SINIRSIZ EĞİTİM VE ARAŞTIRMA DERNEĞİ

# Sınırsız Eğitim ve Araştırma Dergisi

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**Dear Readers,**

We are delighted to present you the November 2025 issue of the Journal of Limitless Education and Research.

The aim of our journal, the Limitless Education and Research Association (LERA), has continuously been published since 2016 is to contribute to the field of education and research with new scientific studies. To this end, theoretical and experimental original research, review articles, thesis summaries, and other scientific works are published for free and shared with readers at both nationwide and worldwide.

The Journal of Limitless Education and Research (J-LER) is published three times a year in both Turkish and English. As an international peer-reviewed journal, it is prepared with the scientific endeavors, contributions, and support of academics, scholars, researchers, educators, and teachers from different countries. Each issue including current and new studies is meticulously presented to the readers in the field, following thorough reviews.

Maintaining its academic and scientific quality for ten (10) years, the Journal of Limitless Education and Research (J-LER) is indexed in the EBSCO, Education Full Text (H.W. Wilson) Database Coverage List, which is recognized by the Council of Higher Education (ÜAK). It is also indexed in various national and international databases such as ASOS, DRJI, ESJI, OAJI, ROAD, SIS, SOBİAD, and Worldcat, and receives a significant number of citations. According to the SOBİAD impact factor, our journal ranks highly among scientific journals in our country. Efforts to have our journal indexed in more extensive national and international databases are ongoing.

In the November 2025 issue of our journal, five (5) scientific research and review articles are featured. We would like to thank all the editors, authors, reviewers, and translators who contributed to the preparation and publication of this issue. With the hope that our journal will bring contributions to scientists, researchers, educators, teachers, and students in the field, we extend our best regards.

LIMITLESS EDUCATION AND RESEARCH ASSOCIATION

*The Journal of Limitless Education and Research, Volume 10, Issue 3*

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**Değerli Okuyucular,**

Sizlere Dergimizin Kasım 2025 sayısını sunmaktan büyük mutluluk duyuyoruz.

Sınırsız Eğitim ve Araştırma Derneği (SEAD) tarafından 2016 yılından bu yana 10 yıldır kesintisiz olarak yayınlanan Dergimizin amacı, yeni bilimsel çalışmalarla eğitim ve araştırma alanına katkı sağlamaktır. Bu amaçla kuramsal ve deneysel özgün araştırmalar, derleme makaleler, tez özetleri ve diğer bilimsel çalışmalar ücretsiz yayınlanmakta, ulusal ve uluslararası düzeydeki okuyucularla paylaşılmaktadır.

Sınırsız Eğitim ve Araştırma Dergisi (SEAD), yılda üç sayı olarak Türkçe ve İngilizce yayınlanmaktadır. Uluslararası hakemli dergi olarak farklı ülkelerdeki akademisyen, bilim insanı, araştırmacı, eğitimci ve öğretmen yazarların bilimsel çaba, katkı ve destekleriyle hazırlanmaktadır. Her sayıda titiz incelemeler sonucu güncel ve yeni çalışmalar alandaki okuyuculara sunulmaktadır.

Akademik ve bilimsel kalitesinden ödün vermeden on (10) yıldır yayın hayatını sürdüren Sınırsız Eğitim ve Araştırma Dergisi (SEAD), ÜAK tarafından alan indeksi olarak kabul edilen EBSCO, Education Full Text (H.W. Wilson) Database Covarage List'te taranmaktadır. Ayrıca ASOS, DRJI, ESJI, OAJI, ROAD, SIS, SOBİAD, Worldcat gibi ulusal ve uluslararası çeşitli indekslerde taranmakta ve çok sayıda atıf almaktadır. SOBİAD etki faktörüne göre Dergimiz, ülkemizdeki bilimsel dergiler içinde önemli bir sırada bulunmaktadır. Dergimizin daha geniş ulusal ve uluslararası indekslerde taranması için girişim ve çalışmalarımız devam etmektedir.

Dergimizin Kasım 2025 sayısında beş (5) bilimsel araştırmaya yer verilmiştir. Bu sayının hazırlanması ve yayınlanmasında emeği geçen bütün editör, yazar, hakem ve çevirmenlere teşekkür ediyoruz. Dergimizin alandaki bilim insanı, araştırmacı, eğitimci, öğretmen ve öğrencilere katkılar getirmesi dileğiyle, saygılar sunuyoruz. Dergimizin alandaki bilim insanı, araştırmacı, eğitimci, öğretmen ve öğrencilere katkılar getirmesi dileğiyle saygılar sunuyoruz.

