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Investigation of The Effects of STEAM- Based Art Education on The Photography and Photo- Manipulation Works of Gifted Students

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The aim of the research is to reveal the effect of STEAM-based art teaching on photography education given to secondary school students and students' photo-manipulation studies. In line with this purpose, it was aimed to use manipulation in education in a positive way with the manipulation applications that the students made on the photographs they took at the end of the activities made more comprehensive with the STEAM approach. The problem of the research was determined as 'What is the effect of STEAM-based art teaching on gifted students' photography and photo-manipulation studies?'. In this context, the research was planned as a qualitative study and was designed as a quasi-experimental study. The data obtained in the research were analysed by content analysis method. During the implementation process of the research, it is noteworthy that the students actively participated in the lesson, successfully completed the activities and performed above the expectations of the researcher. In the findings related to the research questions, students' motivations towards the course, their interests and perspectives towards photography, their thoughts on the process of creating photo-manipulation, and their opinions on the course process and participants were reached. As a result of the research, it was seen that the students' awareness of photography and photo-manipulation increased, they started to put the education they received into practice and started to use it in real life, each student mentioned at least one photo editing programme, and all of the students stated that they used the photoshop programme. Considering the results of expert opinion, it was concluded that the students showed a positive development from the 1st activity to the 3rd activity in photography and photo-manipulation studies. Considering the results obtained from the student interview form findings, it was observed that there were students who stated that the students improved themselves, contributed to their general culture and gained a different perspective. In this direction, it was concluded that the education they received fulfilled its objectives.

Keywords: Art Education, STEAM, Photograph, Photo-manipülation

INTRODUCTION

Photography is considered one of the most important discoveries in human history. The photographic adventure, which began with the invention of the camera, has increased the scope of visual use with the development of technology. Cameras, which people have used to preserve memories and create visual documents over time, have enabled us to make great strides in recording the world and the events that occur.

With the widespread adoption of photography around the world, photography received significant patronage in the Ottoman Empire, particularly during the reign of Sultan Abdülhamid II, especially in Istanbul. Sultan Abdülhamid II's interest in art, his love of photography, and his own involvement in photography made significant contributions to its development (Çiçek, 2018).

Photography education was first introduced as a subject in the Ottoman Empire within an institutional framework at the Mühendishane-i Behr-i Hümayun (Naval Engineering School). Graduates of the painting class at this school served as photography teachers. It is known that the Ottoman Sultans and Princes of the time also received private photography lessons. When we come to the period after the Republic, a mobilization occurred in the field of photography and visual communication with the support of Atatürk. The use of photography in fields such as press, history, archeology, propaganda, and promotion has become increasingly widespread and has been adopted as a functional tool (Kaya, 2010).

In the contemporary art environment of Turkey, photography has been on the agenda since the 1980s, sometimes in its documentary aspect, sometimes in other dimensions. Art and photography first merged in the 1920s with Soviet photomontage practices, and then with Dada and later Surrealism placing photography at the center of their movements (Benjamin et al., 2009).

Today, the trend of using photographic techniques in art creation is increasing. Beyond pasting a photograph into the middle of a painting, as the Cubists and Surrealists did, it has become possible to paint with the eye of a camera (Freund, 2008).

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Thanks to technological advancements, photography's progress in our lives has accelerated, and its scope of use has expanded by merging with art. Photography is no longer just a medium where the shapes captured by machines are stereotyped. Today, photographs are gaining a new dimension through various interventions and editing, incorporating a process called manipulation. Manipulation is a word of French origin that occurs with the presentation of a new image obtained by selecting, adding, or removing information (Dumlu, 2021). With the development of the digital age, it has also become possible to manipulate photographs through computer-aided design programs. Artists use these technologies to create works that reflect surreal or imaginary worlds, inviting their viewers to a surprising experience. Researchers and policymakers recognize the lasting benefits of participation in high-quality arts education and the integration of arts into other content areas (Dell'Erba, 2020). In their article "Framework of STEAM Integrated Learning Model and its Importance for Talent Development," Tezeren, Balım, and Yürümez (2022) state that the 21st century is the century of skills and talents, and in order to keep up with the digitalized world and succeed as humanity, students need to be equipped with skills such as solving real-life problems, thinking multi-dimensionally, and being able to collaborate. In today's world equipped with technology, education needs to adapt to the times by incorporating technology, digital design, and photography into an approach as wide-ranging as STEAM in order to keep up. This study integrates digital design and the photo editing program Photoshop with photography into the STEAM approach, ensuring both the weight of the artistic aspect and greater inclusion of technology.

STEAM (science, technology, engineering, art, and mathematics) education, a method used to make learning more permanent and effective, is given at many stages from the lowest level of education to the highest. The method, which emerged as STEM (science, technology, engineering, and mathematics) in the first stage, has taken the name STEAM in recent years by including art, as it fell short in terms of the creativity and innovation process (Mercin, 2019; Wahyuningsih et al., 2020; Dell'Erba, 2020).

Institutions where different disciplines meet on the basis of education together have emerged in recent years. One of these is BİLSEM (Science and Arts Education Center). These are special education institutions affiliated with the state, established with the aim of ensuring that gifted students identified through exams in primary schools are aware of their individual talents without disrupting their education at formal educational institutions, and to develop their existing capabilities to a high level and use them effectively (Bilsem Online, 2020). These institutions contribute to the development of gifted students as individuals who are productive, problem-solving, and self-realized, combining scientific behaviors and thoughts with aesthetic values. Visual Arts talent; Having an imagination, planning broadly using color widths and appropriate proportions between pieces, perceiving images and showing variety in various ways, having the ability to produce originality (Kızılkaya, 2023).

