all students towards the science and technology lesson. According to the Science Achievement Test and Science Attitude Scale pre-test results, it was determined that there was no significant difference between the subjects. Accordingly, the students were determined as experimental and control groups. Before the experiment, one hour of pre-training was given to the experimental group students to get acquainted with the PRS and get used to the remote handles (clickers). The experimental period covered six weeks. Following the course curriculum, two hours of lectures per week continue, and one hour of question solutions are given in this process. As a result of the 6-week research, the same Science Achievement Test and Science Attitude Scale were applied to the experimental and control groups as a post-test. In addition, the PRS Attitude Scale was administered to the experimental group. PRS Interview Questions were asked in the form of an interview with the course instructor and six students selected from the experimental group.

2.2. Data Collecting Tools

The effect of using PRS on students' course achievement and attitudes toward the course was determined in this study while solving questions in the 6th-grade science and technology course. Furthermore, the attitudes of the lesson teacher and the students in the experimental group toward the use of PRS were assessed. Three data collection tools were used to collect the necessary data for the study. The Science Achievement Test (SAT) was created by the science and technology course instructor and consists of 24 multiple-choice questions. All of the questions in the test are related to the course curriculum units "Let's Travel and Get to Know the World of Living Beings" and "The Indispensable of Our Lives: Electricity" and are applied following the program. As a result of the test and material analysis performed during the test development process, the materials' difficulty, distinctiveness, and item-total correlation coefficients were calculated. For the validity study, a table of specifications was prepared, and the Content Validity Index (CVI) was found to be 0.94 by taking an expert opinion. As a result of the analysis, six items were removed from the test, and the KR-20 reliability coefficient of the final test consisting of 18 items was calculated as 0.87. As a result of the item analyses, while item difficulty indices were valued between 0.30 and 0.74, item distinctiveness indices were valued between 0.31 and 0.72. The average difficulty of the test was calculated as moderate (0.57), and its distinctiveness was calculated as very good (0.48). The researcher developed the Science Attitude Scale (SAS) to assess students' attitudes toward science and technology course. The scale was prepared in a 5-point Likert type (Strongly disagree to strongly agree) and consisted of 28 items. The overall score ranges from 28 to 140 points. High scores on the scale indicate that students have more positive attitudes towards science. According to the CFA results ($\chi 2$ /df = 3.80, RMSEA=.08, SRMR = .02, CFI = .93, GFI = .93) the scale is valid and reliable. The scale had one factor, and explained variance was found to be 42.95%. Cronbach's Alpha reliability coefficient analysis was performed and found quite reliable (0.926). Expert opinions were obtained from one professor of science, one teacher of science and technology course, one professor of psychological counseling, and a linguist for the scale.

The researcher developed the PRS Attitude Scale (PAS) to assess students' attitudes toward using PRS in science and technology course. The scale was prepared in a 5-point Likert type (Strongly disagree to strongly agree) and consisted of 30 items. The overall score ranges from 30 to 150 points. High scores on the scale indicate that students have more positive attitudes towards PRS use in science and technology courses. According to the CFA results ($\chi 2$ /df = 3.77, RMSEA = .063, SRMR= .09, CFI = .86, GFI = .85), the scale was valid and reliable. The scale had one factor, and explained variance was 40.35%. Cronbach's Alpha reliability coefficient was 0.74 and was found to be quite reliable. For the scale, the opinions of one computer education and instructional technology professor, one science and technology course teacher, and a linguist were gathered. In addition, the researcher conducted interviews with instructors and students to learn about their experiences and perspectives on using PRS as supplementary material for addressing questions in the classroom.

2.3. Scale Development Process

In order to determine the statements that will be included in the scale development process, the scale development resources were examined in the literature; a likert-type scale was developed based on the scale development principles and steps of DeVellis (2017). The following steps were taken during the SAS and