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# The Effect of Metaverse-Based Science Education on Student Achievement

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**Abstract:** This study aims to investigate the effect of science education supported by metaverse applications on students' academic achievement. Additionally, students' views on metaverse-supported science education were also obtained. The participants in the research consisted of 60 students in the seventh grade of secondary school. The study employed a mixed research methodology. Half of the participating students received science education using a program designed for metaverse applications, while the other half received traditional science education based on textbooks. An electricity unit achievement test and an interview form were used as data collection tools. The achievement test data obtained in the study were analyzed by transferring them to the statistics program, and the interviews were analyzed using the content analysis method. The results of the study found that science instruction supported by the metaverse application increased science achievement compared to traditional science instruction. Furthermore, students' opinions about metaverse-supported science instruction were found to be positive. In line with the positive results, the study suggests that the metaverse application can be used to improve student learning.

**Keywords:** Technology, Augmented reality, Mateverse, Science teaching, Achievement.

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**1. Introduction**

Changing and developing technologies day by day bring with them the need to provide interaction with digital environments in all areas of life and to make sense of the digital world. Digital environments continue to gain mobility in the lives of individuals and make their presence felt by being integrated into every aspect of life. It is possible to say that education is one of the fields that is driven by digitalization with the advancing technology. Schmidt and Tang (2020) point out that digitalization is a turning point in terms of education, and it carries out strategic initiatives that ensure the continuation of the quality of the teaching and learning environment. While the reflections of digitalization in education continue, all levels are directly affected, and the course of activities carried out by students, teachers, administrators, and other stakeholders is changing (Petrusevich, 2020). In addition, electronic textbooks, internet portals, and databases providing information are becoming widespread in the field of education, and online training is becoming active (Sousa et al., 2020). Important transformation processes are experienced with digitalization that call for quality in education. Special attention is given to the provision of appropriate teaching aids and curricula for the educational process in order to cope with national and global challenges in terms of the development of educational institutions and to support digital technologies (Matveeva et al., 2020). In the education process, in which students gain the necessary knowledge and skills, traditional methods have started to remain in the background, and in this process, the need to introduce students to digital tools and to include digital tools in their teaching flows has been encountered. In order to meet the needs of teachers and students in the education process, it becomes a necessity to take a step forward in the teaching strategy and include digital student-centered applications in the teaching process. In the process of improving the field of education and moving it to a more qualified point, the concept of the metaverse, which is located at the center of virtual technology and emerges quite rapidly, is encountered. The use of the metaverse in education has come to the fore more clearly, especially as a result of the COVID-19 epidemic that the countries of the world are facing (Lee, 2021). Similarly, Damar (2021) emphasizes that the metaverse platform is a term that can cover countless different technology areas.

The concept of the metaverse first appeared in a science fiction novel in 1992 and took the role of an avatar character in a game (Narin, 2021; Joshua, 2017; Kye et al., 2021). The metaverse platform, which has been a virtual reality system tool since then, has more than a hundred years of history. It can also be explained in the form of a cyber-social platform that uses different advanced technologies, which offer countless possibilities by carrying a new reality

simultaneously and integrally (Kuş, 2021). Although there is an opinion that metaverse applications that can create a new reality environment are shaped based on virtual reality, it may be insufficient to say only virtual reality (Damar, 2021). Dionisio et al. (2013) point to its progress with the metaverse in four areas, expressing it as immersive realism, ubiquitous access and identity, interoperability, and scalability.

The use of the metaverse platform in education, which has entered our lives with great speed, creates the need to understand the existing examples in educational applications (Kye et al., 2021). Knox (2022) points out those metaverse applications will shape the future and shed light on the ways. It is emphasized that metaverse-based education should focus on the interaction between learners in the metaverse world, where learning-teaching activities, as well as holistic education activities such as communication and empathy, are carried out (Jeon & Jung, 2021). It is obvious that the Metaverse can offer a new perspective to the field of education, create new opportunities for students, and provide effective learning supports (Díaz et al., 2020; Hwang & Chien, 2022; Rospigliosi, 2022). The benefits of metaverse applications are considered in the development of students' more meaningful learning and learning experiences (Suh & Ahn, 2022). In addition, with metaverse teaching, it is separated from the perception of a uniform curriculum and a teacher with a uniform view, independent of time or place elements. In addition, students' creativity and problem-solving skills are also developed (Akpınar & Akyıldız, 2022).