In BİLSEM, educational activities begin with a short-term adaptation training program given to newly enrolled students in the general intellectual ability area and the music and visual arts talent areas to help them adapt to the institution, get to know their teachers, other students, and programs. Students who have completed the adaptation program and have been identified in the general intellectual ability area continue with the support education program, BYF (Individual Talent Awareness), ÖYG (Special Talent Development), and Project Production and Management program, while gifted students identified in the visual arts and music talent areas continue with the ÖYG program and Project Production and Management program at BİLSEM (Ministry of National Education [MEB], 2022). Students who have been granted the right to study at BİLSEM can receive

additional education according to their wishes in lessons and workshops that aim to teach different talents and skills and include enrichment content, which is one of the differentiation strategies (deepening is done by going into depth on a topic-by-topic basis, while also making supportive and enriching additions to topics within the framework of the individual's interests and needs) (MEB, 2022). In the BİLSEM Visual Arts Lesson Curriculum Framework, one of the field-specific skills, the Artistic Original Application section, under the heading of Digital Visualization, includes the following achievements for students: "Recognizes the basic components and functions of digital technologies. Uses digital tools and software. Uses visual expression techniques in the digital environment. Transfers visual projects to digital environments." The Digital Art Applications theme in the visual arts program content encompasses art production in the digital environment using the tools offered by technology and contributes to the development of new media art. It has been seen in literature reviews that manipulation is used on television, in advertising, in the media, especially in war photography, in politics, and in art. However, there is no study on the use of photo-manipulation in art education. In this regard, this research has concluded that it is necessary to investigate the effects of STEAM-based art education on the photography and photo-manipulation works of gifted students receiving education at BİLSEM.

The purpose of this study is to investigate the changes and developments in students' photography and photo-manipulation works by implementing STEAM-based art teaching and having gifted students engage in photography and photo-manipulation practices. The aim of the study is to reveal the effect of STEAM-based art teaching on photography education given to secondary school students and on students' photo-manipulation work. In line with this aim, the framework of the study has been established in light of the following sub-problems:

1. **What is the impact of STEAM-based art teaching on the photography education of middle school students?**
2. **What is the impact of STEAM-based art teaching on the photo-manipulation works of middle school students?**
3. **What are students' opinions about the effect of STEAM-based art teaching on photography and photo-manipulation studies?**

METHOD

In this section, the design of the study, the participants, the data collection tools and the techniques used in the analysis of the data are given.

Research Design

This research was planned as a qualitative study and patterned as a case study.

Qualitative research, at its best, is an umbrella term encompassing a range of interpretive techniques that seek to describe, decode, translate, and otherwise come to terms with the meaning, not the frequency, of certain phenomena in the social world (Van Maanen, 1979).

Qualitative research can be defined as research where qualitative data collection methods such as observation, interviews, and document analysis, literature review are used, and a qualitative process is followed that aims to reveal perceptions and events realistically and holistically in their natural environment (Şen, 2005). According to Merriam (2018), a desire to learn more about a study, or even improve it, leads people to ask researcher questions, and some of those questions are answered with a qualitative research design. Mc Millan (2000) defines case studies as a method in which one or more events, environments, programs, social groups or other interconnected systems are examined in depth. In research, case studies are used to describe and see the details that make up an event; to develop possible explanations for an event or to evaluate an event (Büyüköztürk et al., 2018).

According to Creswell (2017), the most distinctive feature of a good case study is the collection and analysis of qualitative data such as interviews, observations, documents and visual materials from multiple sources. In this direction, the student diaries, interviews and student studies resulting from steam applications used in this research diversified the research data and enabled the case study to be examined well.

Participants

According to Creswell (2017), the convenience sampling model "saves time, money, and effort at the expense of knowledge and reliability." The students in the groups the researcher teaches were included in the study group of the research. The students in the study group are taking ÖYG2 and ÖYG3 classes. Therefore, there was no intervention in the distribution of female and male students. Information about the participants is presented in Table 1.

Table 1. Demographic Information of Students Participating in the Study

Student Code	Gender	Age	Class	Bilsem Group
S1	Male	12	7	ÖYG3
S2	Male	12	7	ÖYG3
S3	Female	10	5	ÖYG2
S4	Male	11	6	ÖYG2
S5	Male	11	6	ÖYG3
S6	Female	10	5	ÖYG2

The population of this study consists of all 5th, 6th, and 7th graders in BİLSEMs across Turkey. From this population, a sample of six gifted middle school students, two girls and four boys, were selected from Siverek Science and Arts Center in Siverek district, Şanlıurfa province, using a convenience sampling method.

Data Collection Tool

The following data collection tools were used in the study:

1. **Pre-evaluation:** The name given to a small-scale test conducted on individuals or groups who will participate in a research or experiment before the data collection process (Tonya, 2007).
2. **Self-assessment:** A measuring tool that is applied for individuals to assess their own performance, given the opportunity to examine their performance, identify their strengths and weaknesses (Satter, t.y.).
3. **Semi-structured interview form:** Interviews are a very powerful method used to reveal people's perspectives, experiences, feelings, and perceptions (Bogdan and Biklen, 1992, cited in Yıldırım, 1999, p. 10). Semi-structured interviews allow the participant to tell their story in the way they perceive the world and with their own thoughts (Merriam, 2018).
4. **Final-evaluation:** These are evaluation questions that are made before a research or experiment and are asked to individuals or groups who will participate in the data collection process (Tonya, 2007).
5. **Expert Opinion Form:** A document used to systematically record the opinions obtained by consulting with individuals who are experts in a particular subject (Büyüköztürk, 2005).