PAS scale development processes. *Clearly identifying the structure to be measured*: This measurement tool was developed to reveal the attitudes of students about science and PRS use. *Determining the measurement format and creating the item pool*: A literature review was conducted about science attitude. As a result, the specified statements were converted into a format that could be used in the scale form, and a Likert-type draft form was designed, creating an item pool of 46 items with positive and negative statements. *Review of the item pool by the experts (determination of coefficient of concordance):* At this point, the draft form was sent to field experts (one professor of science, one teacher of science and technology course, and one professor of psychological counseling) and a linguist (faculty member) for evaluation of both the scale's content validity and whether the prepared items were appropriate for the measurement tool. Scale items were designed as "appropriate, appropriate after corrections, and inappropriate" in the draft form sent to experts. The Miles and Huberman (1994) consensus formula was used to calculate the coefficient of concordance among the raters. After determining the coefficient of concordance among the raters, the draft form of 46 items was reduced to 28 items, and the coefficient of concordance was determined to be 93% for the agreement among the raters for the 28-item form. This result indicates that the items discovered in the draft form will reveal students' attitudes toward science. The same procedure was repeated for PAS scale development. Based on the literature, the specified statements were converted into a format that could be used in the scale form, and a Likert-type draft form was designed, creating an item pool of 42 items with positive and negative statements. The draft form was sent to field experts (one professor of computer education and instructional technology, one science and technology course teacher, and a linguist). The draft form of 42 items was reduced to 30 items after determining the coefficient of concordance among the raters, and the agreement among the raters was determined to be 95% for the 30-item draft form. Pilot application: The draft SAS scale and PAS scale were applied to 92 secondary school students outside the sample group within the scope of validity for usefulness. As a result of the pilot implementation, the final form of the SAS scale included a total of 28 items, seven of which were negative (Appendix A). PAS scale included 30 items, and nine of the items were negative (Appendix B). *Application of items to the scale development sample*: Draft forms were implemented for 92 secondary school students in northwestern Turkey in the 2018-2019 academic year. *Evaluation of items and putting the scale into the most appropriate form:* Following the application of the items to the scale development sample, statistical analyses were performed, the items were revised for the final time, and the scale was given its final form for factor analysis. The KMO and Barlett results of the 28 items, which remained after excluding 18 items from the draft PAS scale as a result of the analyses, were 0.682, and the Bartlett' test of sphericity was statistically significant. According to the CFA results ($\chi 2$ /df = 3.80, RMSEA=.08, SRMR = .02, CFI = .93, GFI = .93) the scale is valid and reliable. The KMO and Barlett results of the 30 items, which remained after excluding 42 items from the draft PAS scale as a result of the analyses, were 0.848, and the Bartlett' test of sphericity was statistically significant. According to the CFA results ($\chi 2$ /df = 3.77, RMSEA = .063, SRMR= .09, CFI = .86, GFI = .85) the scale is valid and reliable.

2.4. Data Analysis

The data from the attitude scales and achievement tests were analyzed using the AMOS 22 and SPSS 20.0 statistical package program, while the data from the interviews with the instructors and students were analyzed using the descriptive analysis approach. Differences between SAT and SAS pre-test and post-test results were analyzed by independent samples t-test.

3. Findings and Discussions

In order to investigate the difference between pre-test and post-test scores for the science achievement test, independent samples t-test was run. Table 2 shows the results for both the experimental and the control groups.

Table 2.

Descriptive statistics and Independent groups t-test results for SAT pre-test and post-test scores for experimental and control groups

	Groups	N	Mean	Std. Error	t	Sd	p (Sig.)
SAT pre-test	Experimental Group	23	72.16	17.73	.250	42	.80
	Control group	21	70.63	22.53			
SAT post-test	Experimental Group	23	79.08	15.46	1.140	42	.26
	Control group	21	72.70	21.37			

According to the data collected with the SAT pre-test of the groups ($t_{(42)}$=.25, p>0.05, d=0.10), there is no statistically significant difference between the experimental and the control groups at the 0.05 level. To put it another way, the academic achievements of both groups are comparable before the trial begins. According to the SAT post-test results, there was no statistically significant difference between the mean scores of the experimental and control groups, despite a 6.26 rise in favor of the experimental group ($t_{(42)}$=1.14, p>0.05, d=0.49). SAS pre-test and post-test scores were analyzed with the independent groups' t-test. Results are presented in Table 3.

Table 3.

Descriptive statistics and Independent groups t-test results for SAS pre-test and post-test scores for experimental and control groups

	Groups	N	Mean	Std. Error	t	Sd	p (Sig.)
SAS pre-test	Experimental Group	23	117.69	12.02	.11	42	.91
	Control group	21	118.57	20.97			
SAS post-test	Experimental Group	23	101.66	15.76	1.59	42	.04
	Control group	21	91.78	24.17			

Prior to the experiment, it was discovered that both experimental and control groups' attitudes regarding science and technology courses were quite similar ($t_{(42)}$=.11, p>0.05, d=0.04). When the SAS post-test averages are compared, it is clear that there is a substantial difference in favor of the experimental group after the experiment in the attitudes towards the Science and Technology course($t_{(42)}$=.1.59, p<0.05, d=0.69). In order to determine whether there is a significant difference between the SAS pre-test and post-test of the experimental group, a t-test was applied to two paired groups. Table 4 presents the results.

Table 4.