There are programs designed to meet many different purposes based on the Metaverse platform. The "metaverse studio gometa" program, which is one of the applications based on the metaverse platform, which can be made in augmented reality, was used in the study. This program can be accessed free of charge, and many models and scenes can be created with many different characters. In addition, scenes in the form of filmstrips can be designed with the program, names for the design that were shaped before it was published, and necessary explanations can be included. The created augmented reality media is an application that can be scanned and reviewed by students with a QR code after publishing. Students can follow up by connecting to devices such as phones, and also answer directly. In learning processes, it is stated that it strengthens student learning and facilitates the process (Marini et al., 2022).

It is becoming a necessity for teachers and students to benefit from different digital platforms in order to make teaching effective in educational environments. As a matter of fact, it is a proposition that this need has accelerated with the pandemic process that the countries

of the world are facing. Existing digital platforms, which are gaining momentum in the learning process, should have the necessary competence to make the teaching process effective and meaningful for the users. In the 21st century, where digitalization skills gain value, it is important to encourage individuals to use digital technologies. As a matter of fact, it would not be wrong to state that individuals who spend most of their time teaching can acquire these skills only through the teaching process. It is important that students and teachers, who are accepted as teaching subjects, are in contact with digital technologies in the teaching process, develop an understanding of their use, and create a framework for their sustainability. In particular, it can be stated that the science teaching process is suitable for the use of the aforementioned digital technologies. Science courses bring with them the need to be supported with visual, video, three-dimensional, etc., activities due to the content flow and the abstract concepts they have. Therefore, in the current study, it is thought that it may be valuable to introduce the metaverse application, which is a result of digitalization, to the use of science teaching. With the study, the reflections of the metaverse application on science teaching and digitalization skills were observed, and the operation of a new system on this subject could be tested. It is among the outputs of the study that it guides educators and learners at the point of digitization of the teaching process and creates a framework for science educators who make improvement efforts in science classes. The aim of the study was shaped by considering the contributions of the study to the field and its reflections in the teaching process. As a result, it aimed to investigate the effects of science teaching supported by metaverse applications on student academic achievement.

In line with the purpose of the study, the main research question, "Is there an effect of science teaching supported by the Metaverse application on student achievement?" was determined. Within the framework of the determined main research question, sub-research questions were formed and included, respectively.

1. Is there a statistically significant difference in the pre-test academic achievement scores between students who received Metaverse-supported science instruction and those who received traditional science instruction?

2. Is there a statistically significant difference in the post-test academic achievement scores between students who received Metaverse-supported science instruction and those who received traditional science instruction?

3. What are the opinions of the students who were taught science supported by the metaverse application about metaverse applications?

## 2. Method

### 2.1. Research Pattern

The study was carried out with a mixed method based on the use of qualitative and quantitative data together. In the research, an explanatory sequential design based on a mixed research method was used. The explanatory sequential design is expressed as first, quantitative data were collected and analyzed, then qualitative data were gathered and examined. In the current mixed design, it is aimed to provide qualitative data as a basis for the quantitative data obtained (Creswell & Clark, 2017). In the explanatory design, a quasi-experimental pretest-posttest control group design was employed in the quantitative phase. The quasi-experimental design is expressed as an effective scientific method in which comparable operations are performed and the effect of the current procedure is examined (Büyüköztürk et al., 2012). The study process and stages are given in Figure 1 based on the explanatory design within the framework of the research.

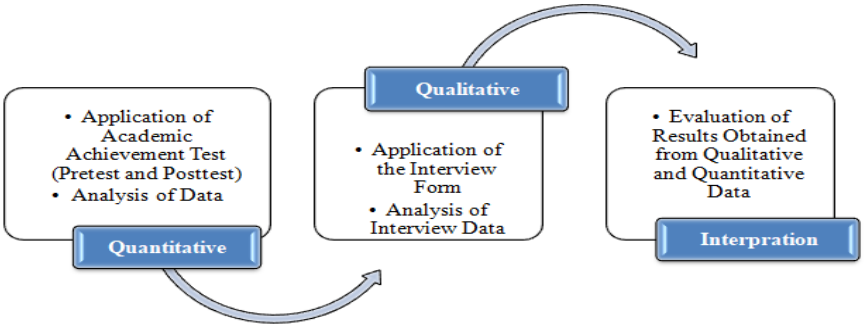


*Figure 1. Stages of the explanatory sequential pattern used in the study*

Figure 1 shows the stages of the explanatory sequential design used in the research. In the research, data were collected and analyzed with quantitative data collection tools, and then qualitative data were collected and analyzed in light of the results of the quantitative data. In the quantitative part of the explanatory design, the electricity unit academic achievement test was applied as a pre-test to the participant groups in which science teaching based on metaverse applications and traditional teaching were carried out. Then, traditional science teaching was applied to the control group, and science teaching based on metaverse applications was applied to the experimental group. After the completed implementation process, the academic achievement test was applied again, and the data obtained were analyzed. In the qualitative

part of the study, interviews were conducted with students to reveal their views on the use of metaverse applications in science teaching. After analyzing the data obtained from the interviews, the findings were interpreted and compared with each other.