Data Collection and Analysis

In the first phase of the study, a pretest was administered to the students who volunteered to participate in the study to see their readiness related to the subject. In the ongoing process, STEAM-based photography and photo-manipulation teaching and application were implemented in an active learning format during the lesson. These planned lessons were planned in line with the achievements included in the science and arts center visual arts lesson curriculum (2021). At the end of this process,

which was planned for 10 weeks, the works created by the students were evaluated by experts in the field. These evaluations were supported by self-assessment. Self-assessment can be defined as the process of an individual reaching a judgment about themselves by comparing a measurement result about themselves with certain criteria (Köstereliоğlu and Çelen, 2016). A final evaluation was administered at the end of this process to see if the students had achieved the relevant learning outcomes. In addition, interviews were conducted with the students to evaluate this teaching process. Interviewing is an activity of obtaining feelings and thoughts from individuals on a specific topic (Sönmez and Alacapınar, 2013). Interviewing is a widely used data collection tool in qualitative research and involves asking participants open-ended questions (Creswell, 2017). Merriam (2018) says, "It is the fundamental work to be done in the field of research to understand the phenomenon." At the same time, evaluations were obtained from 5 experts in the field using an expert opinion form to ensure valid and reliable evaluation of students' art work. Data obtained from self-assessment and student interviews were analyzed using content analysis. Content analysis is a technique within qualitative research methods that aims to analyze a variety of materials such as documents, texts, and documents systematically (according to rules such as sampling, coding, categories, etc.) with the aim of reaching objective, measurable, and verifiable information (Metin and Ünal, 2022). In the analysis of the expert opinion form evaluation, the Kendall coefficient of concordance test, which is a test used in situations where at least two observers independently attempt to measure the same things, was used. The Kendall coefficient of concordance is a statistic that measures the agreement between multiple raters who evaluate a given set of objects (Legender, 2005).

FINDINGS

This section presents the findings of the research. The findings related to the data obtained from the pretest conducted with the students at the beginning of the research process, the total of 3 self-assessments conducted after each activity during the 10-week application period, and the final evaluation conducted at the end of the process, and the semi-structured interview form and expert opinion forms, have been examined.

First Sub-Problem: Findings regarding the impact of STEAM-based art education on the photography education of middle school students.

Pre-evaluation and final-evaluation questions were applied in the research to observe a process based on the developmental steps of the students through STEAM-based photography and photo-manipulation teaching.

The first three questions in the pre-evaluation and final-evaluation were related to photography, so their analyses were done in this subheading. The data obtained for each question has been tabulated. The 1st question of the pre-evaluation, "What is photography? Have you ever taken a photo before?", was evaluated in two stages. The first was about the definition of photography. The second was to identify the experience of taking photos before. The answers and frequencies of the questions are shown in Table 2.

Table 2. Content analysis of the first question in the pre- evaluation and final- evaluation

	Question 1: What is the Photograph?		*Have you ever taken a photograph before?*	
	Answers	**f**	**Answers**	**f**
Pre- evaluation	Take an image	1	Yes	6
	immortalizing the moment	5	No	0
Final- evaluation	Digitizing the image we see	4	Yes	6
	Shooting the image we see	2	No	0

According to Table 2, 5 of the students defined photography as "immortalizing the moment." Here, more definitions such as fixing the image, recording, documenting on a surface are seen. For example, “Photography is a preservable form of our memories. I took a photo before (S1).”, “Photography is

immortalizing a moment or a moment (S4).” When looking at the definition of photography in the literature, it is seen that the student answers are consistent with this definition. One student emphasized that photography is only about taking an image. This answer is also consistent with the definition of photography. Therefore, it is understood that the students are not unfamiliar with the concept of photography and are able to define it correctly. In the second stage, it was questioned whether the students had previously experienced photography. Based on the answers received, it was seen that all students had previously experienced this with a camera or a mobile phone.

Looking at the final-evaluation, the 1st question, "What is photography? Have you ever taken a photo before?" was evaluated in two stages, as in the pre-evaluation. In this regard, when looking at the answers given by the students to the question of what photography is, 4 students said "transferring the image we see to a digital environment," and 2 students said "taking the image we see." The answers given are consistent with the definition of "Photography is a form of documenting on any surface by recording entities and shapes that can be seen in nature" in the literature (Özdemir, 2022). Therefore, it has been observed that all of the students have learned the concept of photography after the training. For example; “Photography is transferring the image we see to a digital environment with the help of a machine (Ö3).”, “Transferring the object we see by taking a picture to the digital environment. Yes, I took a photo (Ö4).”, “Taking a picture of the image we see. Yes, I took a photo (Ö5).” In the second stage, it was evaluated whether the students had taken photos, and it was observed that all students had taken photos.

Table 3. Content analysis of the second question in the pre-evaluation and final-evaluation

Question 2: When you take a picture, do you use the picture directly, or do you edit it?		
	Answers	**f**
Pre-evaluation	Editing	2
	I don’t edit	1
	Sometimes I do	3
Final- evaluation	Editing	4
	I use it directly	1
	Sometimes I do	1

The 2nd question in the pretest, "Do you use that photo directly when you take it or do you edit it?" was evaluated. 2 out of 6 students said that they edit the photo. For example; "I edit carefully. (If it is a beautiful and special photo) (Ö1)”, "I edit it (Ö4)". One of the students said "I use the photo directly, but it depends on the location where I am (Ö5)" and stated that they don't edit. 3 students stated that they sometimes edit and sometimes use it directly. For example; "If there are too many of those photos, I choose the best one and sometimes make corrections (Ö2)", "Usually I use it directly, but sometimes I edit (Ö3)", "Sometimes I edit, sometimes I use it directly (Ö6)". Looking at the answers given, it is seen that most of the students do edit photos, even if it is occasionally.

When the answers given to the 2nd question, "Do you use that photo directly when you take it or do you edit it?" in the final evaluation are examined, it is seen that 4 students stated that they use the photo after editing, one student stated that they sometimes edit, and one student stated that they use the photo directly. For example; "Yes, I can edit now (Ö3)", "I edit it (Ö4)", "Sometimes I use it, sometimes I don't and edit it (Ö1)", "I use that photo directly (Ö5)."

