e-ISSN 2795-3272
p-ISSN 2795-3264

10.5281/zenodo.10854964 Vol. 07 Issue 02 Feb - 2024 Manuscript ID: #01273

THE EFFECT OF AUGMENTED REALITY APPLICATIONS ON STUDENTS' SELF-EFFICACY PERCEPTIONS AND SOCIAL SKILLS TOWARDS SCIENCE LEARNING

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Abstract

This study aims to examine the effect of augmented reality applications on students' self-efficacy perceptions and social skills towards learning science in the "Sound and Properties" unit. For this purpose, a learning material containing augmented reality applications called SesAR was developed to be used in the 6th grade science course, Sound and Properties unit. The research was conducted with a quasi-experimental design, which is one of the quantitative research methods. The study group of the research consisted of 160 sixth grade students studying in two public schools in the central district of a medium-sized city in the Marmara region. During the application, augmented reality material was used in the experimental group and normal course materials such as textbooks, videos, animations, etc. were used in the control group. The data of the study were collected with "Self-Efficacy Belief Scale for Science Learning" and "Social Skills Scale". Mixed measures ANOVA and dependent independent groups t-test were used to analyze the data. The statistical results of the study showed that AR applications were effective on the level of self-efficacy beliefs towards learning science in teaching the 6th grade "Sound and its Properties" unit. At the level of social skills, it was determined that the pre-test scores of the students had medium level social skills, but the post-test scores remained at medium level and there was no statistically significant difference.

Keywords

Augmented Reality, Science teaching, Self-efficacy, Social skills, Sound and its properties.

Introduction

Information and communication technologies are used effectively in almost every aspect of modern life. From communication to business, from scientific research to our daily lives, these technologies have become indispensable tools. However, perhaps one of the fields that it has affected and transformed the most is education. Today, the rapidly changing era and technological advances create new requirements and expectations in education. Education is no longer limited to traditional classrooms. In the past, commonly used tools were simple technologies such as blackboards, chalk and classroom projectors. However, over time, these traditional tools have been replaced by more advanced technologies such as computers, tablets, smart boards, smart phones and the internet (Keleş & Yavuz, 2022). The advantages provided by the use of technology in education can generally be evaluated under two main categories: Benefits to the teacher and benefits to the student. The integration of technology into the field of education has reduced the workload of teachers. Developing tools and applications have shortened the course preparation process by utilizing technology in many areas such as exam preparation and planning of course activities (Alpar et al., 2007). The use of technology not only provides students with easy access to information, but also enables them to better understand the information and develop their affective skills. Technology-supported multiple learning environments can increase learning achievement by providing students with a safe, remarkable and intriguing learning experience similar to real life (Bursalı, 2022). Due to the rapid evolution of technology and the innovations it brings to our lives, it is important for educators to master technology and current approaches in education and to be able to apply this knowledge effectively in order to act in accordance with the needs of the new generation (Güner, 2018).

Science and technology should not be considered separately from each other today (Çepni, 2014). Science is a field that facilitates daily life and forms the basis of technologies (Doğru & Kıyıcı, 2005). The science course, which is suitable for the use of technology, facilitates the use of different teaching methods and techniques in teaching many scientific and abstract concepts (Ayas et al., 2001). Science teaching should benefit from the developments in instructional technologies as in other fields. Falling behind these developments or not using the technologies that make learning more efficient effectively in learning environments may negatively affect the learning process. Therefore, especially in science lessons, it is important to use tools and materials that focus on new technologies that increase students' learning efficiency (Fidan, 2018). The use of technology in science education provides visualization and experimentation opportunities that enable students to better understand subjects and concretize abstract concepts. Tools such as graphics, simulations and 3D visuals can help students better visualize abstract concepts. Also, thanks to technology, students can have the chance to learn science subjects by experiencing them.

One of the technologies recently used in the field of education is Augmented Reality (AR) technology. In the context of Augmented Reality education, it is a learning content that enables students to see different experiences and environments interactively in their environment through electronic devices (Klopfer, 2008; Sheehy, Ferguson, & Clough, 2014). AR is different from virtual reality in two ways. Firstly, AR allows virtual objects to be used in the real world with simultaneous interaction. The second is that it provides concrete interaction (Altıntaş, 2018). The use of augmented reality technology in education has many educational contributions. It makes learning more effective by providing students with the opportunity to embody and experience abstract concepts (Shelton & Hedley, 2002; Zagoranski & Divjak, 2003). By creating interactive learning environments, it encourages students' active participation and provides personalized learning experiences (Dunleavy et al., 2009; Yusoff & Dahlan, 2013). In addition, it helps students to better understand the subjects by supporting visual learning. In this way, students' motivation increases and the learning process

becomes more enjoyable (O'Brien & Toms, 2005; Sumadio & Rambli, 2010; Abdusselam & Karal, 2012; Aziz et al., 2012). This technology allows students to develop their self-efficacy and social skills along with their motivation. Therefore, augmented reality gains importance in education with its contributions to the individual and social development of students.

