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International Journal of Curriculum and Instruction 14(3) (2022) 2188- 2217

IJCI
International Journal of Curriculum and Instruction

Examining the effect of STEAM approach applications on attitude towards STEAM in visual arts education

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Abstract

The aim of present study is to decide the effect of Visual Arts Education delivered with the activities developed as a part of STEAM approach, which is based on the integration of Art into the disciplines of Science, Technology, Engineering and Mathematics, on the attitude towards the disciplines that constitute this approach. Views upon STEM approach also are identified. This study, which was carried out in a public school based in a central district city in the Western Black Sea region of Turkey, lasted 6 weeks as a part of the Visual Arts course. There are 48 students studying in 6th grade as for research sample, 25 of which are experimental and 23 are control group. Embedded mixed design, one of the mixed design types was used in the study. Quantitative data were obtained with STEAM Attitude Scale using a quasi-experimental design with pretest-posttest control group. In qualitative terms, data was collected by semi-structured interviews on the basis of case study. STEAM Attitude Scale data were analyzed by dependent / independent groups t test and ANCOVA. Content analysis was used for analysing the semi-structured interview form data. When the research findings were examined, a significant difference was found in favor of the post-test between the experimental group STEAM Attitude Scale pre-test-post-test mean scores. As a result of the analysis of the post-test scores of the experimental and control groups, a significant difference was found in favor of the experimental group. With the STEAM approach, it has been concluded that visual arts education leads to an increase in individuals' attitudes towards the Science, Technology, Engineering, Art and Mathematics disciplines that form STEAM. When the interview findings were examined, it was found that the positive opinions of the experimental group regarding the process carried out with the STEAM approach were intense. Based upon the findings, it has been determined that the application has a helpful effect on the development of attitude towards STEAM disciplines. Suggestions have been made to researchers and program makers to clarify the framework of the STEAM approach and to enrich the application examples.

Keywords: Visual arts education; interdisciplinary approach; STEM; STEAM

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1. Introduction

Education is a system that is constantly renewed, changing, searching the best and constantly performing this search process. The motivation that provides the dynamism of education is the necessity of educating individuals who are critical thinkers, entrepreneurs and have high-level skills in order to reach the economic and political level that countries target (Bybee, 2010). Competencies determined by the National Research Council [NRC] (2010, 2012) and desired to be acquired by individuals are based on creative thinking, analytical perspective and design skills. Since these foundations can be rooted by using different disciplines together, there is a tendency to use different disciplines together at the international level (Ministry of National Education [MoNE], 2018).

In the interdisciplinary approach, different fields constitute the background of the curriculum; therefore, different fields are used together. This approach, which has been used in different ways in education for many years, assists in the resolution of complex problems (Condee, 2004) and the development of high-level mental skills. (Condee, 2004; Haring & Kelner, 2015; Michelsen, 2015). In other words, the creation of individuals who are researching, questioning, creative and able to make decisions (Brophy, Klein, Porstmore & Rogers, 2008; Tyler-Wood, Knezek & Christensen, 2010), which are the most important requirements of our age, are within the domain of interdisciplinary approach. One of the most recent examples of interdisciplinary approach is STEM. STEM concept is formed from the English initials of Science, Technology, Engineering and Mathematics disciplines (Science, Technology, Engineering, Mathematics).

STEM is an educational approach that enables individuals to use their knowledge of Science, Technology, Engineering and Mathematics disciplines in their education process in order to reveal their skills and interests in questioning, researching, creating new products and making inventions (Innovation and Educational Technologies General Directorate [YEGITEK], 2018). STEM approach was introduced to the world education literature in 2001 by the director of the United States of America (USA) National Science Board Judith A. Ramaley (Yıldırım & Altun, 2015). This approach, pioneered by the USA, has been rapidly adopted in the education system in the Far East and European countries (Yılmaz, Koyunkaya, Güler & Güzey, 2017). STEM, which we have seen in our national education in the last decade, has been included in our education system with the revisions made in our curricula in 2018 (MoNE, 2018, p.4-11). In textbooks, there are activities on the use of science and engineering disciplines in the new curriculum formed with STEM.

STEM is an approach that includes different levels from pre-school to higher education (Çorlu, Caprao & Caprao, 2014). In this context, with a perspective that spans the STEM education process, there is a need to develop education policies and programs with the disciplines of entrepreneurship (STEM-Entrepreneurship, STEM + E) and programming (STEM-Computing, STEM + C) considering the country's needs (Akgündüz et al., 2015). One of the interpretations of the STEM approach adapted to the 21st century conditions is STEAM, which is formed by integrating Art into the STEM discipline.

1.1. STEAM approach

STEAM derived from English initials of the Science, Technology, Engineering, Art and Mathematics disciplines. STEAM is one of the most up-to-date and innovative combinations of an interdisciplinary approach. It acts as a connective tissue among the disciplines and brings STEM to a more distinctive dimension. Education systems around the world integrate STEAM education, which originated in Korea. This holistic interdisciplinary training was developed by Yakman in 2010 (Ayvacı & Ayaydın, 2017; Batı, Çalışkan, & Yetişir, 2017; Braund, 2015; Yakman, 2010). The goal of STEM is to develop a society that can supply products to solve problems that will arise in the future by addressing today's problems in a realistic way. Meanwhile, STEAM is a process that gets involved at this point and contributes to product originality by adding aesthetic measures. According to Watson & Watson (2013), one of the most important arguments of the STEAM existence process is that the STEAM approach, which is formed by the addition of the art discipline, is not much different from STEM. This perspective of STEAM enables its structure to be strengthened and valued. The STEAM process is not only a solution proposal product, but also customized designs with aesthetic concerns. The emphasis on this design process stems from the aim of building a different society with the use of art. Societies that feed on the creativity of art, support different ideas, and value the original come to a different place in art (Yılmaz, 2015). As seen in Figure 2, STEAM disciplines were thought of as a pyramid by Yakman, and Art was positioned as the top point of this pyramid.