Table 4. Content analysis of the third question in the Pre-evaluation and Final-evaluation

Question 3: Which photo editing programs do you know? If you know any, which one do you use?				
	Themes	**f**	**Themes**	**f**
Pre-evaluation	Photoshop	2	Using	3
	Adobe illüstratör	1		
	İnshot	1		
	Capcut	2	Not using	3
	Picsart	1		
	Canva	1		
	Adobe clocd	1		
	Bilmiyorum	2		
Final-evaluation	Photoshop	6	I know	6
	Adobe illüstratör	1		
	Canva	3		
	Photoshop CC	1	I don't know	0
	Picsart	1		

The 3rd question in the pretest, "Which photo editing programs do you know? If you know, which one do you use?" was evaluated in two stages. In the first stage, the photo editing programs that the students wrote were listed. According to this, it was observed that 3 students knew more than one editing program, one student knew the photoshop application but could not use it, and 2 students did not know any programs. For example; "Photoshop, adobe illustrator, there is no other (Ö1)", "I use "inshot" and "capcut" for both photo and video editing (Ö2)", "Canva, capcut, picsart, adobe clocd. I generally use canva and capcut (Ö4)" they mentioned the programs they know. "I know Photoshop but I can't use it (Ö5)", "I don't know (Ö3)", "I write under it, put an emoji, and adjust its size (Ö6)". In the second stage, the number of students who use and do not use photo editing programs was listed. Accordingly, 3 students use photo editing programs while the other 3 do not.

In the final evaluation, the answers given to the 3rd question, "Which photo editing programs do you know? If you know, which one do you use?" were evaluated in two stages. In the first stage, the photo editing programs that the students know were listed. In the second stage, whether they know or not was stated. Accordingly, all students stated that they know photo editing programs. In addition, some students mentioned other photo editing programs they know. For example; "Yes, I know. Adobe Illustrator, Adobe Photoshop (Ö1)", "Photoshop CC, piscart, canva I use photoshop more (Ö4)", "I know photoshop, canva, I use them (Ö5)."

Second Sub-Problem: Findings regarding the impact of STEAM-based art education on the photo-manipulation works of middle school students.

The 4th, 5th, and 6th questions in the pretest and final evaluation were asked to obtain data related to manipulation, so they were analyzed in this subheading. The data obtained for each question has been tabulated. The student answers given to the 4th question in the pretest, "Have you used Photoshop before? If so, what did you do?" were evaluated in two stages.

Table 5. Content analysis of the fourth question in the pre-evaluation and final-evaluation

Question 4: Have you used Photoshop before? If so, what have you done with it?				
	Themes	**f**	**Themes**	**f**
Pre-evaluation	I used	1	I usually edit	1
	I haven't used	5		
Final-evaluation	I used	6	I combined photos	1
			I did photo-manipulation	5
			mirror manipulation	1
	I haven't used	0	golden ratio	1
			starry night with lights	2

Accordingly, 1 out of the students stated that they used the photoshop program, while the remaining 5 students stated that they did not. For example; "Yes, I used it and I usually edit (Ö4)", "I haven't used it before (Ö2)".

In the final evaluation, the answers given to the 4th question, "Have you used Photoshop before? If so, what did you do?" were evaluated in two stages. In the first stage, all of the students stated that they used the Photoshop program. In the second stage, when talking about what they did, 5 students said that they directly did photo-manipulation, while 1 student said that they combined photos. They also talked about other works they did. For example; "I used it. We did photo-manipulation, mirror manipulation, golden ratio, starry night with lights (Ö3)", "Yes, I used it after taking the lesson. I did photo-manipulation (Ö4)", "Yes, we did starry night and photo-manipulation (Ö6)."

Table 6. Content analysis of the fifth question in the Pre-evaluation and Final-evaluation

Question 5: Do you know what manipulation means? Write it down.		
	Themes	**F**
Pre-evaluation	I know	0
	I don't Know	6
Final-evaluation	Transform photos	1
	Orientation	5

When the 5th question in the pretest, "Do you know what manipulation means? Write it down." was examined, it was observed that the students did not know what manipulation was. For example; "I don't know at all, but I have a guess that its root is to manipulate (Ö1)", "No, I don't know (Ö2)".

The answers given to the 5th question in the final evaluation, "Do you know what manipulation means? Write it down." were evaluated, and five of the students said manipulation means to influence, while one said it means to transform photos. For example; "It means influencing the photo (Ö5)", "Yes, I know. It means influencing (Ö3)", "To transform photos. It is also used in psychology (Ö1)". When looking at the definition of manipulation in the literature, it is seen that the student answers are consistent with this definition.

Table 7. Content analysis of the sixth question in the pre-evaluation and final-evaluation

Question 6: Do you know the meaning of the concept of photo-manipulation? Please write it down.		
	Themes	**f**
Pre-evaluation	I know	0
	I don't Know	6
Final-evaluation	Combining photos and guiding people	5
	Photoshopping the photo to make it different from what it is.	1

The 6th question in the pretest, "Do you know what photo-manipulation means? Write it down." was examined. Looking at the answers given, only one of the students' answers, "Manipulating photos. I don't have another idea (Ö1)." is close to the definition of photo-manipulation in the literature, but it is not fully explanatory. The other five students said they didn't know.

The 6th question in the final evaluation, "Do you know what photo-manipulation means? Write it down." was examined, and five of the students defined photo-manipulation as combining several photos and influencing people with photos. For example; "Combining or editing photos (Ö1)", "Yes, combining several photos and influencing with photos (Ö4)", "Directing people with photos to where we want (Ö6)." One student defined it as "Altering a photo from its original state by photoshopping it (Ö2)". When looking at the definition of photo-manipulation in the literature, it is seen that the student answers are consistent with this definition.