Self-efficacy perception is an important psychological factor (Bandura, 1986) that has a great influence on individual success, motivation and learning processes and affects individuals' confidence in their own skills and abilities. Self-efficacy is defined as an individual's ability to plan the activities required to accomplish a certain task and his/her personal evaluation of successfully completing this task (Aşkar & Umay, 2001). When self-efficacy perception towards science lesson is considered from a discipline-oriented perspective, it can be defined as the belief that the individual can evaluate and overcome the tasks, difficulties or situations in the field of science by evaluating his/her own abilities (OECD, 2016a). Before performing a behavior, individuals generally make a positive or negative evaluation about that behavior in the context of their self-efficacy beliefs (Yılmaz, 2007). Individuals with positive self-efficacy beliefs do not give up when faced with difficulties and can achieve success with a lower level of anxiety, while individuals with negative self-efficacy beliefs generally avoid difficulties or may fail by exhibiting low performance under extreme stress (Gordon et al., 1998 cited in Ercoşkun, 2022).

Considering the general goals of science education (Ministry of National Education [MoNE], 2018), it is thought that individuals with strong self-efficacy beliefs in science play an important role in terms of the progress of society (Hızlıok, 2012). A high self-efficacy perception of science subjects enables students to evaluate their science-related learning experiences more effectively (Akıllı & Genç, 2017). In many schools, the lack of content or materials in learning environments causes the applications not to be carried out at the desired level (Bozkurt & Sarıkoç, 2008). This situation reduces the opportunities for students to experience and learn by experiencing the applications, and the applications carried out in crowded groups or only watched applications limit the active participation of students (Abdüsselam, 2022). This passive participation may prevent students from raising their self-efficacy beliefs to the desired level. Accessing adequate learning resources and adopting effective learning strategies will help students learn and participate more efficiently. It is clear that an individual's thoughts about self-efficacy play an important role in understanding his/her performance and achievements in educational life. For this reason, a teacher who wants to increase students' self-efficacy should make teaching practices suitable for students' individual needs, include various activities by taking individual differences into consideration, use cooperative teaching methods and avoid comparing students with each other (Senemoğlu, 2007). Giving positive feedback to students, emphasizing achievements, giving responsibility and creating a positive classroom environment can also increase students' self-efficacy. In addition, innovative tools such as Augmented Reality have a significant potential to strengthen students' self-efficacy in science. Considering the interest of Generation Z children and young people in technology, AR applications in science lessons provide students with visual, auditory, tactile learning opportunities and help them understand the subjects better by attracting their attention. It increases students' interest and motivation. Therefore, AR applications in science education are expected to positively affect students' self-efficacy beliefs toward science learning.

Another element as important as self-efficacy perception in social life and the learning process is social skills. Social skills include developing behavioral patterns by focusing on social and emotional goals such as understanding the feelings of others by using one's emotional intelligence, communicating effectively, defending one's own rights without hurting others, helping and cooperating, and waiting one's turn (Whitted, 2011). Social skills play a critical role in many areas

such as success in social relationships, effective communication in business environments and harmony in group work. Being a peaceful and successful individual is closely related to social cohesion; this cohesion is based on the acquisition of social skills at an early age. Children should be equipped with these skills, which are among the requirements of social life, in schools where they are prepared for life. Thus, the peace and happiness of individuals as well as the unity and solidarity of societies can be secured (Samancı & Uçan, 2017). In this context, developing children's social skills is an important step to help their personal development and support them to be successful in social relations.

In order to develop social skills in lessons, it is necessary to have students work in groups, give projects and assignments that they can do collaboratively, have discussions and presentations in the classroom, and create environments where they can interact with various technologies. One of the applications that increase interaction in the classroom is AR technology (Azuma, 2004; Kerawalla et al., 2006; Ivanova & Ivanov, 2011; Behzadan et al., 2011; Bujak et al., 2013; Wojciechowski & Cellary, 2013; Wu et al., 2013; Enyedy et al., 2015). AR combines the virtual and real world. It not only interacts with virtual objects but also works in the real world. It is also a suitable technology for collaborative learning that provides interaction between learners (Chen, 2013). In this framework, AR applications in science education are expected to positively affect students' social skills.