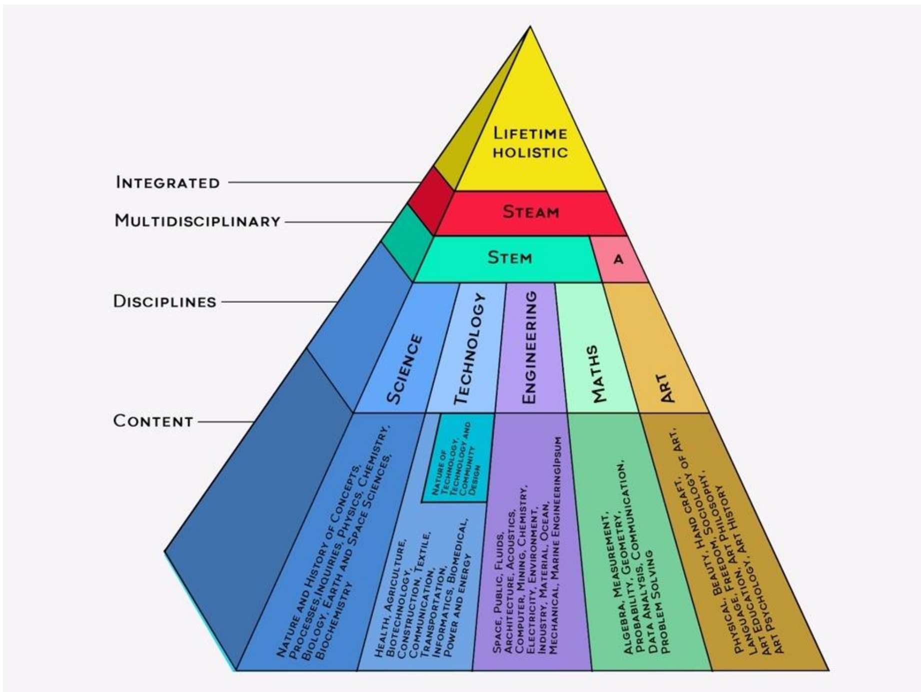

Figure 1. STEAM education (Yakman, 2008)

STEAM is positioned above the level desired to be reached with STEM. Within the art discipline, there are contents such as aesthetics, handcraft skills, free design process (Yakman, 2008). It is very important to include Art in order to create a solid and comprehensive STEM content. The contents that should be included in STEAM education are listed as follows (Park & Ko, 2012):

1. It should be introduced into an integration process without creating confusion among the disciplines that make up the STEM approach in current curricula. In addition, integrated thinking or inclusived thinking activities can be used with STEAM, or it can be studied separately for each discipline of STEAM.

2. It is necessary to target the acquisitions of thinking strategies for science, technology and engineering disciplines at the stage of providing education for the development of creativity of the STEAM approach. In STEAM education, individuals should gain knowledge and skills about basic scientific theories and develop an idea for

the use of these scientific theories in technology development. STEAM disciplines need to be linked to real life.

3. Education that succeeds in achieving goals and develops creativity is the basis of the STEAM approach and it is necessary to provide creative tools to educators to achieve this. Methods, tools and activities should be developed for educators to improve creativity. The integration of the concept of creative activity, which is often referred to with STEAM, with the STEAM approach is also important.

4. One of the focal points of STEAM education is to gain the ability to perceive the big picture.

5. A science, technology and engineering education that can compete with the developing world can be very meaningless when human characteristics are ignored. Educational philosophy must undergo a metamorphosis process to adapt to these changing conditions.

6. STEAM education should participate in the education system in an integrated process not only with science, technology, engineering, arts and mathematics disciplines, but also with the disciplines of politics, environment, society and economics.

7. One of the key points of STEAM education is the holistic design mentioned for the engineering discipline. Holistic design is a deeper concept than training scientists and engineers to shape the future. It refers to an intense talent development design that includes scientific ethics, social development, leadership and effective communication skills.

Biffle (2016) includes five sub-dimensions in the framework determined for the STEAM approach:

Figure 2. STEAM approach framework (Biffle, 2016)

According to Biffle, *Lifelong Learning* sub-dimension is based on interdisciplinary, multidisciplinary and lifelong learning; *Project/Problem Based Inquiry and Research* sub-dimension is based on integration of knowing and doing; *Interdisciplinary/Multidisciplinary Approaches* sub-dimension is based on STEAM applications, which are in the form of using problem-oriented process elements, sharing and collaborative work and an integrated curriculum teaching design; *Specific Discipline* sub-dimension is based on Science/Science, Technology, Engineering, Art and Mathematics; *Specific Content* sub-dimension consists of the concepts, theories and principles that are taught and learned in relation to the relevant scientific reality.

Although STEAM is thought to be a new interpretation of the interdisciplinary approach, when the lives of many scientists who progress in Mathematics and Science are researched, it is seen that they are nourished by the artistic background (Watson & Watson, 2013). The engineering genius of Leonardo Da Vinci, who lives the scientific process intensely, and the flawless products in terms of design created by this intelligence are among the most concrete examples of the point desired to be reached in STEAM's pyramid. The use of science, technology, engineering and mathematics together and the continuation of this companion with the pursuit of uniqueness and aesthetics brings a progressive perspective in education. In addition, the feature of art that enables individuals to adapt to different situations (Yılmaz, 2005) can make it one more step forward.

When the literature on the STEM approach are analyzed (Judson & Sawada, 2000; Roth, 2001; Tal, Krajcik, & Bluemenfeld, 2006; Lam, Doverspike, Zhao, Zhe & Menzemer, 2008; Weber, 2011; Wyss, Heulskamp, & Siebert, 2012 ; Cotabish, Dailey, Robinson & Hughes, 2013; Knezek, Christensen, Tyler-Wood, & Periathiruvadi, 2013; Watter & Diezman, 2013; Barrett, Moran & Woods, 2014; Robinson, Dailey, Hughes & Cotabish, 2014; Tenaglia, 2017; Yıldırım & Selvi, 2017), it seems to be a field that has been studied for a long time in different education levels and subject areas. When studies on integrating Art into STEM disciplines are examined, it is seen that the effect of using these disciplines together on knowledge, perception, attitude and creativity is examined (Yakman, 2008; Kwona, Namb & Lee, 2011; Sousa & Pilecki, 2013; Jin, Chong & Cho, 2013; Kim, Ko, Han & Hong, 2014; Henriksen, 2014; Jeong & Kim, 2015; Gülhan & Şahin, 2016; Rolling, 2016; Sochacka, Guyotte & Walther, 2016; Ayvacı & Ayaydın, 2017; Cook, Bush & Cox, 2017; Cook & Bush, 2018). In the national literature, the number of studies on STEAM is quite low (Batı, Çalışkan & Yetişir, 2017; Özkan & Umdu-Topsakal, 2017; Gülhan & Şahin, 2018a; Gülhan & Şahin, 2018b). In this context, STEAM studies are conducted with science and mathematics educators (Özkan & Umdu-Topsakal, 2017; Gülhan & Şahin, 2018a; Gülhan & Şahin, 2018b); it is observed that the framework of the practices that can serve as an example for the integration of these disciplines and at the level of secondary school students is not fully drawn. An important concern is the lack of studies that illuminate these points about the STEAM approach. Studies in the field of STEM and STEAM have been carried out with science-based educators and researchers, and art-oriented courses that provide aesthetics and design skills and have not been studied by those who work in this field. All this information mentioned are the reasons for the realization of the study.