**2.2. Participants**

The study group consisted of 60 students from the seventh grade of a public secondary school. While choosing the study group, easily accessible sampling, which is one of the purposive sampling types, was used. The mentioned sampling type aims to bring speed and practicality to the study (Yıldırım & Şimşek, 2018). Half of the participants included in the research process (n:30) constitute the group in which science teaching based on metaverse applications is made, and the other half (n:30) constitute the group in which traditional science teaching is performed. The students in the working group were selected from two different classes at the same level. In addition, the study participants consisted of 26 female students and 34 male students.

**2.3. Instruments**

In the research process, the academic achievement test prepared for the electricity unit and the student interview form of the metaverse applications used in the science teaching process were used as data collection tools.

In the study, the achievement test developed by Dumanoğlu and Bezir Akçay (2018) for seventh-grade students in accordance with the achievements of the electrical unit was used. The achievement test consists of two factors: "Types of Connecting Light Bulbs" and "Conversion of Electric Energy". There are 25 multiple-choice questions in the achievement test, which was created to determine the achievement levels of the students in the subject. The highest score that students can get from the knowledge test is 25, and the lowest score is 0. The reliability of the academic achievement test is 0.79. It is understood that item discrimination power indices are good values, and test-retest reliability is 0.80. Thus, the achievement test used in this study can be considered reliable.

In the study, an interview form was used to determine the students' views on science teaching based on the metaverse application. It is said that through interviews, individuals are allowed to express their thoughts on a topic in their own words (Patton, 2018). In this direction, an interview form developed by the researchers and finalized by taking expert opinion was created within the framework of the subject.

### 2.4. Application Process

#### 2.4.1. Teaching Science Based on Metaverse Applications (Experimental Group Students)

The application period of the experimental group students is determined within the scope of the study covers 12 lesson hours, including each step. The implementation timeline and process were structured based on the curriculum. In the experimental group, science teaching was carried out by choosing the "metaverse studio gometa" program, one of the metaverse applications based on the mobile augmented reality learning environment. In the first stage, the program was introduced to the students, and a few trial applications were made with the students in the classroom environment. Afterwards, a lecture on the subject was given by the teacher. In the next stage, the achievement test of the electrical unit decided to be used in the study was applied as a pre-test. In the program of the Metaverse application, the subject design was carried out by the teacher in the first stage and then the students were included. The subject flow designed with the current program was terminated and it was started to be explained to the students by the teacher. The lecture phase was completed with the students in the accompaniment of the program. In the next stage, the achievement test, which was applied as a pre-test, was also applied as a post-test. Of the 12-hour application period, 2 lesson hours were allocated to the application of the tests and the remaining 10 lesson hours were reserved for the metaverse application. Lesson planning, sub-topics, duration, and visuals of the program used in the science teaching process, made according to the 5E, which was taken as the basis during the study, are included (Table 1).

Table 1

*Images of the lesson planning process and the metaverse application prepared based on the 5E model*

| Subject Titles | Lesson Hours | 5E Model | Images of Metaverse Application |
|---|---|---|---|
| | **1** | **Engage:** The subject is briefly explained by the teacher. Background information on the subject is revealed. |     |

| | | | |
|---|---|---|---|
| **Series and parallel light bulbs**<br><br>**In cases where the bulbs are connected in series and parallel, their brightness** | **2** | **Explore:**<br>Students are provided with an interpretation and discussion of electricity, with a question from daily life about the way light bulbs are connected. |  |
| **Electrical current**<br><br>**Transfer of electrical energy to circuits by current** | **3** | **Explain:**<br>Based on the comments made by the students in the discussion environment provided, necessary explanations were made by the teacher and feedback was provided to the students' comments. With the Metaverse application, the students were provided with lectures. After the serial and parallel connections, the concepts of current and voltage and the relationship between them are mentioned. |  |
| **The relationship between the voltage between the terminals of a circuit element and the current flowing through it.** | **3** | **Elaborate:**<br>The relationship between bulb brightness and voltage-current was examined by enabling students to establish a more in-depth connection in the subject area of electricity. Necessary information has been provided. |  |
| | **1** | **Evaluate:**<br>After the lecture, the students were evaluated with a 10-question multiple-choice test prepared with a metaverse application of the electrical unit. |  |

As can be seen in Table 1, the experimental group students were taught with the metaverse application by following the specified stages based on the 5E model. After the metaverse teaching was completed in the experimental group, interviews were held with some students about the metaverse application. While determining the students to be interviewed, the scores obtained from the applied academic achievement test were taken into account. Among the students in the experimental group, 16 students were selected based on their test

academic achievement scores. While making this selection, 8 students with the lowest achievement scores and 8 students with the highest achievement scores were included in the group.