It is thought that the current study will make important contributions to the literature in terms of the fact that no previous research has been conducted with AR applications in the "Sound and Its Properties" unit of science course and that it includes the variables of self-efficacy and social skills, which have been studied in a small number of studies.

The aim of the study is to examine the effect of augmented reality technology applications on students' self-efficacy perceptions towards science learning and social skills in the "Sound and its Properties" unit. In line with this purpose, answers to the following questions will be sought.

1. 1. Is there a statistically significant difference between the mean scores of the students' self-efficacy belief scale for learning science and the teaching of the "Sound and Properties" unit of the science course with AR applications?
2. 2. Does the teaching of "Sound and its Properties" unit of science course with AR applications create a statistically significant difference between the mean scores of students' social skills scale?

Method

Research Model

Quasi-experimental design with pretest-posttest control group was used in the study. In quasi-experimental designs, which is a type of research in which the experiment cannot be fully controlled but results are drawn by making comparisons between groups, there is no chance to apply intervention on randomly selected participants or to randomly divide participants into control and experimental groups (Büyüköztürk, 2015). In the current study, the quasi-experimental design was preferred because the classes in the schools affiliated to the Ministry of National Education were predetermined and the experimental conditions were not fully met. In the study groups, the existing classes were taught with materials prepared with augmented reality in the experimental groups and with normal course materials (printed materials, textbook, video, animation, etc.) in the control group within the framework of the MoNE curriculum.

Working Group

The research was conducted in the spring term of the 2022-2023 academic year. The study group of the research consisted of 160 sixth grade students studying in two public schools in the central district of the Marmara region, 84 students (51 girls and 33 boys) in the experimental group and 76 students (40 girls and 36 boys) in the control group. Table 1 shows the distribution of the students in the study group according to the groups and gender.

Table 1. Information about students in the experimental and control groups

Groups		Control Group		Experimental Group	
		Frequency (f)	Percentage (%)	Frequency (f)	Percentage (%)
Gender	**Girl**	40	53	49	58
	Male	36	47	35	42
	Total	76	100	84	100

The schools in which the research will be conducted were selected by convenient sampling method. Although convenient sampling method is preferred in easily accessible situations, it can be used to provide a more effective data collection process with limited resources (McMillan & Schumacher, 2010). While determining the schools, attention was paid to the number of branches at the grade level, the proximity of the schools to each other in terms of transport and the suitability of the existing schools.

Data Collection Instrument Used

Self-Efficacy Belief Scale for Science Learning (SEBSSL)

In the study, the "Self-Efficacy Belief Scale for Science Learning for Middle School Students," developed by Yaman (2016), was utilized. The scale consists of three dimensions: the first dimension of the scale is determined as students' self-efficacy towards individual achievement, the second dimension is self-efficacy towards performance, and the third dimension is self-efficacy towards outcome. The measurement tool, encoded in a 5-point Likert scale, consists of a total of 17 items, namely "Strongly Agree," "Agree," "Undecided," "Disagree," and "Strongly Disagree." The first factor, "Self-Efficacy towards Individual Achievement," consists of 9 items (items 1, 2, 3, 4, 5, 6, 8, 9, 10), the second factor, "Self-Efficacy towards Performance," consists of 5 items (7, 11, 12, 13, 14), and the third factor, "Self-Efficacy towards Outcome," consists of 3 items (15, 16, 17). The lowest possible score that can be obtained from the scale is 17, and the highest score is 85.

In Table 2 below, the reliability coefficient of each sub-dimension and general average score of the measurement tool is given.

Table 2. Reliability coefficient results of the total score of the measurement tool and sub-factors

Factors	Number of Items	Cronbach's Alpha Coefficients for the EFA Sample	Cronbach's Alpha Coefficients for the CFA Sample
Factor 1	10	0.83	0.82
Factor 2	4	0.74	0.73
Factor 3	3	0.69	0.66
Total	17	0.85	0.83

Social Skills Scale (SSS)

In the study, the "Social Skills Scale" developed by Kocayörük (2000) to measure the development of some fundamental social skills of students at the primary education level was utilized. The scale measures social skill areas such as initiating and maintaining conversation, listening, asking questions, expressing gratitude, participating in group activities, fulfilling group responsibilities, seeking help, and adhering to task division.
The scale, coded as "Never," "Sometimes," "Generally Appropriate," "Completely Appropriate," is in a 4-point Likert format and consists of 20 items. The lowest possible score that can be obtained from the scale is 20, and the highest score is 80. In terms of total score, the Social Skills Scale categorizes scores between 20-39 as low level, 40-59 as moderate level, and betwen 60-80 as high level.