1.2. Aim and importance of research

The STEM approach deals with realistic steps towards determining the needs of the future and taking measures for these needs based on today (Barrett, Moran & Woods, 2014). Assuring the STEAM-based art-oriented link between product design (originality) will result in a more steady perspective on future design. It is an important field of study to determine how an education to be provided with STEAM activities that allow the use of the disciplines of Science, Technology, Engineering, Art and Mathematics together and the level of realizing what this education promises. When the literature is examined, although there are studies using STEM approaches in national and international fields (Barrett, Moran & Woods, 2014; Cotabish, Dailey, Robinson & Hughes, 2013; Lam, Doverspike, Zhao, Zhe & Menzemer, 2008; Robinson, Dailey, Hughes & Cotabish, 2014; Tenaglia, 2017; Yıldırım & Selvi, 2017), education studies provided with the STEAM approach are not sufficient. One of the shortcomings in the literature is that STEAM studies are generally carried out in the fields of math-based educators and education, and not sufficiently studied from the perspective of art educator. The same is true for the number of informative studies on the structure of STEAM studies. With this information in mind, the purpose of present research is to evaluate the effect of STEAM applications to be applied in the Visual Arts course on attitudes towards STEAM disciplines and to examine opinions about this application process. The following research questions were addressed in this study, which can be an example of integrating STEM with different disciplines and STEAM-related application areas:

1. Is there a significant difference between STEAM attitude scale pre-test and post-test scores of the group in which the STEAM approach was applied in the Visual Arts Course?
2. Is there a significant difference between STEAM attitude scale pre-test and post-test scores of the groups in which the STEAM approach and the approach suggested by the curriculum are used in the Visual Arts Course?
3. What are the opinions of the group to which the STEAM approach is applied in the Visual Arts Course about the application process?

2. Method

2.1. Research design

This study was designed with mixed design. The mixed design enables a relationship between qualitative and quantitative research methods (Onwuegbuzie & Leech, 2004). Embedded mixed design, one of the mixed design types (Creswell & Plano-Clark, 2011) was used in this study. In embedded mixed design, the researcher can add a qualitative process into a quantitative process such as an experimental study or a qualitative process such as a case study (Creswell & Plano-Clark, 2011). In this context, in the quantitative part of the research, pre-test-post-test quasi-experimental design with control group; In the qualitative part, the case study was used (Figure 3).

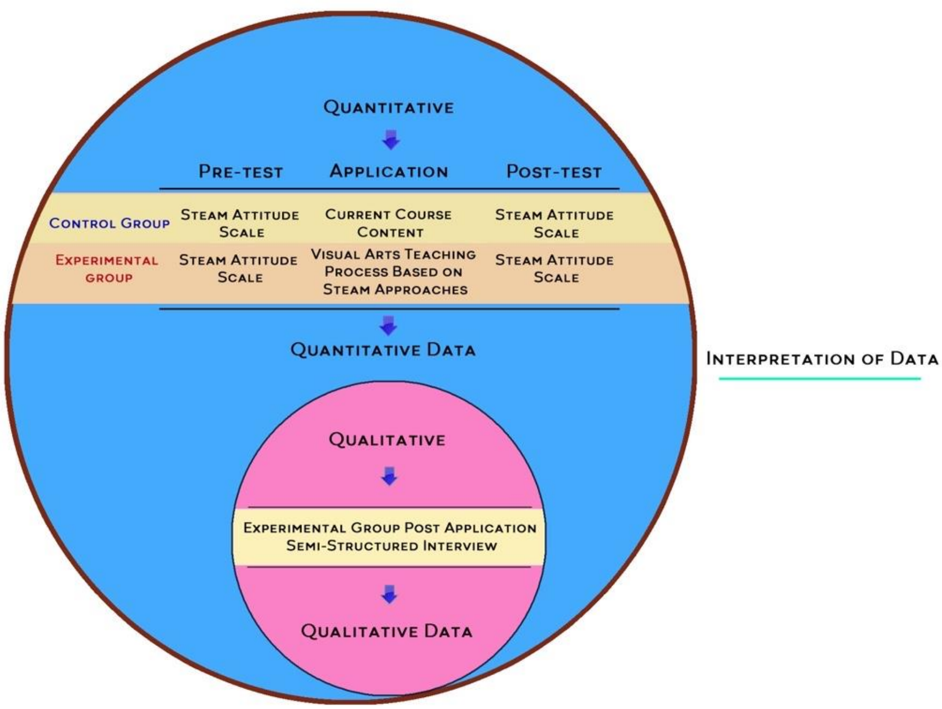

Figure 3. Research design

Qualitative and quantitative data were collected simultaneously in the study. Collecting quantitative data in the experimental and control groups before the application was carried out simultaneously with the collection of qualitative data in the experimental group. At the end of the application process, the data was collected in the same way and a data set was created. Based on the data, the effect of the application on the students' attitudes towards STEAM and the opinions of the experimental group regarding the application process were determined.

2.2. Participants

Fourty-nine students included as the sample of the study who are studying in the 6th grade in a public school based in a central district of the province in the Western Black Sea region of Turkey in the spring semester of the 2017-2018 academic year. In the selection of the experimental and control groups, two branches in the school were chosen and their groups were determined randomly. Information on the characteristics of the working group is included in Table 1.