**2.4. 2. Traditional Science Teaching Group (Control Group)**

In the control group, the subject-related gains from the current curriculum were delivered through lectures based on the textbook, utilizing direct instruction and the question-and-answer method. First of all, the electrical achievement test was applied as a pre-test in the experimental group. In the next stage, the traditional science teaching process was started. Similarly, the readiness of the students for the past years was checked. Then, the science teaching process was continued with the lectures in the current curriculum, through the teacher's slides and with the textbook activities. After the lecture, the activities of "Let's connect the light bulbs in series and parallel" and "Let's connect the voltmeter and ammeter to the electrical circuit" in the textbook were carried out, and the students were also allowed to take notes and discuss their interpretations with each other. After the course process was completed, a multiple-choice test was answered and the course process ended. Then, the academic achievement test, which was done as a pre-test, was applied again as a post-test.

**2.5. Data Analysis**

The data obtained from the academic achievement test were transferred to the SPSS statistical software for analysis. During the analysis process, students' correct responses were coded as 1 and incorrect responses as 0. There were no questions left blank by the students in the achievement test. Before the analysis of the achievement test data, the Kolmogorov–Smirnov test was conducted to examine the normality of the distribution. Upon confirming that the data obtained from the academic achievement test were normally distributed, parametric statistical tests were applied. The mean scores and standard deviation values of the experimental and control groups were calculated. To compare the academic achievement levels of the experimental and control groups, both pre-test and post-test scores were analyzed using the independent samples t-test. The data obtained from the interviews with the students were analyzed using content analysis. Yıldırım and Şimşek (2018) stated that the processing of qualitative data consisted of four stages: coding the data, finding the themes, organizing the codes and themes, defining and interpreting the findings. Codes were assigned to participants included in the study by the researcher to ensure the confidentiality of their identities. Each student was coded and numbered as S1, S2, ... S16. 'S' stands for student. Thus, the students'

first and last names were kept confidential. The views of each participant were examined, similar views were brought together, codes generalizing similar features were created, and categories were determined by connecting the determined codes to each other. In the last stage, the frequency values of the codes that emerged during the coding process were written and tabulated. When calculating the frequency values of the tables created, the situation of a student having more than one answer was taken into account. Since the students gave more than one answer, the frequency values were higher than the number of participants. Direct quotes from the views of the participating students were also included.

### 2.6. Ethical Process of the Research

The middle school students who participated in the study were provided with detailed explanations about the research methodology and the intended use of their responses. To ensure participant confidentiality, student names and surnames were anonymized and a coding system was applied to protect their identities. As part of the ethical procedures, the necessary permissions were obtained from the Ethics Committee of the university to which the researchers were affiliated.

## 3. Results

Within the scope of the study, the data obtained from the students are analyzed and the results of the analysis are presented within the framework of the research questions.

The first sub-research question aimed to determine whether a significant difference exists between the pre-test academic achievement scores of students who were taught science supported by the Metaverse application and those who received traditional science teaching. An independent samples t-test was conducted to compare the pretest scores of the experimental and control groups. The test results are shown in Table 2.

Table 2

*Independent t-test results of the academic achievement test, pre-test scores*

| | Groups | N | X | SS | Sd | t | p |
|---|---|---|---|---|---|---|---|
| Score | Exper. | 30 | 10.43 | 2.60 | 58 | 1.79 | .079 |
| | Control | 30 | 9.16 | 2.86 | | | |

When Table 2 is examined, the pre-test mean score of the academic achievement test for the experimental group was found to be 10.43, with a standard deviation of 2.608. For the control group, the pre-test mean score was 9.16, with a standard deviation of 2.685. An

examination of the pre-test achievement scores indicates that there is no significant difference between the experimental and control groups (t = 1.79; p > .05).

The second sub-research question of the study asked: “Is there a significant difference between the post-test academic achievement scores of students who received science instruction supported by the Metaverse application and those who received traditional science teaching?” Accordingly, the post-test scores of the experimental and control groups were analyzed using the independent samples t-test. The post-test achievement scores and t-test results are presented in Table 3.