Third Sub-Problem: Findings regarding the impact of STEAM-based art education on photography and photo-manipulation work.

The findings obtained regarding the impact of STEAM-based art education on the students' photography and photo-manipulation work, which constitutes the third sub-problem, have emerged in three stages: from the expert evaluations of the student work, from the student interview forms, and from the self-assessment forms. In the first stage, the photographs and photo-manipulation works produced by the students as a result of the STEAM education they received were examined and evaluated by experts. Table 8 shows the consistency of the experts in evaluating student work.

Table 8. Consistency analysis results of teacher opinions

N	5
Kendall's W[a]	,831
Chi-square	145,492
Df	35
Asymp. Sig.	,000

According to Table 8, Kendall's W analysis was used to test whether there was consistency among the expert opinions. As a result of the analyses conducted, the consistency value between the 5 experts' evaluations of the student works was observed to be .83. This indicates that there is consistency among the experts in evaluating student work.

When this evaluation is examined, it is concluded that there is a consistent development in the students' work. he minimum and maximum scores of the experts for each student's two studies of the three activities are shown. Each student's photograph and photo-manipulation work was evaluated separately by the experts. According to the weighted mean and standard deviation values of each activity, the change in student work was observed. Accordingly, it was understood that the success of the students at the end of each activity showed a consistent development.

Table 9. Expert assessment of student development in photography and photo-manipulation

Type of Application		N	Arith. average	Ss
Photograph	1	30	2,63	,490
	2	30	3,63	,490
	3	30	4,43	,568
	Total	90	3,57	,900
Photo-manipulation	1	30	2,73	,583
	2	30	3,77	,568
	3	30	4,63	,556
	Total	90	3,71	,963

Based on expert evaluations, the progress of students between applications 1, 2, and 3 was examined through the scores given by the experts. Considering the average scores given by experts for the student works, the average for photography work was observed to be 2.63 for the 1st application, 3.63 for the 2nd application, and 4.43 for the 4th application. This indicates that students have shown progress throughout the application process. A graphical representation of the results is given below.

In Photoshop work, the average was observed to be 2.73 for the 1st application, 3.77 for the 2nd application, and 4.63 for the 4th application. This indicates that students have shown progress throughout the Photoshop application process. A graphical representation of the results is given below

The data obtained from the student interview forms in the second stage was examined. The answers given to the 1st question in the semi-structured interview form prepared to obtain student opinions on

the impact of STEAM-based art teaching on photography and photo-manipulation work, "What are the aspects of this lesson that you liked and disliked? Why?", were evaluated in two stages. The first was to identify the overall evaluation of the lesson content implemented. The second was to evaluate the weaknesses and strengths of the application.

Table 10. Content analysis results of the first question of the interview form

Question 1: What are the aspects of this course that you liked and disliked? Why?			
Liked aspects	**f**	**Dislikes**	**f**
Making Photoshop	3	There is nothing I don't like about it.	5
Taking a photo	4		
Science	2		
Mathematics	1		
Art (Visual)	1		
Informatics	1		
Golden ratio	1	Spending too much time in front of the screen.	1
Infinity	1		
Designing a Galaxy	2		
Long exposure shooting	2		
I like them all	1		

5 students said they liked the content of the lesson, while 1 student said, "I didn't like the fact that we spent a lot of time on the screen, my head ached sometimes at the end of the lesson (Ö2)." 4 students said that their favorite part was taking photos, while 3 students said that their favorite part was doing Photoshop. At the same time, they included science, math, art (visual arts), and computer science classes as their favorite aspects. Topics such as the golden ratio, infinity, designing galaxies, and long exposure photography, which are included in the activity plan, were also among the mentioned aspects. For example; "I liked using Photoshop, taking photos. It's fun and enjoyable (Ö1).", "I developed myself in areas like science, math, visual, computer science for myself (Ö2).", "I liked all of them, my favorite was taking pictures (Ö3).", "While doing Photoshop, while designing galaxies, while taking photos, while doing long exposure (Ö6)." Looking at the answers given to the question "Which of the lessons you learned did you like and why?" in the semi-structured interview form, science lessons were mentioned by 5 students.

Table 11. Content Analysis Results of the Second Question of the Interview Form

Question 2: Which of the subjects you learned did you enjoy, and why?	
Lessons	**f**
Informatics	1
Science	5
Visual Art	1
All of them	1

There are also students who said they liked computer science, painting (visual arts), and all of the classes. For example; "Computer science, because I am interested in using computers (Ö1).", "All of them, but I like science the most because we did nice activities (Ö2).", "Science, the mirror topic was fun. I liked the small lights in the galaxy and simple circuit topic (Ö3).", "I liked science class because I love space (Ö4).", "Science, it was very beautiful when we were making galaxies. Painting, while watching the moving starry night (Ö6)."

Table 12. Content Analysis of the Third Question of the Interview Form

Question 3: Which subject did you find difficult to connect with the painting lesson? In what way did you find it difficult?	
Themes	**f**
No difficulties	5
Mathematics	1

Looking at the answers given to the 3rd question in the semi-structured interview form, "Which lesson did you struggle with? What aspects did you struggle with?", 5 students said they didn't struggle, while one student said, "It was difficult to place math on the photo in the golden ratio (Ö2)."

Table 13. Content Analysis of the Fourth Question of the Interview Form

Question 4: What subjects did you combine while photo-manipulating? How?	
Subjects	**f**
İnformatics	4
Mathematics	6
Science	6
Technology	1
Visual Art	4

Looking at the answers given to the 4th question in the semi-structured interview form, "Which subjects did you combine when doing photo-manipulation? Why?", 6 students answered math and science, while 4 students answered computer science and art. 1 student also answered technology. For example; "Computer science, math, science, technology, visual arts helped us to complete our work quickly (Ö1).", "Science, art, math, we combined the galaxy and mirror topics in science. The golden ratio and pi in math. We combined them with art (Ö3)", "Science and math, because I thought that science and math are in the same group so I can reflect it better (Ö4).", "Science, art, computer science, math, we learned about infinity in science. We did Photoshop in computer science. We also drew galaxies in art, and we combined infinity with pi numbers in math (Ö6)."