Kocayörük (2000) found the reliability coefficient of the Social Skills Scale to be 0.75. Yükselgün (2008) used the same scale and found a reliability coefficient of 0.88, while Şara Hüroy and Güneş (2019) found a reliability coefficient of 0.88 in their study.

In the implementation process, materials were initially planned and developed based on the curriculum objectives and lesson plans. Augmented Reality (AR) cards were designed to cover the 6th-grade unit "Sound and Its Characteristics." These cards were developed by a software company over a period of 8 months, ensuring alignment with learning objectives and technical requirements. The content of the cards was evaluated by experts, and necessary revisions were made. As a result, 36 AR application contents were prepared, which can be scanned using a phone or tablet without requiring an internet connection. These applications present content related to the topic knowledge and objectives of the "Sound and Its Characteristics" unit in audio, visual, and video formats. Additionally, the worksheets include instructional texts and symbols on how to use pointers with tablets or phones. Some of the pointers used are shown in Figure 1.

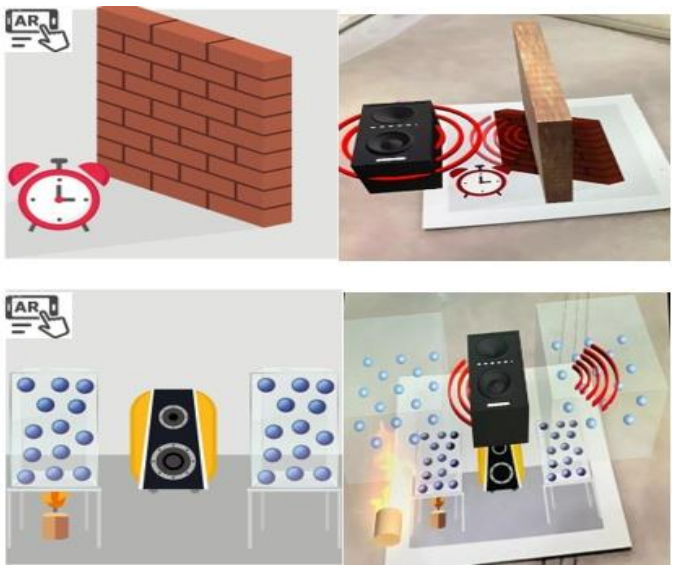

Figure 1. Some pointers used in AR applications and the images created when scanned

During the spring semester of the 2022/2023 academic year, an application was conducted within the scope of the 6th-grade science course, focusing on the "Sound and Its Characteristics" unit. Necessary permissions for the application were obtained before the research began. The study was conducted over a period of 7 weeks, equivalent to a total of 28 class hours. Pre-tests were administered to both experimental and control groups before the research. While AR materials were used for instruction in

the experimental groups, normal course materials (textbooks, printed materials, videos, animations, etc.) were used in the control groups. All groups utilized resources from the Education Informatics Network (EIN) and Ministry of National Education (MoNE) workbooks to reinforce learned topics. Students in the experimental group were briefed on the purpose and details of the study, followed by information on AR applications and technology. Groups of 4-6 students were formed in the experimental group, and each student was assigned group tasks. Phones, tablets, and worksheets related to the relevant learning outcomes were distributed to these groups. The application was initiated simultaneously in all groups. The teacher regularly monitored and guided the groups throughout the application process. Activities were implemented according to the instructions on the worksheets. Images related to the application are presented in Figure 2.

Figure 2. Images of the application

In the control groups, during the course sessions, questions were asked to engage students in inquiry-based learning, and determine their readiness and prior knowledge regarding the subject. Students were encouraged to conduct research from primary and secondary sources to find answers to the questions. They were also asked to make predictions based on their research findings and compare the research data and results. Experiments and activities from the textbooks were conducted, various videos and content related to the topic were shown on the smart board, and resources from MoNE workbooks and EIN were utilized to reinforce the learned topics.