Descriptive statistic and Independent groups t-test results for SAS pre-test and post-test scores of the experimental group

	N	Mean	Std. Error	t	Sd	p (Sig.)
SAS pretest	23	117.69	12.02	5.08	22	.000
SAS posttest	23	101.66	15.76			

The results show a significant and moderate difference between experimental groups' pre-test and post-test scores in terms of attitude toward science and technology courses ($t_{(22)}$=.5.08, p<0.00, d=0.44). PAS scale results were also analyzed with independent groups t-test in terms of gender. Table 5 shows the results.

Table 5.

Descriptive statistic and Independent groups t-test results for PAS in terms of gender

	Gender	N	Mean	Std. Error	t	Sd	p (Sig.)
PAS	**Boys**	10	78.70	13.14	2.93	21	.049
	Girls	13	65.66	7.37			

According to Table 5, the average score of boys belonging to PAS is 78.70, while 65.66 for girls. According to the PAS results ($t_{(21)}=2.93$, $p<0.05$, $d=0.53$), there was a significant and moderate difference in favor of boys, with 13.04 points between students' opinions regarding the use of PRS by gender.

At the end of the experiment, the researcher conducted semi-structured interviews with the course teacher and six students to get their feedback on PRS use in the classroom. The teacher was asked whether PRS use affected students in terms of interaction and what changes he observed in the students. According to the teacher's response, the children were more eager to participate in the lesson. Teachers said that "*Electroy provides quick feedback in terms of students' learning. The student also understands and learns the questions he made wrong. In another question, he observes a decrease in his mistakes and a decrease in his incorrect answers. Electroy encourages students and motivates them to participate in class*." He also stated, "*The competitive atmosphere generated when answering the questions encouraged the kids to do better. They improved their ability to answer questions more quickly than previously*." The teacher was asked about the advantages and disadvantages of using PRS in terms of the efficiency of the lesson. He stated that "*It gives immediate feedback on children's progress. The student also comprehends and remembers the questions that he answered incorrectly. In another inquiry, he notices his errors and incorrect replies are decreasing. Complementary to the subject's comprehension*." He also stated that since not every school or classroom has the same infrastructure, it would be unfair to use Electroy (PRS system) in one class but not in the other. Interview results can be interpreted that PRS use may help teachers encourage active learning in science and technology courses and may help the lessons fun and memorable. When the lesson is taught with the method of asking questions through personal PRS, it may be easier to reveal the subjects that the students misunderstood.

In the interview with the students, firstly, "Did you like using PRS in the lesson?" and "What kind of benefits do you think PRS has for you?" questions were asked. The students who participated in the interview stated that the Science and Technology course taught using PRS was more enjoyable. Sıla noted that "A*fter our teacher taught us the lesson, it was so fun to answer the questions all together with clickers. We tried to compete with each other, and the course was more enjoyable. We remember more this way. Some of the questions were asked during the final exam. Since I remembered the questions, it was easy for me to answer during the exam."* They solved more questions because they read and answered the questions faster. And they also stated that they learned better, their participation and interest in the lesson increased, and it was entertaining to use PRS, as the teacher instantly identified the wrong questions and explained the correct ones thanks to PRS. One of the students stated that "*it is better than the traditional method for the teacher to explain the subject first and then solve the question with PRS. It makes it easier for us to remember. It's also a lot of fun this way. We may have solved the same question in the exam. When we make the wrong subject that the teacher tells us, he solves the question again. I used the method the teacher explained to the same question that appeared in the exam, and I answered that question correctly*." Students were also asked whether they would like PRS to be adapted to other courses. Most of the students answered yes. One of the students suggested that "Mathematics would not be tough if we use PRS." Interview results revealed that in the lessons taught with PRS, it is seen that the students are engaged in the tasks at the maximum level, they pay more attention, they both have fun and learn the specific subjects.

4. Conclusion and Suggestions

The Science and Technology course is linked with daily living in terms of the disciplines covered. Students apply what they've learned in class to their daily lives, and they use what they've learned to solve difficulties. As a result, the supplementary materials, resources, and equipment utilized to help students enjoy the lesson more, come voluntarily to the class, learn easier, and get the most out of the lesson are extremely important. In this regard, the usage of PRS in the course is a critical component in satisfying these requirements. In line with prior research, in this study, students found PRS to be simple and enjoyable to use, and they believed it improved their learning, class engagement, and overall classroom learning effectiveness (Chen & Lan, 2013). Consistent with previous studies, this study demonstrated that students found PRS to be enjoyable and straightforward to use and that it increased their learning, class engagement, and overall classroom learning effectiveness (Akkuş, Özkan & Çakır, 2021; Arthur & Owusu, 2020; Baltaci-Goktalay, 2016; Chen & Lan, 2013). Wichadee and Pattanapichet (2018) stated that providing immediate feedback greatly affects students' motivation, and PRS allows all students to participate and receive feedback simultaneously. In this study, one of the prominent opinions of one of the participants about the PRS application is that it makes a positive contribution to concentration. Chaiyo and Nokham (2017) conducted an experimental study on the effect of PRSs on student perceptions. Their study stated that PRS application has positive contributions to concentration. Interview results in this study show that most of the students were in the direction of using PRS instead of worksheets in evaluation in the lesson.