Table 1. Characteristics of the study group

	Grade	Female	Male	Total	Evaluated
Experimental Group	6	14	12	26	25
Control Group	6	10	13	23	23

The arithmetic mean of the students of the participants is 73-98, in the 10-12 age range. Out of the 26 sixth grade students who participated in the study, 1 student was not included in the study data set because that student did not participate in some activities during the process. In obtaining the data of the qualitative part of the study, the opinions of 25 students before and after the application were consulted. The study was conducted with a group of participants whose academic averages ranged from 76-98, 13 females and 12 males, and ages 10-12. Participants were coded as S1, S2, S3 ... S25.

In testing the equivalence of the experimental and control groups, the average scores of the STEAM attitude scale, which was applied as a pre-test, were compared (Table 2).

Table 2. Independent groups t-test results for the experimental and control group STEAM attitude scale pre-test scores

	Group	n	$\bar{X}$	Ss	df	t	p
STEAM Attitude Scale	Experimental	25	199.8	9.35	46	.896	.375
	Control	23	195.4	10.21			

$p < .05$

When the data on the STEAM attitude scale pre-test mean scores of the experimental and control groups were examined, no significant difference was found ($p = .375 > .05$). In the light of these data, it was accepted that the groups were equivalent and the application process started.

2.3. Data collection tools

The STEAM Attitude Scale was used in the quantitative dimension of the study and the semi-structured interview form was used in the qualitative dimension.

2.3.1. STEAM attitude scale

The STEAM Attitude Scale used in the study is a scale created by combining two tests based on the study of Gülhan and Şahin (2018). These tests are STEM Attitude Test and Attitude Scale towards Art. STEM Attitude Test was developed by Friday Education Innovation Institute (2012) and adaptation studies to Turkish were carried out by Yıldırım and Selvi (2015). There are 37 items in the scale. Cronbach Alpha internal consistency coefficients of the dimensions of the scale were found between .86 and .89.

The Attitude Scale towards Art developed by Dede (2016), consists of 21 items. The reliability of the scale was found as .894 by the researcher. It has 58 items in the STEAM Attitude Scale created by combining these two tests. In order to determine the reliability of the test, the scale was applied to 97 seventh grade students before the application. In the reliability analysis, the Cronbach α value was determined as .875. It has been determined that the test is reliable for the application to be conducted.

2.3.2. Semi-Structured Interview Form

The interviews that constitute the qualitative dimension of the research were carried out with semi-structured interviews made after the application. An academician who is expert in qualitative research was asked to form the interview questions. Before starting the implementation, pilot preliminary interviews were conducted with 4 participants in a different school than the state school where the application was carried out. The interviews lasted about 15 minutes.

2.4. Procedure

In the research 6 activities developed by the researcher were applied. The application process was conducted by the researcher. In addition, support was received from an academician who was a science education doctor with the title of "Science Expert", in the experimental group where the application was carried out throughout the study. This precaution has been taken by foreseeing the healthy progress of the scientific part of the application and the information needs that may risk the research. The Visual Arts course in which the application is carried out is 1 lesson hour per week and is included in the compulsory course in the secondary school curriculum. During the research process, 8 weeks were spent with the participants, and pre-test and post-test data were collected in the first and last week of this process. The application process of the activities lasted 6 weeks and one activity was applied every week. The application process of the activities and the STEAM disciplines covered by the activities are explained in Figure 4.

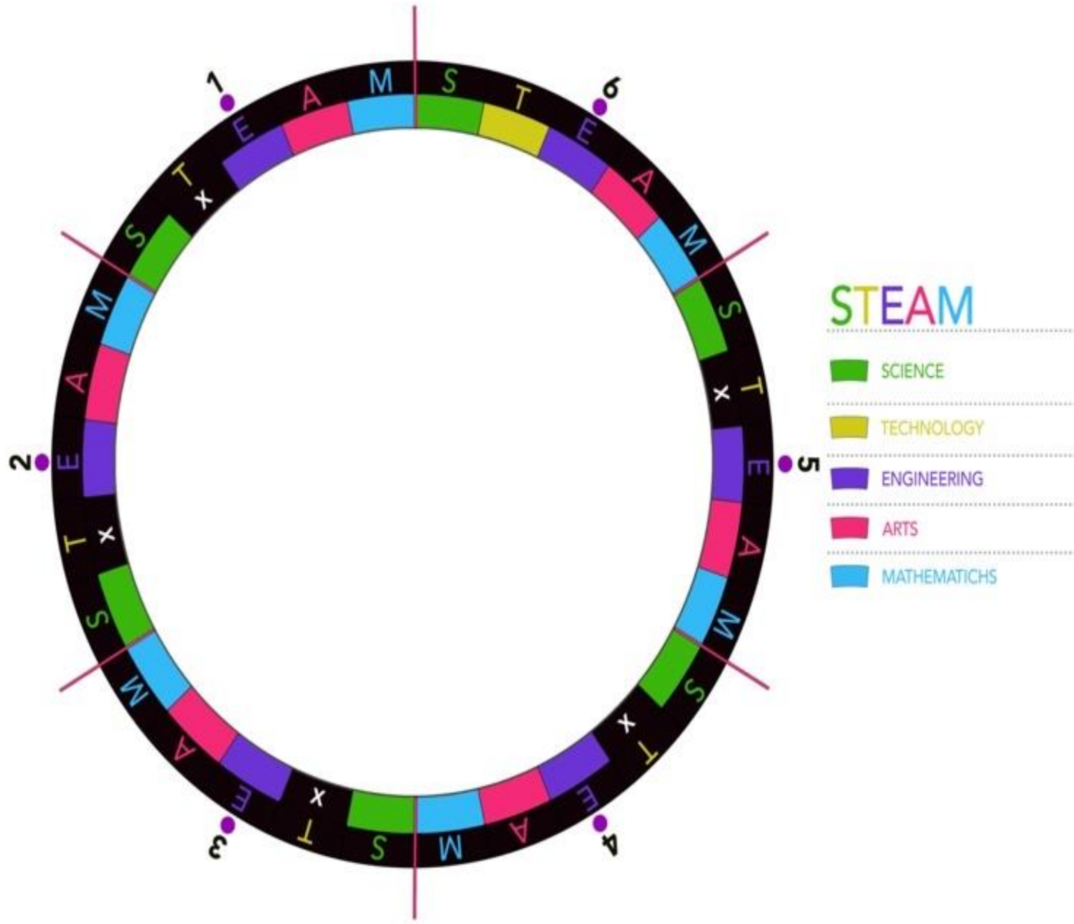

Figure 4. Application process

In the first five of the six activities applied, the use of the Science, Engineering, Art and Mathematics disciplines from STEAM disciplines is observed. The sixth activity, the last activity of the application, covers all areas. The activities are designed to gain spiral outcomes in Science Course, Mathematics Course, Information Technologies and Software Course Curriculum and Visual Arts Course Curriculum. During the application, 2013 Science Curriculum (1st -8th Grades), 2013 Secondary School Mathematics Course Curriculum (5th -8th), 2017 Visual Arts Course Curriculum and 2018 Information Technologies and Software Course Curriculum (5th and 6th Classes) learning outcomes are taken into consideration. The contents of the application process and activities are as follows:

Table 3. Independent groups t-test results for the experimental and control group STEAM attitude scale pre-test scores

Name of the Activity	Content of the Activity
Color Riot Activity	This activity aims at learning outcomes in the Science, Engineering, Art and Mathematics fields of the STEAM approach. Light, full and half shadow in Science discipline; Product design in engineering discipline; distance, circle, area in Mathematics discipline; in the Art discipline, they are expected to make their designs by gaining the concept of main and intermediate colors and aesthetics. Collaborative work is used in this activity.
Spaghetti Bridge Activity	This activity aims at learning outcomes in the Science, Engineering, Art and Mathematics fields of the STEAM approach. Center of gravity and balance in Science discipline; product design in Engineering discipline; length, geometric shapes and mathematical operations in Mathematics discipline; in the art discipline, they are expected to make their designs by gaining the concept of main and intermediate colors and aesthetics. Collaborative work is used in this activity.
Pollock Orbit Activity	This activity aims at learning outcomes in the Science, Engineering, Art and Mathematics fields of the STEAM approach. Rotational motion, gravity, oscillation, planets in science discipline; product design in engineering discipline; geometric shapes and mathematical operations in Mathematics discipline; in the Art discipline, they are expected to make their designs by gaining the concept of main and intermediate colors and aesthetics. Collaborative work is used in this activity.
Bubbling Ebru Activity	This activity aims at learning outcomes in the Science, Engineering, Art and Mathematics fields of the STEAM approach. Physical and chemical reactions in science discipline; Product design in engineering discipline; Geometric shapes and mathematical operations in mathematics discipline; in the Art discipline, they are expected to make their designs by gaining the concept of main and intermediate colors and aesthetics. Collaborative work is used in this activity.
White Ballerina	This activity aims at learning in the Science, Engineering, Art and Mathematics fields of the STEAM approach. Electromagnetic forces, magnets in Science discipline; product design in Engineering discipline; geometric shapes and mathematical operations in Mathematics discipline; in the Art discipline, they are expected to make their designs by gaining the concept of main and intermediate colors and aesthetics. Collaborative work is used in this activity.
Short Film: States of Matter	This activity aims at learning outcomes in the Science, Technology, Engineering, Art and Mathematics fields of the STEAM approach. States of matter in Science discipline; using a technological tool in the Technology discipline, technology integration and program use in education; product design in Engineering discipline; geometric shapes and mathematical operations in Mathematics discipline; in the Art discipline, they are expected to make their designs by gaining the concept of design and aesthetics. Collaborative work is used in this activity.

In the application, each group was given an activity box containing activity materials before the activities. The boxes were fixed every week and the interior materials were changed in accordance with the week's activity. The names of the group members and the number of the group they belong to are displayed on the activity boxes. Boxes are customized to belong to groups (Figure 6). During the activities, the name badges containing the numbers and names of the groups that the students belong to were prepared. Badges were given to the students in the activity boxes after the activity and placed these cards in their boxes. In the next week of the activity, the badges were placed in the box with new materials and used throughout the entire process. The same name badges were also available to researchers (Figure 5).

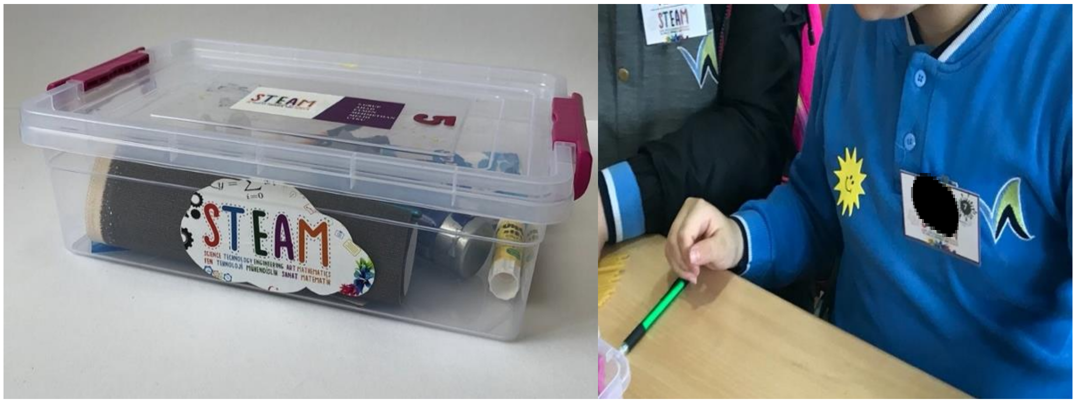

Figure 5. Examples of activity boxes and name badges used in the application process

In the process carried out in the control group, it was sticked to the approach envisaged by the curriculum and the annual plan. Participants received training in accordance with the acquisitions of the Visual Arts Course in the activities they performed during this period (Table 4).