Table 14. Content analysis of the fifth question in the interview form

Question 5: What did you aim to do while photo-manipulating? Why?	
Themes	**f**
To edit photos	1
To combine the topics we learned	4
To digitally create a starry night	1

Looking at the answers given to the 5th question in the semi-structured interview form, "What did you aim to do when doing photo-manipulation? Why?", 4 of the students said they aimed to combine the subjects they had learned. For example; "We aimed to combine the other subjects I learned, science, math, computer science, with art (Ö3).", "I combined one thing with another. Because I predicted I would create a beautiful visual (Ö4)." One student said "I aimed to edit photos. That's how it's done in Photoshop (Ö1)." and another said "To make a starry night digitally (Ö6)."

Looking at the answers given to the 6th question in the semi-structured interview form, "Do you think the class you took contributed to you?", all students said yes.

Table 15. Content analysis of the sixth question in the interview form

Question 6: Do you think the course you took contributed to your learning?	
Themes	**F**
Yes	6
No	0

Students said they have developed themselves, it has contributed to their general culture, and they have gained a different perspective. For example; "Yes. I looked at an area from different angles (Ö1).", "Yes, I developed myself in the field of Photoshop (Ö2).", "My perspective on life has changed (Ö3).", "Yes, I think so. Because it contributed to my general culture (Ö4)", "Yes, I can take pictures (Ö5)."

In the third stage, where the findings of the third sub-problem were obtained, students were given self-assessment forms to evaluate their own work and performance. The findings related to the evaluations made at the end of each activity are as follows:

In the self-assessment form given to the students after the implementation process of the first activity, "Let the Mirrors Reflect You," students mentioned what they discovered in their work as "How mirrors are used, how the Photoshop program and the camera are used (Ö1).", "Photo-manipulation, destroying all unwanted things in the photo with cloning (Ö2).", "I learned how to take pictures. I learned the Photoshop application. I learned how to use the Photoshop application (Ö3).", "I didn't know the details of photography very well. I also didn't know about mirrors (Ö5)."

They said that the aspects they want to improve in their work are "I would like to do and improve more realistic cloning (Ö2).", "I want to improve my Photoshop use. I want to improve the use of the camera (Ö4)."

When expressing the points they were excited about in the work, they used the following phrases: "Being able to destroy everything with cloning (Ö2).", "I was very excited when I was going to take the first picture. Because it was the first time I was going to take a picture with a camera (Ö3).", "The moment I took my first picture, the moment I did Photoshop, the moment I learned about mirrors (Ö6)."

As for the aspects they didn't like in their work, "Looking for a photo to take with mirrors for a long time (Ö1).", "Taking pictures is too troublesome (Ö2)." Ö3, Ö4, Ö5 and Ö6 said there were no aspects they didn't like.

In the self-assessment form given to the students after the implementation process of the second activity, "Discovering the Art in Nature," students listed what they discovered in their work as "I discovered that the golden ratio is a part of our lives. Masking in Photoshop (Ö1).", "That the golden ratio is everywhere (Ö3).", "That there is a golden ratio in flowers, that painters draw their paintings according to the golden ratio (Ö6)."

They said the aspects they want to improve in their work are "Taking more photos and finding more suitable places for photos (Ö2).", "I want to improve and do Photoshop better (Ö6)."

When mentioning the points they were excited about in the work, they used the following phrases: "Using Photoshop and taking pictures (Ö1).", "Taking pictures (Ö5).", "I got excited while looking for the golden ratio (Ö6)." All of the students participating in the research said that there were no aspects they didn't like in their work.

In the self-assessment form given to students after the implementation process of the third activity, "Starry Night with Light Traces," students mentioned what they discovered in their work as "Infinity, Hilbert hotel, long exposure (Ö1).", "That pi is infinite. That there are too many galaxies (Ö3).", "I learned about the types of galaxies. I learned what long exposure is and we implemented long exposure (Ö4).", "Long exposure, the infinity of space, and many more things (Ö6)." They said the aspects they want to improve in their work are "Learning new types of photography (Ö1).", "I want to take pictures with more light. I want to do Photoshop (Ö3).", "I want to examine galaxies and infinity more closely (Ö4).", "I want to improve long exposure (Ö6)."

When mentioning the points they were excited about in the work, they used the following phrases: "Being able to write with light in long exposure (Ö2).", "I got very excited when we first started and this excitement continued (Ö3).", "I got excited when I made my own galaxy. I got excited when I took long exposure pictures with the camera (Ö5).", "When I was doing long exposure, when I was doing Photoshop with long exposure photos (Ö6)."When mentioning the aspects they didn't like in their work, they said "This project takes a long time. I could only use my own photos (Ö2)." Ö1, Ö3, Ö4, Ö5 and Ö6 said there were no aspects they didn't like.

RESULT and DISCUSSION

Results from the First Sub-Problem

Looking at the findings regarding the impact of STEAM-based art teaching on the photography education of middle school students, a positive change can be observed in the answers given by students to the question "What is photography? Have you ever taken a photo before?", which is included in the pretest and final evaluation. In the pretest, 5 students defined photography as "immortalizing the moment," while 1 student

defined it as "taking a picture." In the final evaluation, the same question was answered by 4 students as "transferring the image we see to a digital environment" and 2 students as "taking the image we see." As a result of the education they received, it was concluded that the majority understood that photography is related to transferring images, and that students used artistic language in their definitions.
While 2 students said that they edited photos before the application, this number increased to 4 students after the training.