As far as the second research question is concerned, whether the use of PRS has a positive influence on students' attitudes, the results confirm that PRS was highly appreciated. Results of the study show a significant difference in the attitudes toward PRS according to gender in the experimental group in which the PRS-assisted teaching method was applied. It was observed that male students' attitudes towards PRS were more positively affected than female students. It is seen that the competition of the students positively affects the activity in the lesson, their interest in the lesson, the development of question-solving techniques, and their gaining practicality.

This study has brought to light how class interactions can be improved in class. Because of the students' stated experiences, it is thought that if teachers employ PRS technology, student-teacher relations will improve. In order to make the use of PRS effective, internet infrastructure and support equipment should be provided across the schools. Recently, many Web 2.0 applications have been created to allow student interaction, brainstorming, and commenting via personal devices. Quiz applications, in particular, Socrative, Poll Everywhere, and Kahoot!, replicate the functionality of Electroy while introducing new features such as gaming aspects, modalities, and design (Ranieri, Raffaghelli & Bruni, 2021). The use of background sounds and music, timed questions and scores for correct answers, and player rankings are all examples of gaming aspects. These applications may also be used during the science and technology courses to boost the "fun" factor and add a game aspect to the classes.

Based on the results of this study, the following recommendations were made. Teachers should see PRS as an assistive tool in their teaching practice. The fact that they accept PRS-assisted teaching as an auxiliary teaching element can positively affect students' attitudes toward science and technology course. The difficulty level of the questions to be used within the scope of PRS, the number of choices, the content of the subjects, and other features can be arranged and used according to the target audience's characteristics. Seminars or pre-trainings can be organized to provide teachers with the necessary knowledge and skills to integrate PRS into their instruction. The experimental process should be spread over a wider period of time, and research should be carried out with a larger number of subjects. The research was carried out in secondary schools' science and technology course. Similar studies can be conducted in different disciplines.

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APPENDIX A

Fen ve Teknoloji Tutum Ölçeği

Sevgili Öğrenciler,
Bu anket sizin fen ve teknoloji dersine karşı tutumlarınızı ölçmek için geliştirilmiştir. Her cümleyi dikkatlice okuduktan sonra, cümleye ne derecede katıldığınızı veya katılmadığınızı belirtmek için yanındaki seçeneklerden birini (X) şeklinde işaretleyiniz.

Cinsiyet: Kız ◯ Erkek ◯ | Sınıf: | No:

	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1. Fen ve teknoloji konularında öğrendiklerimin hayatımı kolaylaştıracağını düşünüyorum.					
2. Fen ve teknoloji konularının gelecekte öneminin gittikçe artacağına inanıyorum.					
3. Fen ve teknoloji konuları ve uygulamaları ile ilgili kitaplar okumaktan hoşlanırım.					
4. Fen ve teknoloji konularının ilerideki meslek hayatımda önemli bir yeri olacağını düşünüyorum.					
5. Benim için fen ve teknoloji konuları eğlencelidir.					
6. Bana hediye olarak fen ve teknoloji ile ilgili bir kitap veya konu ile ilgili alet verilmesinden hoşlanırım.					
7. Fen ve teknoloji dersi sıkıcıdır.					
8. Fen ve teknoloji dersi zordur.					
9. Boş zamanlarımda Fen ve Teknoloji dersinin konularını okumaktan zevk alırım.					
10. Fen ve Teknoloji dersi beni korkutur.					
11. Okuldan sonra arkadaşlarla fen ve teknoloji konuları hakkında konuşmak zevklidir.					
12. Fen ve Teknoloji dersinin konuları ilgi çekicidir.					
13. Fen ve teknoloji konularında yapılacak iş ne kadar zor olursa olsun elimden geleni yaparım.					
14. Fen ve teknoloji konularını kolayca öğrenirim.					
15. Fen ve Teknoloji dersinin yaşamıma katkı sağlayacağına inanmam.					
16. Fen ve Teknoloji dersinin konuları aklımı karıştırır.					
17. Fen ve teknoloji konularını öğreneceğimden eminim.					
18. Fen ve teknoloji konularında öğrendiklerimin günlük hayatta işime yaracağını düşünüyorum.					
19. Fen ve teknoloji konularında başarılı olabileceğimden eminim.					
20. Fen ve teknoloji topluluğuna üye olmak isterim.					
21. Yeterince vaktim olursa fen ve teknoloji ile ilgili en zor problemleri bile çözebileceğimden eminim.					
22. Arkadaşlarla fen ve teknoloji konuları veya uygulamaları ile ilgili sorunları konuşmaktan hoşlanırım.					
23. Fen ve teknoloji ile ilgili daha zor problemlerle başa çıkabileceğimden eminim.					
24. Fen ve teknoloji konularında başarılı olmak için elimden geleni yaparım.					
25. Fen ve teknoloji konularında başarısız olduğumda daha çok çaba gösteririm.					
26. Sadece fen ve teknoloji dersinde başarısızım.					
27. Fen ve Teknoloji dersi benim için gereksizdir.					
28. Arkadaşlarımla Fen ve Teknoloji dersinin konularını tartışmaktan zevk alırım.					