Table 4. Characteristics of the study group

Week	Hour	Course Gains	Theme/Activities
1	1	G.6.3.1. It uses the technique of carving, assemblage or modeling to create three-dimensional works. It is emphasized that the assembly is composed of natural, industrial objects or their parts brought together in a new order. G.6.3.2 Explain the feelings and thoughts reflected in the artist's work. G.6.2.2 Examines handicraft samples through products in ethnographic museums. Where there are no ethnographic museums, facsimiles, documents, etc. makes use of materials.	Providing designing of promotional posters, invitations and business cards on museums.
2	1		
3	1		
4	1		
5	1		
6	1	G.6.1.1 Students prepare a presentation file consisting of visual art works. It starts with brainstorming; follows the process of synthesizing, designing, sketching and detailing ideas. G.6.2.5 Realize how the visual arts, history and culture affect each other.	*"I am preparing an art activity file with my group"/ An activity file is prepared consisting of works by local and foreign art masters; The names of the works in this file, the date and purpose of the work, the mood of the artist, cultural purpose, art criticism and aesthetic evaluation, etc. criteria are included. & Children who are integrated with Turkish art and world art, culture, local activities… .collage, mixed technique etc.*

2.5. Application of data collection tools

Before starting the research, the necessary permission was obtained from the parents of the experimental and control group students through the Voluntary Participation

Form, and the necessary explanation regarding the research was presented to the parents in writing. In the next process, the qualitative and quantitative data collection tools of the study were applied simultaneously. STEAM Attitude Scale and semi-structured interview form were applied to the experimental group as a pre-test, and the STEAM Attitude Scale was used as a pre-test for the control group. In the final of the six-week application, the same measurement tools were applied to the groups in the same way.

2.6. Analysis of data

Qualitative and quantitative analysis methods were used in accordance with the nature of the data obtained from the research. The data of the STEAM Attitude Scale, which constitutes the findings of the quantitative dimension of the study, were predicted by dependent groups t-test, independent groups t-test and ANCOVA. Interviews with qualitative data were analyzed using content analysis method. Content analysis is the process of outlining and specifying the basic contents of the written documents and the messages they contain (Cohen, Manion & Morrison, 2007). There are four steps in content analysis: processing of qualitative research data obtained from documents, coding of data, finding themes, organizing codes and themes, defining and interpreting findings (Yıldırım & Şimşek, 2018). At first step, the interview forms were written in computer environment without changing. A total of 43 pages written document was obtained, consisting of 15 pages before the application and 28 pages after the application. The interview data, which were transferred to the computer environment without any changes, were also reviewed by another researcher, and the deciphered records of the interview were cleared from daily spoken language for suitability for analysis, and arranged for understandability (Coolican, 2009; Kvale, 1996). Afterwards, the interview was rearranged according to the rules of documentation (Mayring, 2000). Inductive analysis was used in the analysis of the data. The obtained data were read independently by the author and qualitative study specialist, and individual codes and categories were created. These codes and categories created individually were compared and the records were examined until a consensus was reached. In order to determine the reliability of the study, among the individual data solutions, Miles & Huberman's (1994) formula was used (Percentage of Compliance = (Compromise) / (Reconciliation + Disagreement) X 100). The Compliance Percentage was calculated as 87.15. Before and after the application, coding and categorization of each research problem was made, and the findings were presented with quotations.

3. Findings

3.1. The Effects of the STEAM Approach in Visual Arts Education and the Approach Stipulated by the Curriculum on the STEAM Attitudes of the Groups

Kolmogorov-Smirnov and Shapiro-Wilk tests were applied to the test and all sub-dimensions of the test in order to determine the distribution of STEAM Attitude Scale pre-test and post-test scores of the experimental group in which the Visual Arts Course was conducted with the STEAM approach (Table 5).

Table 5. Normality test analysis of experimental group STEAM attitude scale pre-test and post-test scores

	Dimensions	Kolmogorov-Smirnov K-S			Shapiro-Wilk S-W		
		statistic	df	p	statistic	df	p
STEAM Attitude Scale pre-test	Science	.169	25	.040	.921	25	.063
	Mathematics	.173	25	.060	.927	25	.073
	Engineering and Technology	.231	25	.020	.926	25	.070
	21st century Skills	.187	25	.007	.897	25	.056
	Art	.192	25	.003	.938	25	.102
	All	.245	25	.005	.949	25	.109
STEAM Attitude Scale post-test	Science	.198	25	.068	.943	25	.080
	Mathematics	.195	25	.200	.965	25	.098
	Engineering and Technology	.286	25	.200	.971	25	.101
	21st century Skills	.238	25	.054	.956	25	.094
	Art	.248	25	.063	.945	25	.083
	All	.253	25	.078	.965	25	.098

For the STEAM Attitude Scale dimensions, $K\text{-}S_{pre\text{-}test}$ .005 $KS_{post\text{-}test}$ .078 and $S\text{-}W_{pre\text{-}test}$ .109 $S\text{-}W_{post\text{-}test}$ .098. Although it is determined that the K-S pre-test values move away from the normal distribution, it is known that it is appropriate to consider the S-W test values in the interpretation in cases where the small participant group is studied. For this reason, it has been determined that the S-W test scores show a normal distribution since they fulfill the $p>.05$ condition in all sub-dimensions in the pre and post-test values. It was decided to apply parametric tests to the data set.

In order to determine the effect of the STEAM approach on the STEAM attitudes of the participants, dependent groups t-test was applied to the experimental group pre-test and post-test mean scores (Table 6).

Table 6. Experiment group STEAM attitude scale pre-test-post-test scores dependent groups t-test results

		n	X̄	ss	df	t	p
STEAM Attitude Scale	Pre-test	25	199.80	25.44	24	-21.71	.000
	Post-test	25	252.60	18.94	24		

p <.05

As a result of the dependent groups t-test applied to the experimental group data, a significant difference was found in favor of the post-test (t = -21.71; p>.05). It shows that the Visual Arts course conducted with STEAM activities helped the experimental group students to increase their attitudes towards STEAM disciplines. The dependent groups t-test was applied to all sub-dimensions of the scale in determining the dimensions of the scale in which the development occurred in the experimental group (Table 7).

Table 7. Experiment group STEAM attitude scale sub-dimensions pre-test-post-test scores dependent groups t-test results

Sub-dimensions		n	X̄	ss	df	t	p
Science	Pre-test	25	31.57	12.123	24	-4,35	.000
	Post-test	25	41.16	9.387			
Mathematics	Pre-test	25	29.61	12.410		-2,62	.015
	Post-test	25	35.21	9.806			
Engineering and Technology	Pre-test	25	30.92	13.474		-4,82	.000
	Post-test	25	42.38	8.675			
21st century Skills	Pre-test	25	39.63	11.931		-4,73	.000
	Post-test	25	49.60	9.699			
Art	Pre-test	25	68.07	12.507		-6,73	.000
	Post-test	25	84.25	10.577			

p <.05

In all sub-dimensions of the scale, Science, Mathematics, Engineering and Technology, 21st Century Skills and Art disciplines, a significant difference was found in favor of the post-test before and after the application. It was determined that the process carried out with the experimental group participants increased the attitude towards STEAM and the disciplines that make up STEAM. Visual arts education given with the STEAM approach has been beneficial for science, attitudes towards mathematics, considering these disciplines in achieving their targeted profession in the future, considering originality and aesthetic dimensions in design and making sense of art.