Table 3

*Independent t-test results of the academic achievement test, posttest scores*

| | Groups | N | X | SS | Sd | T | p |
|---|---|---|---|---|---|---|---|
| **Score** | Exper. | 30 | 19.76 | 3.65 | 58 | 7.82 | .000 |
| | Control | 30 | 12.30 | 3.73 | | | |

When Table 3 is examined, the post-test mean score of the academic achievement test for the experimental group was 19.76 with a standard deviation of 3.65. For the control group, the post-test mean score was 12.30 with a standard deviation of 3.73. Analysis of the post-test achievement scores revealed a significant difference between the experimental and control groups (t = 7.82; p < .05).

An answer was sought for the fifth sub-research question of the study, "What are the opinions of the students who were taught science supported by the metaverse application, about the metaverse applications?". In this direction, the interview data obtained from the experimental group students were evaluated. The opinions of the students on the positive aspects of the metaverse application used in the teaching process are given in Table 4.

Table 4

*Students' opinions regarding the positive aspects of the metaverse application used in the teaching process*

| Theme | Category | Code | Frequency |
|---|---|---|---|
| **Opinions of Metaverse Application** | Positive Opinions | Reading with QR Code | 11 |
| | | Ability to Connect from Other Smart Devices | 9 |
| | | Having a Three-Dimensional View | 8 |
| | | Being Attractive | 8 |
| | | Being Fun | 8 |
| | | Usable from Anywhere | 5 |
| | | Always Available | 5 |
| | | Ability to Visualize | 4 |
| | | Ability to Create On-Demand Content | 4 |
| | | Creating Relationships Between Designed Scenes | 3 |
| | | Having Many Characters | 2 |
| | | Having Many Backgrounds | 2 |
| | | Ability to Add Optional Character and Background | 1 |
| | | High Technological Applications | 1 |

When Table 4 is examined, the positive opinions of the students whose science course process is followed with the metaverse application are seen. Opinions are presented under the title of “Positive Opinions” category under the theme of “Opinions of Metaverse Application”. 11 students expressed their opinions in the codes of “Reading with QR Code”, 9 students “Connecting from Other Smart Devices”, 8 students “Having Three-Dimensional Display”, “Being Interesting” and “Having Fun”. 2 of the students expressed their opinions in the codes of "Having Many Characters" and "Having Many Backgrounds", and 1 of the students "Adding Optional Character and Background" and "Very Technological Applications" codes. Quotations from students' opinions on their positive aspects are included.

Student coded S3 said, *“… No matter where we prepare the lecture, we can reach the lecture by reading it from the place we want to enter, together with the QR code we have created. I can also log in whenever and wherever I want by reading it with my phone in my hand. Even if I don't have a book with me, I think he can always help me follow up on the subject,”* expressing his opinion in the form of a point that both other devices can be connected and that it is independent of place and time. Similarly, the student with the code S9 said, *“We can do the lectures in the way we want in our program. We can place every picture and my visual possibilities are very good. There are many backgrounds and characters when designing. Even if we cannot find the character and the appropriate background that we cannot use, we can add whatever we want…”* Emphasizing that the application provides the necessary possibilities at

the design point, he expressed his views. The student coded S16 commented that the applications were interesting and fun, *"… I think this application is very entertaining and it gives pleasure to design. It is very interesting and nice to scan some places, especially with QR codes"*.

In order to find an answer to the fifth sub-research question of the study, the interview data obtained from the interviews with the experimental group students were evaluated. The opinions of the students about the negative aspects of the metaverse application used in the teaching process are given in Table 5.

Table 5

*Students' opinions regarding the negative aspects of the metaverse application used in the teaching process*

| Theme | Category | Code | Frequency |
|---|---|---|---|
| **Opinions of the Metaverse Application** | Negative Opinions | Require Access Connection | 7 |
| | | Require Usage Authorization | 6 |
| | | Difficult to Use | 6 |
| | | Waste of time | 6 |
| | | Boring | 4 |
| | | Trying | 4 |
| | | Leading to Technology Addiction | 3 |

When Table 5 is examined, the negative opinions of the students whose science course process is followed with the metaverse application are seen. Opinions are presented under the title of "Negative Opinions" category under the theme of "Opinions of Metaverse Application". 7 students expressed their opinions in the codes of "Require Access Connection", 6 students in "Require Competency to Use", 6 students in the codes of "Difficult to Use" and "Waste of Time". Quotations from the students' opinions about the negative aspects are included.

Student coded S2*"… Sometimes my internet is not working or the connection is broken. Then I may have problems following the lesson. In fact, sometimes I have a lot of difficulties when I design without my teacher. Because I haven't used the program much before, I think I need to learn more."* The form of the program requires user competence and there are access problems. The student with the code S8 also stated that it requires hardware during use and said, *"I didn't like the program very much. I need to know the program well to use it. For this reason, I was very bored while using the program. In fact, I think it might even be a waste of time."* He expressed his opinion in his statements. Student coded S15 said, "I think it is very boring and challenging. It also works connected to the internet." supports the views of other participants with their views.