Looking at the answers given to the 3rd question in the pretest and final evaluation, "Which photo editing programs do you know? If you know, which one do you use?", it is seen that 3 students used photo editing programs before receiving education, while the number of students who used photo editing programs after the training was 6 students. At the same time, while each student mentioned at least one photo editing program at the beginning of the application, all students stated at the end of the application that they were able to use more than one editing program.

Overall, looking at the results of the lesson and application processes, it is understood that STEAM-based art teaching has a positive impact on the photography education of gifted students.

Results from the Second Sub-Problem

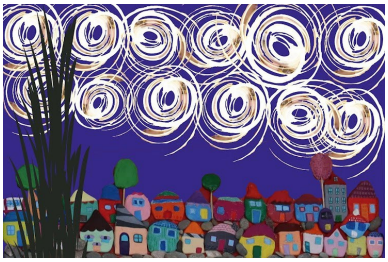
Looking at the findings regarding the impact of STEAM-based art teaching on the photo-manipulation work of gifted students, a positive change can be observed in the answers given by students to the question "Have you used Photoshop before? If so, what did you do?", which is included in the pretest and final evaluation. While only 1 student said that they used the Photoshop program and edited in the pretest, 6 students say they used the Photoshop program at the end of the training. At the end of the training, 5 students clearly said that they did photo-manipulation, while 1 student said that they combined photos, which means they did manipulation. In addition, some students also mentioned their artistic works and concepts such as mirror manipulation, starry night with lights, the golden ratio, which they did in photo-manipulation.
When the 5th question, "Do you know what manipulation means? Write it down.", which is included in the pretest and final evaluation, is examined, it is observed that students did not know what manipulation was before the training. After the training, it was observed that 5 students said that manipulation means "to influence", while 1 student said that it means "to transform photos." At the end of the training, it is seen that the concept of manipulation was learned by all students.
When the 6th question, "Do you know what photo-manipulation means? Write it down.", which is included in the pretest and final evaluation, is examined, it is seen that students did not have knowledge about the concept. After receiving the training, 5 students defined photo-manipulation as "combining photos and influencing people," while 1 student defined it as "photoshopping a photo to make it different from its original state."

While students had no knowledge about photo-manipulation before the training, it is seen that all students learned the concept of photo-manipulation after the training. Therefore, it is concluded that STEAM-based art teaching positively affects the photo-manipulation work of gifted students.

Results from the Third Sub-Problem

To evaluate the photographs taken by the students at the end of the activities and the photo-manipulation work they did on these photographs, an expert opinion form was prepared. This form was used to evaluate student work by five experts in the field. It was observed that the experts were consistent in evaluating student work.
Looking at the scores given by the experts for the photographs taken by the 6 students in the 3 implemented activities and the photo-manipulation work done using Photoshop, a positive difference is observed between the photo-manipulation work done at the end of the 1st activity and the work done in the 3rd activity. Looking at the process, it is concluded that students have developed in photo-manipulation and successfully completed the activities.
Below are examples of student work that includes photography and Photoshop. First, it can be seen that the student, using long exposure on the camera, obtained a light movement image and made a work inspired by Vincent Van Gogh's "Starry Night."

Picture 1: Student work on light trail with long exposure



Picture 2: Adaptation of light trace in photography to "Starry Night" Painting

Looking at the answers given to the 1st question in the semi-structured interview form, "What are the aspects of this lesson that you liked and disliked? Why?", 5 students said they did not dislike any aspects, while one student said that their head ached because they spent a lot of time in front of the screen. It was observed that the most liked theme by the students was taking photos and doing Photoshop. They also mentioned activity names such as long exposure shots, galaxy design, infinity, the golden ratio, and subjects such as art, computer science, science, and math when mentioning their favorite aspects. Accordingly, it is concluded that students were satisfied with the activity content and the process of creating their own products.

Looking at the answers given to the 2nd question in the semi-structured interview form, "Which of the lessons you learned did you like and why?", science lessons were mentioned by 5 students. It was observed that science lessons were more entertaining and appealing to students. At the same time, there are students who said they liked computer science, visual arts, and all of the subjects.

Looking at the answers given to the 3rd question in the semi-structured interview form, "Which lesson did you struggle with? What aspects did you struggle with?", 5 students said they didn't struggle with any subject, while one student said, "It was difficult to place math on the photo in the golden ratio (Ö2).".

Picture 3. Pine cone photo

Picture 4. With photoshop editing on pine cone

This research demonstrates that integrating different disciplines is beneficial for fostering students' creativity and problem-solving abilities.

In the semi-structured interview form, question 4 asked, "What subjects did you combine while doing photo-manipulation? Why?". Six students answered mathematics and science, while four students answered computer science and painting, and one student answered technology. Mathematics and science were the most commonly mentioned disciplines by the students, followed by computer science and painting. In this study, the use of computers, photo editing software, and any camera or phone for taking photographs naturally integrated computer science and technology into the process.

In the semi-structured interview form, question 5 asked, "What did you aim to do while doing photo-manipulation? Why?". Four students said they aimed to combine the subjects they had learned, one student said they aimed to edit the photos, and one student said they aimed to digitally create a starry night. Based on the students' answers, it can be said that they have successfully synthesized the topics of the activity and used information technology as a tool for producing artwork.

In the semi-structured interview form, question 6 asked, "Do you think the course you took contributed to your learning?". All students answered yes. It was observed that there were students who said they developed themselves, that it contributed to their general knowledge, and that they gained a different perspective. Therefore, it was concluded that the education they received achieved its goals.