The data were analyzed to determine the relationship between the STEAM Attitude Scale pre-test and post-test scores of the control group and the experimental group in which the Visual Arts Course was conducted with the STEAM approach, in other words, the effectiveness of the application. The ANCOVA test was performed by assigning pre-test data to covariance. It was thought that covaryent assignment would strengthen the study's validity and reliability. Descriptive analysis of post-test scores, which were corrected according to pre-test scores, was performed (Table 8).

Table 8. STEAM Attitude Scale Corrected Pre-test and Post-test Scores of the Control and Experimental Groups

		Groups	n	$\bar{X}_{pre\text{-}test}$	$\bar{X}_{post\text{-}test}$	$\bar{X}_{corrected\ post\text{-}test}$
STEAM Attitude Scale Sub-dimensions	Science	Experimental	25	31.57	41.16	41.76
		Control	23	30.63	31.45	30.97
	Mathematics	Experimental	25	29.61	35.21	35.81
		Control	23	30.22	33.57	33.13
	Engineering and Technology	Experimental	25	30.92	42.38	42.87
		Control	23	27.46	30.78	30.42
	21^{st} Century Skills	Experimental	25	39.63	49.60	49.95
		Control	23	38.23	41.07	40.97
	Art	Experimental	25	68.07	84.25	85.02
		Control	23	68.86	69.73	69.16
STEAM Attitude Scale All		Experimental		199.80	252.60	255.41
		Control		195.40	206,60	204,65

ANCOVA analysis was performed on the data obtained from the experimental and control groups (Table 9).

Table 9. ANCOVA results on the STEAM attitude scale post-test scores of the control and experimental groups

	Source of Variance	Sum of Squares	df	Average of Squares	F	p	η²
Science	Pre-test	1663.452	1	1663.452	11.021	0.001	0.19
	Group(experimental/control)	5526.826	1	5526.826	36.618	0.000	0.44
	Error	6942.853	46	150.931			
	Total	12469.680	48				
Mathematics	Pre-test	1595.365	1	1595.365	12.203	0.001	0.21
	Group(experimental/control)	4369.981	1	4369.981	33.427	0.000	0.42
	Error	6013.590	46	130.730			
	Total	10383.572	48				
Engineering and Technology	Pre-test	7,632	1	7.632	0.118	0.732	0,00
	Group(experimental/control)	1032.695	1	1032.695	15.962	0.000	0.26
	Error	2964.018	46	64.435			
	Total	3996.713	48				
21st Century Skills	Pre-test	2098,373	1	2098,373	10.770	0.002	0.19
	Group(experimental/control)	6743.280	1	6743.280	34.639	0.000	0.43
	Error	8954.985	46	194.673			
	Total	15698.265	48				
Art	Pre-test	4622.520	1	3622.250	19.743	0.000	0.30
	Group(experimental/control)	13601.964	1	13601.964	58.100	0.000	0.56
	Error	10769.088	46	234.110			
	Total	25371.053	48				
STEAM Attitude Scale	Pre-test	36886.323	1	36886.323	65.026	0.000	0.58
	Group(experimental/control)	87934.735	1	87934.735	155.018	0.000	0.77
	Error	26093.739	46	567.255			
	Total	114028.475	48				

As a result of the covariance analysis performed with the corrected pretest scores of the control group, where the implementation process was carried out with the approach envisaged by the curriculum and the experimental group, where the STEAM approach was carried out, a significant difference was found between the posttest scores ($F_{(1-46)}$=155.018; p=.00<.05). It has been determined that the process based on STEAM approach creates a significant difference in their attitudes towards STEAM disciplines. When the post-test scores of the experimental group and the control group were compared ($\bar{X}_{post\ test-control}$= 206.60 , $\bar{X}_{post\ test-experimental}$ = 252.60), a more positive increase was observed in the experimental group. When the eta-squared values (η^2), which is the effect power value, were examined to determine the reason for this increase, it was determined that 77% of the difference in the final test was due to the process carried out with the STEAM approach. In order to investigate this effect in more depth, the scale's sub-dimensions were examined in-depht.

After performing a covariance analysis with the corrected pretest scores in the science sub-dimension, a significant difference between the posttest scores was found ($F_{(1-}$

$_{46)}$=15.962; p=.00 < .05). When the posttest mean scores of the experimental group and the control group obtained from the STEAM Attitude Scale Science sub-dimension are compared ($\bar{X}_{\text{Science pos test-control}}$= 31.45 , $\bar{X}_{\text{Science post test-experimental}}$ = 41.16), it is seen that there is a significant increase in the experimental group compared to the control group. It can be said that the application of STEAM approach creates an increase in attitude towards Science. When the eta-square value (η^2) for this effect was examined, it was found that being in different groups within the study explained 44% of the difference between the post-test scores in this sub-dimension.

Based on the covariance analysis carried out with the corrected pretest scores in the mathematics sub-dimension, significant differences were found between the posttest results and the pretest scores ($F_{(1\text{-}46)}$=33.427; p=.00 < .05). When the post-test mean scores of the experimental group and the control group obtained from the STEAM Attitude Scale Mathematics sub-dimension are compared ($\bar{X}_{\text{Mathematics post test-control}}$= 33.21 , $\bar{X}_{\text{Mathematics post test-experimental}}$=35.57), it is seen that there is an increase in the experimental group compared to the control group. It is seen that the application of STEAM approach causes an increase in attitude towards mathematics. When the eta-square value (η^2) for this positive increase was examined, it was found that being in different groups within the study explained 42% of the difference between the post-test scores in this sub-dimension.