In order to seek an answer to the fifth sub-research question of the study, the evaluation of the interview data was continued. The opinions of the students about how content prepared with the metaverse application affects the science course are given in Table 6.

Table 6

*Students' opinions on the effect of the metaverse application on the science course*

| Theme | Category | Code | Frequency |
|---|---|---|---|
| **Views Regarding the Effect of Science Lessons** | **Positive Effect** | Conformity to Science Course Content | 10 |
| | | Making the Lesson Understandable | 8 |
| | | Providing Visualization | 8 |
| | | Making the Lesson Fun | 7 |
| | | Making the Lesson Less Boring | 7 |
| | | Increasing Test Score | 7 |
| | | Designing Electrical Symbols the Way We Want | 4 |
| | | Making sense of the way light bulbs are connected | 3 |
| | | Associating with Daily Life | 2 |
| | | Making it Three-Dimensional | 2 |
| | | Increasing Class Participation | 1 |
| | | Ability to Return to an Understood Subject Area | 1 |
| | | Repetition of Past Information | 1 |
| | **Negative Effect** | Making the Lesson More Boring | 4 |
| | | Getting Out of the Subject Focus | 3 |
| | | Making Understanding Difficult | 2 |
| | | Waste of Time | 2 |
| | | Decreasing Class Efficiency | 1 |

When Table 6 is examined, the opinions of the students whose science course process is followed with the metaverse application are seen on the effect of the application used on the science lesson. Opinions were presented under the theme of "Opinions on the Effect of Science Class" under two categories as "Positive Opinions" and "Negative Opinions". 10 students expressed their opinions in the codes of "Being Appropriate to the Content of Science Course", 8 students of "Making the Lesson Understandable" and "Recognizing the Opportunity of Visualization", 7 students of "Making the Lesson Fun" and "Increasing the Test Scores". 4 of the students presented their negative opinions in the codes of "Lesson is more boring" and 3 of them "Getting away from the subject focus" codes. Quotations from students' opinions about the effect of the science course are included.

The student with the code S4 said that it could be a program suitable for the science teaching process. *"In fact, there are too many pictures in the course content. With this program, difficult concepts stay in our minds more and learning is even fun. Since our subject was electricity, we had to see the light bulbs to learn. With the program, our teacher did not waste time on drawing, and we learned more easily. In my opinion, our teacher should use this program*

*in other science subjects as well."* The student coded Ö7 stated that it had a positive effect on the Achievement of science teaching: *"… "I had difficulties with electricity before. I was even messing around with the circuit symbols I saw last year. Now I have learned better. Also, since my test score has increased so much, I think that I am more achievement-oriented in science class with this program"*. Contrary to the other participants, the student with the code S13 said*, "… It would be better if we did the science lesson as we always do. Because I got used to my teacher. Doing it this way makes the lesson more boring and even lowers efficiency, I think. It takes a long time to design with the program, so I did not like it as much as my other friends,"*.

**4. Discussion and Conclusion**

The research aimed to investigate the effects of science teaching supported by a metaverse application on student academic achievement. Considering the students' electrical unit achievement test pre-test results to find an answer to the first sub-question of the research, it was revealed that the group that supported science teaching based on the metaverse platform and the groups in which traditional science teaching was performed were statistically equivalent to each other. The study groups' knowledge of the electrical unit was about equal. Therefore, it was possible to subject these two groups to any experimental treatment. In the next step, in response to the second sub-question of the research, the variation of the statistical difference in the electrical unit achievements of the study groups after the experimental process was investigated. Despite the increase in the achievement scores of the study groups, it was observed that there was a statistically significant difference in favor of the experimental group. This result showed that science teaching supported by metaverse applications was more effective in student achievement compared to traditional science teaching. It is clear that the applications based on the Metaverse platform will improve the achievement levels of the students compared to the traditional methods and will raise the students to higher points in terms of achievement. In a similar international study, it was emphasized that using metaverse applications could positively affect students' learning outcomes and could be used by educators to provide better learning outcomes for students (Marini et al., 2022).