Data Analysis

After collecting SEBSSL and SSS data in the study, these data were analyzed in the SPSS program. In order to perform parametric tests with existing data, it was checked whether the distribution of the data met certain conditions. For parametric tests, the data must be at least on an interval scale (maybe a ratio), must comply with normal distribution, and must satisfy the assumptions that the variances of the groups are equal (Can, 2014). In the process of determining the tests that should be used for analysis, the normality assumptions of the data were first tested. It was determined whether the data were normally distributed or not by looking at the median, mode and arithmetic mean values, as well as the skewness and kurtosis coefficients. When the skewness and kurtosis coefficients are divided by

the standard error of skewness and kurtosis, respectively, the resulting values (Z score) are between -1.96 and +1.96, and the distribution is considered normal (Can, 2014). If the skewness and kurtosis values are between -1.5 and +1.5 and the median, mode and arithmetic averages are equal or close to each other, it means that normality can be achieved (Tabachnick and Fidell, 2007). Below, the descriptive statistics of each test were calculated and checked whether they had a normal distribution or not, according to the reference information.

In Table 3, descriptive statistics data of the self-efficacy belief scale and social skills scale are given, and in Table 4, the Z skewness and kurtosis scores of the tests are given.

Table 3. Descriptive statistics of the pre-test and post-test results of the SEBSSL and SSS scales

	Group	Test	N	Average	Median	Mode	S	Skewness	Kurtosis
SEBSSL	Control Group	Pre-test	73	58.74	59	62	10.22	-.091	.417
		Post-test	73	56.56	56	55	11.05	. 043	.094
	Experimental Group	Pre-test	82	57.89	57	57	10.92	.159	.439
		Post-test	82	61.62	61	61	9.24	.100	-.735
SSS	Control Group	Pre-test	73	59.21	59	60	7.01	-.074	-.084
		Post-test	73	58.59	59	62	6.31	-.122	-.211
	Experimental Group	Pre-test	82	57.02	57	59	7.41	.250	-.494
		Post-test	82	59.50	60	60	8.25	.009	-.662

When Table 3 is examined, it is seen that the average mode median values for each test are close to each other and the skewness and kurtosis values are between -1.5 and +1.5. In addition, the Z Skewness and Z kurtosis scores of the tests are between 1.96 and +1.96 (Table 4).

Table 4. Pretest and posttest Z Skewness and Z kurtosis statistics results of SEBSSL and SSS scales

Tests	Group		Z Skewness		Z Kurtosis
SEBSSL	Control Group	Pre-test	-.091/.309	**-0.29**	.417/.608	**0.68**
		Post-test	.043/.309	**0.13**	.094/.608	**0.15**
	Experimental Group	Pre-test	.159/.266	**0.59**	.439/.526	**0.83**
		Post-test	.100/.266	**0.37**	-.735/.526	**-1.39**
SSS	Control Group	Pre-test	-.074/.309	**-0.23**	-.084/.608	**-0.13**
		Post-	-.122/.309	**-0.39**	-.211/.608	**-0.34**

	test				
Experimental Group	Pre-test	.250/.266	**0.93**	-.494/.526	**-0.93**
	Post-test	.009/.266	**0.33**	-.662/.526	**-1.25**

As a result of the analyses, it was determined that SEBSSL and SSS pre-test and post-test scores of the experimental and control groups were normally distributed. Two-factor ANOVA, Dependent and Independent Samples T-Test were used to compare the scores of the experimental and control groups.

Validity and Reliability

In our study, the concepts of validity and reliability are important elements that increase the quality of the research. Validity refers to how accurately the measurement tool can measure the desired feature without confusing it with other variables (Yıldırım & Şimşek, 2013). To determine the validity of a test, the scope of the test is analysed, the test results are compared with an appropriate criterion and the structure that the test wants to measure is examined (Atılgan, Kan, & Doğan, 2009). The validity and reliability of the results of a scientific study are directly related to the accurate description of the data collection method and process (Bakioğlu & Kurnaz, 2011). In the present study, the data collection tools and process were explained in detail, and the data analysis process was explained step by step. Associating the method used with the literature increases the validity of the study (Balat et al., 2019). The rationale for the choice of the method used was explained and associated with the literature. In terms of validity, the sample selection and characteristics of the study were explained in detail, and it was stated that the study group was balanced in terms of certain characteristics (previous achievement, academic achievement, class size). The experimental process was described in detail, necessary permissions were obtained before the application and the participants participated voluntarily. By keeping the implementation period long, the factors threatening internal validity were tried to be minimized. In addition, the study included explanations about validity and reliability. In terms of reliability, reliability values were expressed in data collection and analysis processes, pilot applications were conducted and expert opinions were consulted. In the research, raw data, coding, photographs, and documents are kept by the researcher, which increases confirmability.