In the self-assessment form given to students after the first activity, "Let the Mirrors Reflect You," students mentioned their discoveries in their work, mostly focusing on learning how to take pictures, what manipulation is, and how it is done. They also listed mirrors and cloning through manipulation as their discoveries during the activity. It was observed that the activity had the desired impact on the students. Students identified improving cloning, photography, and the use of Photoshop as areas for improvement in their work. This leads to the conclusion that the activity time was insufficient. They mentioned that their excitement was in the initial moments of taking pictures, the moments when they were doing Photoshop, and when they saw that they could erase everything with cloning. Therefore, the positive impact of the activity on the student, who learned new things after an activity prepared with enriched content, is evident. When asked what they disliked in their work, four students said they had no dislikes, one student disliked the laboriousness of taking pictures, and one student disliked searching for pictures to take with mirrors for a long time.

In the self-assessment form given to the students after the second activity, "Discovering Art in Nature," students mentioned their discoveries in their work, with the majority mentioning the "golden ratio." They stated that they discovered that the golden ratio is present in many aspects of our lives, such as flowers and paintings. It is understood that the students' perception of the environment has increased thanks to the activity. They stated that they wanted to improve their ability to take pictures and do Photoshop. All the students said they had no dislikes about their work. They stated that they were excited while taking pictures, doing Photoshop, and looking for the golden ratio.

In the self-assessment form given to the students after the third activity, "Starry Night with Light Trails," students mentioned their discoveries in their work, including long exposure, infinity, galaxy types, and pi. When asked about their areas for improvement, the majority stated they wanted to improve their photography and Photoshop skills. It was observed that long-exposure photography with light was the most desired area for improvement. When asked about the exciting parts of the work, the majority mentioned long exposure. Five students said they had no dislikes in their work, while one student said they disliked the length of the project and only being able to use their own pictures.

Overall, considering all the activities, it was observed that the majority of students said they had no dislikes about the activities, that they were excited while taking pictures and using Photoshop, and that they wanted to improve these skills. Therefore, it can be concluded that the activities were suitable for the students' levels. During the implementation process of the research, the students' active participation in the lesson, their successful completion of the activities, and their performance exceeding the researcher's expectations are noteworthy.

The findings obtained during the research process provide data on activities related to photography and photo-manipulation that can be carried out in STEAM-based art education courses. The activities include camera use, Photoshop program use, mirrors, infinity, galaxy design, Fibonacci numbers, and the golden ratio. In these activities, which were prepared before the implementation began, topics where STEAM, photography, and photo-manipulation intersect were selected and linked with relevant learning outcomes. This situation, as understood from the students' artworks, has enhanced the students' problem-solving, creativity, and critical thinking skills. This result aligns with the findings of Kim and Park (2012), who stated that STEAM-based activities develop students' imagination, close communication among team

members, creative thinking ability, problem-solving, invention ability, and ultimately engineering and design skills. This result is also consistent with the findings of Erol (2023), which concluded that STEAM education positively influences children's visual and auditory perception and problem-solving skills. Another study in line with this result is the Master's thesis of Akçin (2023), who investigated the general opinions of middle school students studying in Visual Arts and general mental ability programs about STEAM education. Akçin (2023) concluded that STEAM education supports creative thinking, invention, success in social relationships, leadership, communication, and artistic skills and that creative thinking enriches learning with art in students.

According to another finding from Akçin's (2023) research, STEAM education enables each individual to benefit from all communication systems and technological advancements in the training of students who will understand and solve 21st-century global problems, and take precautions against problems. Furthermore, the STEAM program developed in the study of Kim and Kim (2016) was designed to provide opportunities for creative and aesthetic experiences in the use of robots based on fine arts rather than being a secondary tool to help students understand principles and knowledge in science, technology, and mathematics. They concluded that creating creative fine art works in STEAM lesson content created through science facilitates academic achievement in fine arts and mathematics. These results are consistent with the finding from the research that students have successfully synthesized the topics of the activity and used information technology as a tool for producing artwork.

Generally, looking at the results of the lessons and application processes, it is understood that STEAM-based art education positively influences gifted students' photography education and photo-manipulation studies. In this regard, the research of Arık and Özdemir (2019) determined that the participants were insufficient in developing their cognitive, affective, and psychomotor skills related to technology after the activity. However, they concluded that it developed their cognitive skills in terms of "learning about materials and their properties made from different materials" and "using technological materials more effectively" after the activity.

Based on the opinions obtained from the student interview forms, students said that STEAM-based art education positively impacted their photography education and photo-manipulation studies, that they developed themselves, that it contributed to their general knowledge, and that they gained a different perspective. Therefore, it was concluded that the STEAM education they received achieved its goals. Another result obtained from the research findings is that students stated that they discovered that the golden ratio is present in many aspects of our lives, such as flowers and paintings. In this case, it was observed that STEAM-based activities increased the students' ability to examine and perceive objects in their environment, as well as their creativity. These results are similar to those obtained in the doctoral thesis research of Rusçuklu (2024), who investigated the impact of life-based STEAM activities on the creativity of pre-school students in the six-year-old age group. "It was found that STEAM activities integrated with a life-based learning approach made a contribution to children's creative thinking skills, and a statistically significant difference was found in favor of the experimental group between the final test creative thinking scores of the groups."

Declarations

Conflict of Interest

No potential conflicts of interest were disclosed by the author(s) with respect to the research, authorship, or publication of this article.

Ethics Approval

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The study was approved by the research team's university ethics committee of the Necmettin Erbakan University Social and Human Sciences Scientific Research (Approval Number/ID: 2023/472. Hereby, we as the authors consciously assure that for the manuscript the following is fulfilled:

- This material is the authors' own original work, which has not been previously published elsewhere.
- The paper reflects the authors' own research and analysis in a truthful and complete manner.
- The results are appropriately placed in the context of prior and existing research.
- All sources used are properly disclosed.

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1st author contributed 50%, 2nd author 50%.

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