APPENDIX B

Elektroy Tutum Ölçeği

Sevgili Öğrenciler,

Bu anket sizin derste Elektroy kullanımına karşı tutumlarınızı ölçmek için geliştirilmiştir. Her cümleyi dikkatlice okuduktan sonra, cümleye ne derecede katıldığınızı veya katılmadığınızı belirtmek için yanındaki seçeneklerden birini (X) şeklinde işaretleyiniz.

Cinsiyet: Kız ◯ Erkek ◯ Sınıf: No:

	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1. Elektroy destekli eğitim uygulamalarını kullanmak beni endişelendiriyor.					
2. Elektroy destekli eğitim sınıf arkadaşlarımızla işbirliğini arttırır.					
3. Elektroy destekli eğitim hakkında arkadaşlarımla konuşmaktan hoşlanırım.					
4. Fen Bilimleri dersinin Elektroy destekli olarak öğretilmesinden çekiniyorum.					
5. Elektroy ile sorulara daha rahat cevap veriyorum.					
6. Elektroy ile soruları kendi hızımda cevap verebiliyorum.					
7. Derslerde Elektroyun kullanılması beni eğlendiriyor.					
8. Elektroy ile sorulan sorularda sıkılıyorum.					
9. Derste Elektroy kullanıldıkça okula daha istekli geliyorum.					
10. Elektroy sayesinde derslerde daha çok soru yanıtlıyorum.					
11. Elektroy insanların eğitimde kullandıkları bir araçtır.					
12. Elektroy destekli eğitim uygulamalarını kullanma konusunda zorluk yaşamam.					
13. Elektroy destekli eğitim uygulamaları için gerekli becerileri öğrenme konusunda kendime güveniyorum.					
14. Elektroy ile soruları daha iyi anlıyorum.					
15. Elektroy sayesinde derslerime daha çok çalışıyorum.					
16. Elektroyun Fen Bilimleri dersinde kullanılmasıyla birlikte bu dersi daha iyi anlıyorum.					
17. Elektroy olmasaydı Fen Bilimleri dersini daha iyi anlardım.					
18. Elektroyun, Fen dersi için etkili bir araç olduğunu düşünmüyorum.					
19. Elektroy Fen Bilimleri dersinde daha yaratıcı düşünmeye yardımcı olmaktadır.					
20. Elektroy Fen Bilimleri dersine çeşitlilik katmaktadır.					
21. Elektroy ile Fen Bilimleri dersini işlemek ders kitabına göre daha çok bilgi aktarılmasını sağlamaktadır.					
22. Derste Elektroyun kullanılması zaman kaybına neden oluyor.					
23. Bence öğrenme açısından Elektroyun defter üzerinde soru çözme yönteminden hiçbir farkı yoktur.					
24. Elektroy sayesinde dersi daha dikkatli dinliyorum.					
25. Elektroy destekli eğitim uygulamalarını kullandığımda kafam karışıyor.					
26. Elektroy kullanımı derse olan ilgimi artırdı.					
27. Derslerde Elektroyun kullanılmasını yanlış ve gereksiz buluyorum.					
28. Fen Bilimleri dersini Elektroy destekli olarak öğrenmek isterim.					
29. Elektroyun Fen Bilimleri dersine normal soru çözme yöntemine göre daha fazla katkı sağladığını düşünüyorum.					
30. Elektroy destekli eğitimin benim merakımı arttırdığını düşünüyorum.					