Findings

Findings Related to the Self-Efficacy Belief Scale

The first research problem of the study is "Is there a statistically significant difference between the mean scores of the self-efficacy belief scale for learning science and the teaching of the 'Sound and Properties' unit of the Science course with augmented reality applications?". It is seen in Table 3 and Table 4 that the self-efficacy belief scores obtained related to the research problems are normally distributed. Depending on these data and the research problem, the "Two-Way ANOVA Test for Mixed Measures" was performed from parametric tests. In order to perform the test, the variances of the groups should be homogeneous and there should be no significant difference between the covariance of the groups for the binary combinations of the measurement groups. In this framework, Levine's Test (Table 5) and Box's Test of Equality of Covariance Matrices were performed.

Table Error! No text of specified style in document.**. Homogeneity of variance of SEBSSL test pre-test and post-test results**

		Levene Statistic	df1	df2	p
Academic achievement test	Pre-test	.458	1	150	.49
	Post-test	1.025	1	150	.31

When the table is analyzed, it is seen that SEBSSL pre-test result (p=,49, p>.05) and post-test result (p=,31 p> .05) variances are homogeneously distributed. In addition, Box's Test (p=.38, p>.05) and it was concluded that the covariance of the groups were equal.

Firstly, the mean and standard deviation (sd) values of the pretest and posttest scores of the experimental and control groups on the SEBSSL are shown in Table 6.

Table 6. SEBSSL mean and standard deviation values

Group	**Test**	**N**	**X**	**SD**
Control Group	Pre-test	70	58,76	9,98
	Post-test	70	56,53	11,05
Experimental Group	Pre-test	82	57,89	10,92
	Post-test	82	61,62	9,24

N=number of students, x=average score, SD=standard deviation

When the table is analyzed, while the mean score of the students in the experimental group was 57.89 before the AR application, it was determined as 61.62 with an increase of 3.73 points after the application. In the control group, the pre-test means scores of the students decreased by 2.23 points from 58.76 to 56.53 points. When the increase in group averages was analyzed, it was determined that the students in the experimental group, in which AR applications were made, had an increase in the SEBSSL scores, while the scores of the students in the control group decreased.

The results of the two-factor ANOVA for mixed designs, which was conducted to determine whether there was a statistically significant difference between the pre-test and post-test arithmetic averages of the experimental and control groups for time, are shown in Table 7.

Table 7. Pre-test-post-test two-factor ANOVA results of experimental and control groups.

Variance Source	**KT**	**S**	**KO**	**F**	**p**	**η 2**
Intergroup	13402.671	151				
Group(Experiment/Control)	337.284	1	337.284	3.872	.051	.025
Error	13065.387	150	87.103			
within groups	19517.648	152				
Measurement (Pretest-Posttest)	42.661	1	42.661	.340	.561	.002
Group*Measurement	670.767	1	670.767	5.351	.022	.034
Error	18804.220	150	125.361			

Total	32920.319	303

When Table 7 is analyzed, it is seen that the time-dependent intergroup difference [F(1.150)=3,87, p>.05] was not significant regardless of the difference between the consecutive measurements of the experimental and control groups. The pre-test and post-test mean differences [F(1.150)=0,34, p>.05] were also not statistically significant. However, the Group*Time joint effect [F(1.150)=5,35; p<.05] was statistically significant. The effect size of AR practices on self-efficacy was determined as ,034 according to the Eta-Square value.

Findings Related to the Social Skills Scale

The second research problem of the study is as follows: "Does teaching the 'Sound and Its Properties' unit of the Science course with augmented reality applications create a statistically significant difference between the mean scores of the social skills scale?". It is seen in Table 3 and Table 4 that the social skills scores obtained related to the research problems show normal distribution. Depending on these data and the research problem, "Dependent and Independent T-Test" from parametric tests were performed.

In order to compare the pre-test and post-test averages of the students in the experimental and control groups, a dependent sample t-test was performed and the results of the analyses are shown in Table 8.