The studies conducted demonstrate that integrating metaverse technologies into learning environments to enhance students' science achievement was an important and valuable teaching tool (Al-Muqbil, 2024; Amirbekova et al., 2024; Marini et al., 2022; Yağcı and Şentürk, 2023). Another study found that metaverse technologies improve academic performance (Al Yakin & Seraj, 2023). It has been proven that metaverse applications are a more

effective learning method compared to traditional teaching methods (Çetinkaya et al., 2024). Likewise, Yue (2022) points out that education shared with the metaverse database can increase students' participation in education, unlike traditional education. A meta-analysis study has revealed that metaverse technologies significantly enhance learning. The studies conducted demonstrate that integrating metaverse technologies into learning environments to enhance students' science achievement is an important and valuable teaching tool (Al-Muqbil, 2024; Amirbekova et al., 2024; Marini et al., 2022; Yağcı & Şentürk, 2023). Another study found that metaverse technologies improve academic performance (Al Yakin and Seraj, 2023). It has been proven that metaverse applications are a more effective learning method compared to traditional teaching methods (Çetinkaya et al., 2024). Likewise, Yue (2022) points out that education shared with the metaverse database can increase students' participation in education, unlike traditional education. A meta-analysis study has revealed that metaverse technologies significantly enhance the learning experience (Diao & Su, 2025).

The final research question of the study investigates students' opinions on metaverse applications implemented in the teaching process. Students emphasize the features of metaverse applications, such as being able to scan QR codes, connect from multiple smart devices, and have three-dimensional representation capabilities. It can be said that students view the ability to always access materials prepared with the digital metaverse programme as a significant advantage. Students emphasised that they had both positive and negative thoughts about metaverse applications. Although access to the designed materials has been made easier, being dependent on internet access can be restrictive for individuals. On the other hand, it is stated that metaverse applications used in the science teaching process have many benefits for the field of science in terms of making the lesson more understandable, providing visualization, increasing success scores, and increasing participation in the lesson. The fact that science teaching content contains abstract concepts and, by its nature, requires visual elements may highlight the value of metaverse applications in science teaching. Therefore, it is not surprising that students mention these points. On the other hand, the increase in achievement test scores and students' views that metaverse applications enhance success may be an indication that qualitative and quantitative findings support each other. At this point, it is clear that metaverse applications offer an active, interactive learning process for students and educators (Setiawan et al., 2024).

In addition, being seen as interesting and entertaining by students is another useful dimension of metaverse applications. It is in question that metaverse applications may create

some negativities in counter-science teaching. In the context of opinions, the negative aspects of science teaching that it can be annoying in some cases, that the focus of the subject may deviate, and that there may be losses in the course time, have come to the fore. Similarly, the study conducted by Marini et al. (2022) reveals that students have the opportunity to learn more, understand information easily, and learn in a fun way by using the metaverse application. In this sense, it is understood that the results of the study show overlap with the current study in terms of views on metaverse applications. In another study, in which students were interviewed about the metaverse, it was revealed that the course content could become even more enjoyable with the metaverse, and it would provide an advantage in the classroom environment in the near future. In addition, it has been determined that in some cases, it can cause disconnection in students by distracting and violating classroom discipline. Therefore, it is clear that the data on the positive and negative aspects of the metaverse applications in teaching obtained in our study are supported. It is emphasized that metaverse applications provide students with more opportunities to experience, learn and teach a new world, as well as interact with people (Hwang & Chien, 2022). It is stated that educational performance based on the application of the obtained knowledge in the field can be improved by providing rich and efficient, interactive learning opportunities with Metaverse applications (Damar, 2021). In a study presenting teachers' views, it is stated that metaverse applications support the learning process by providing a fun, lasting, hands-on, and realistic learning environment (Işık and Köse, 2024). Kan and Kumaş (2024) state that metaverse technologies can be used as an effective tool in teaching science subjects that students find difficult to understand and conceptualize. Metaverse applications have the potential to offer an engaging and compelling learning experience, particularly in science education (Karadağ et al., 2024).

According to the results of the study, it has been determined that the metaverse application positively affects students' academic success. In this regard, it is recommended that teachers use metaverse applications to ensure that students' success reaches the desired level. On the other hand, it can be used in science education to ensure participation in the lesson due to its contribution to a better understanding of the lesson and the science education process. Metaverse applications can be used to visually support topics in science content and add a fun and interesting dimension to the lesson.

**CONFLICT OF INTEREST STATEMENT**

The authors declare that there is no conflict of interest in this study.

**RESEARCH AND PUBLICATION ETHICS STATEMENT**

The authors declare that research and publication ethics are followed in this study.

The necessary permission to conduct the study was obtained from the Social and Human Sciences Research and Publication Ethics Committee of Yıldız Technical University (05.02.2025/2025-02).

**AUTHOR LIABILITY STATEMENT**

The authors declare that the "Conceptual Framework, Method Design, Research, Post Draft, Visualization" part of this work was done by Dr. Kevser ARSLAN, "Method Design, Post Draft, Review and Editing" part of this work was done by Prof. Dr. Aslı GÖRGÜLÜ.

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