Table 8. Pre-test and post-test dependent sample t-test results of the students in the experimental and control groups

Group	Test	N	X	S	df	t	p
Control Group	Ön test	70	59,21	7,01	69	,605	,547
	Son test	70	58,59	6,31			
Experimental Group	Ön test	82	57,02	7,41	81	-1,891	,062
	Son test	82	59,55	8,25			

N = number of students, x = average score, t = T test, SD = standard deviation, * p>0,05

In the control group, there is no significant difference between the mean of the pre-test SSS (X=59,21) and the mean of the post-test scale (X=58,59) (t=,605 p>0,05). In the experimental group, there was no significant difference between the mean of the pre-test SSS (X=57,02) and the mean of the post-test scale (X=59,55) (t=-1,891 p>0,05).

In order to determine the effect of the methods applied in the control and experimental groups on social skills, an independent sample t-test was performed between the post-test averages of the groups, and the findings are shown in Table 9.

Table 9. Independent sample t-test results of the posttest mean scores of the experimental and control groups

Test	Group	N	X	SD	t	p
Posttest Scores	Control Group	73	58,59	6,31	-,881	,380
	Experimental Group	82	59,55	8,25		

N = number of students, x = average score, t = T test, SD = standard deviation, * p>0,05

There is no significant difference between the post-test mean of the control group (X=58,59) and the post-test mean of the experimental group (X=59,55) in the independent sample t-test of the social skills test of the control and experimental groups (t=-,881, p>0,05).

Conclusion and Discussion

Conclusion and Discussion on the Self-Efficacy Belief Scale for Science Learning

According to the analyses made after the application, it is seen that AR applications and current teaching have different effects on students' self-efficacy and belief levels. The pre-test and post-test mean scores of the experimental group students who experienced AR practices were 57.89 and 61.62, respectively, while the pre-test and post-test mean scores of the control group students were 58.76 and 56.53, respectively. It was determined that there was a statistically significant difference between the in-group pre-test and post-test mean scores of the experimental and control groups. The post-test averages of the groups were compared to determine which of the methods applied in the control and experimental groups was more effective on the self-efficacy belief levels, and the statistical results showed that AR applications were more effective on the self-efficacy belief level towards learning science than the program prescribed by the Ministry of National Education in teaching the 6th grade "Sound and its Properties" unit. In parallel with the current study, when the national and international literature was examined, it was stated that the studies on AR positively affected the self-efficacy belief (Zhang & Espinoza, 1998; Linder & Erickson, 1989; Akkoyunlu & Orhan, 2003; Berkant, 2013; Baltacı & Yıldız, 2015; Küçük et al., 2015; Saorín et al., 2017; Fidan, 2018; Özçakır & Aydın, 2019; Abdüsselam, 2020; Habig, 2019; Çiloğlu, 2022).

Bandura (1986) explained the concept of self-efficacy as an important psychological factor affecting individuals' self-confidence and abilities and stated that this factor has a great influence on personal success, motivation, and learning processes. Considering the interest of Generation Z children and young people in technology, AR applications in science lessons provide students with visual, auditory, and tactile learning opportunities and help students to show more interest and understand the subjects better by attracting their attention. Therefore, it is thought to have a positive effect on self-efficacy belief. The fact that AR applications provide students with the opportunity to control and manage their learning processes can be explained by giving students the authority to shape their learning environments on their own. In this context, the potential of AR applications to increase students' self-efficacy perceptions is associated with the ability and independence of students to effectively manage their learning processes. Similarly, in the study conducted by İbili and Şahin (2015), it was stated that new technologies facilitate students' learning processes and students' self-efficacy perceptions can be strengthened by incorporating these new technologies into educational environments. Zhang and Espinoza's (1998) study revealed that the use of new technologies in education has positive effects on the teaching of the course. These positive effects directly contribute to students' self-efficacy and also show that there is a positive relationship between the use of new technology in educational environments and student self-efficacy. Çiloğlu (2022) found that the biology course taught with AR application had a statistically significant positive effect on students' self-efficacy compared to the traditional biology course. According to Habig's (2019) study, it was found students' self-efficacy did not decrease, but on the contrary, increased with the use of AR technology integrated into the educational environment.

Özçakır and Aydın (2019), in their study with prospective mathematics teachers, stated that self-efficacy beliefs increased after AR applications. In addition, it was stated that the remarkable, memorable, motivation-enhancing, and ease of use of AR technology during the application were among the factors affecting the self-efficacy beliefs of pre-service teachers. In the study conducted by

Cai et al. (2019), it was stated that the lessons presented with AR applications were actively participated by students and had positive effects on students' self-efficacy. Saorín et al. (2017) emphasized in their study that the use of three-dimensional models in educational teaching processes can help students develop their digital competencies and innovative technologies can have positive effects on student self-efficacy.

Conclusion and Discussion on the Social Skills Scale

According to the social skills scale data, there is no significant difference between the pre-test mean (X=59,21) before the application and the post-test mean (X=58,59) after the application in the control group (t=,605 p>0,05). Although there was an increase in favour of the post-test between the pre-test mean (X=57,02) and the post-test mean (X=59,55) in the experimental group, this difference was not statistically significant (t=-1,891 p>0,05). Similarly, there was no significant difference between the control group posttest mean (X=58,59) and the experimental group posttest mean (X=59,55) (t=-,881 p>0,05). In the scale prepared by Kocayörük (2000), which was used in the present study, in terms of the total score of the social skills scale, 20-39 was determined as low level, 40-59 as medium level, and 60-80 as high level. According to the results, although the pre-test scores of the students showed that they had medium-level social skills, the post-test scores remained at medium level. Therefore, the implementation period of the study may have been insufficient to gain high-level social skills. In addition, the fact that the application also supported individual work may have positively affected the students who like to work alone, but it may not have affected the social skill level of these students too much.

Although there was no significant result in the post-test scores of the experimental group, it was observed that there was an increase compared to the pre-test scores. This situation is thought to be related to the fact that the students helped each other in AR applications during group work, answered the questions in the study jointly, and made joint decisions. Social skills are known as learned behaviors that affect an individual's communication with other people, social adaptation and personal self-esteem. The fact that these skills are learned behaviors indicates that they can be developed with appropriate learning conditions. Since social skills are not limited to a single behavior, the development of social skills even in individuals who do not experience any deficiency can positively affect the quality of life of the individual (Karateke, 2016). Social skills play an important role in people's lives as they facilitate communication with other people. However, many children cannot learn these basic skills on their own (Noz, 2018). Failure to acquire social skills can have a negative impact on academic achievement, social interactions, and adaptation (Carter & Sugai, 1988). Therefore, it is important to improve children's social skill levels and support their healthy socialization to avoid problems in these areas (Antia Shirin & Kreimeyer Kathryn, 1988).

When the literature is examined, it is seen that there is no study investigating the effect of direct AR practices on the social skills variable. However, there are many studies investigating the effect of AR applications on students' class participation (Abdüsselam & Karal, 2012; Bai et al., 2013; Cai, 2013; Yusoff & Dahlan, 2013; Delello, 2014; Sırakaya, 2015). In the study conducted by Sırakaya (2015) with AR learning materials, it was concluded that there was no difference between the groups in terms of students' participation in the lesson. Similarly, Kerawalla et al. (2006) stated that students using AR applications showed less participation in the lesson compared to the students who studied with the traditional method. In contrast to these studies; Cai (2013) and Yusoff and Dahlan (2013) state that AR applications positively affect students' active participation in the lesson.

Based on the results of this research, some recommendations for researchers and practitioners are as follows.

- The research findings indicate that augmented reality (AR) materials increase students' self-efficacy beliefs toward learning science. In light of these findings, it can be suggested to use AR technology more in science classes and to develop similar materials. However, it has been found that AR materials do not have a significant impact on social skills. In this case, it may be necessary to add specially designed activities and applications for the development of social skills or to rearrange AR materials to support social skill development.
- When used alongside traditional teaching materials such as textbooks, videos, and animations, AR materials can better accommodate students' different learning styles and needs. Therefore, integrating AR materials with traditional teaching materials can be encouraged.
- Additionally, it is noted that AR materials can increase students' participation and interaction in lessons. In this context, the use of AR materials can be encouraged in in-class activities and projects.
- Training programs for teachers can be organized to effectively integrate and use AR materials. These training sessions can help teachers fully understand the potential of AR technology and use it effectively in their classrooms.
- Finally, based on the results of this research, it is suggested that similar studies be conducted in different subject areas and age groups. This can help us understand the impact of AR technology on education from a broader perspective.

Statement of Research and Publication Ethics

Erzincan Binali Yıldırım University Human Research Ethics Committee is the study dated 21.06.2021 and numbered 85906. Volunteer individuals selected to collect data from the sample group in the research were informed about the subject by signing a consent form. All rules in the Higher Education Institutions Scientific Research and Publication Ethics Directive have been complied with. Decision number: E-97873615-050.02.04-87607.

Statement of Support

This research was supported by Erzincan Binali Yıldırım University within the scope of the Scientific Research Project (BAP) numbered FDK-2021-807.

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