According to the covariance analysis performed on the corrected pretest scores in the Engineering and Technology dimension, a significant difference was seen between the posttest scores and the pretest scores ($F_{(1\text{-}46)}$=15.962; p=.00 < .05). When the post-test mean scores of the experimental group and the control group from the STEAM Attitude Scale Engineering and Technology sub-dimension were compared ($\bar{X}_{\text{Engineering and Technology pos test-control}}$=30.78, $\bar{X}_{\text{Engineering and Technology postest -experimental}}$ = 42.38), an increase occurred in the experimental group compared to the control group. is seen. It can be said that the application of STEAM approach leads to an increase in attitude towards mathematics and engineering. When the eta-square value (η^2) for this effect was examined, it was determined that being in different groups within the study explained 26% of the difference between the post-test scores in this sub-dimension.

The results of the covariance analysis showing the corrected pretest scores in the 21st Century Skills subdimension revealed a significant difference between the posttest scores ($F_{(1\text{-}46)}$=34.639; p=.00 < .05). Comparing the post-test mean scores of the experimental group and the control group from the STEAM Attitude Scale 21st Century Skills sub-dimension ($\bar{X}_{\text{21st century Skills post test-control}}$= 41.07 , $\bar{X}_{\text{21st century Skills post test-experimental}}$ = 49.60), the experimental group compared to the control group an increase is observed to occur. It can be said that the application of STEAM approach caused an increase in their attitudes towards 21st Century Skills. When the eta-square value (η^2) for this effect was examined, it was determined that being in different groups within the study explained 43% of the difference between the post-test scores in this sub-dimension.

As a result of the covariance analysis performed with the corrected pre-test scores in the sub-dimension of the art discipline, a significant difference was found between the post-test scores $F_{(1-46)}=58.100$; $p=.00 < .05$). When the post-test mean scores of the experimental group and the control group from the STEAM Attitude Scale Art sub-dimension are compared ($\bar{X}_{\text{Art post test-control}}= 69.73$, $\bar{X}_{\text{Art post test-experimental}} = 84.25$), it is seen that there is an increase in the experimental group compared to the control group. Regarding the sub-dimension that should be seen as the focus of the research, this increase is valuable. It can be said that the application of the STEAM approach has caused an increase in their attitudes towards art. When the eta-square value (η^2) for this effect was examined, it was determined that being in different groups within the study explained 56% of the difference between the post-test scores in this sub-dimension.

3.2. Options of the experimental group in which STEAM approach is applied in visual arts education on STEAM application process

The coding and category densities of the data obtained from the interviews conducted to determine the views of the experimental group on the application process of the Visual Arts Course with the STEAM approach are shown in Table 10.

Table 10. Coding and category densities regarding the experimental group's opinions about the application

Category	Code	Reference number	Coding density (%)	Coding density (%)
Positive Opinion Regarding the Process	Like	132	9.3	76,1
	Arouse curiosity	114	8.0	
	Making Art	109	7.6	
	Realization of the idea	97	6.8	
	Not having difficulty	94	6.6	
	Finding it fun	88	6.2	
	Educational process	75	5.3	
	To think freely	73	5.1	
	Working like an engineer	70	4.9	
	Teammate solidarity	69	4.8	
	Use of imagination	66	4.6	
	Use of Art and Engineering	53	3.7	
	Use of Art and Science	46	3.2	
Negative Opinion Regarding the Process	Difficulty in drawing	5	0.4	1
	Difficulty in generating ideas	3	0.2	
	Finding it boring	5	0.4	
Opinion on Activities	Ease of doing	92	6.5	22.9
	Desire to do new activity	65	4.5	
	Finding it enjoyable	48	3.4	
	Doing STEAM	45	3.2	
	Preparation for the profession	36	2.5	
	Difficulty in creating color	31	2.2	
	Finding it bad	7	0.5	
	Feeling neutral	1	0.1	

When the opinions of the experimental group, where art education was given with the STEAM approach-based activities, are examined, it is seen that they are categorized as *Positive Opinion on the Process, Negative Opinion on the Process and Opinion on the Activities*. 76.1% of their opinions are in the category of *Positive Opinion on the Process*. Participants who gave opinions in this direction stated that they liked the activities, they found them interesting and nice, they could use the ideas and imagination they formed in their minds, and they found the activity educational and fun. The interesting finding in the *Positive Opinion on the Process* category is that students stated that they worked like an engineer, and they mentioned their partnerships between Art-Engineering and Art-Science. Discovering the cooperation of art with the disciplines that form STEAM is one of the important results of the research. Sample expressions of the participants regarding their positive views on the process are as follows:

"It was fun [= Finding it fun]. I think we have achieved a nice work [= Like] with my teammates [= Teammate solidarity]. " (Short Film: States of Matter Activity- S13)

"We did what we imagined [= Realization of the idea]." (Bubbling Ebru Activity-Interview S25)

"They were very easy [= Not having difficulty] and fun studies [= Finding it fun] ... Arts and Engineering [= Use of Art and Engineering] were used abundantly." (Color Riot Activity- S2)

"Very nice application [= Like] ... I used Art and Science [= Use of Art and Science] I used light as I never used [= To think freely]." (Color Riot Activity- Interview S6)

"Working like an engineer [= Working like an engineer] I enlightened the building to develop our creativity." (Color Riot Activity- Interview S15)

"An entertaining [= Finding it fun] and instructive [= Educational process] application I hope it occurred positively for each of my friends." (Short Film: States of Matter Activity- Interview S11)

"I think our activity was fun [= Finding it fun] ... I made art [= Making art]." (Spaghetti Table Activity- Interview S19)

"The application was a nice application [= Finding it fun]. It was very educational [= Educational process]. It was very nice about art and science [= Use of Art and Science]. " (White Ballerina Event- Interview S21)

"A nice application [= Like] is an application that requires a lot of imagination [= Use of imagination]. I made art [= Making art] ... an extremely instructive application [= Educational process] "(Spaghetti Table Activity- Interview S8)

"I think this application was very nice [= Like] ... you made us do fun [= Finding it fun] and educational activities [= Educational process]. Thank you very much [= Like]. " (Pollock Orbit Activity- S17)

When the codes of the *Negative Opinion Regarding the Process* category are examined, it is seen that the participants have trouble drawing in the designs during the application, having difficulties in producing ideas and liking/loving the activity. These negative references about the process constitute 1% of all opinions. Sample expressions of the participants regarding their negative opinions about the process are as follows:

"I had difficulty in drawing the house [= Difficulty in drawing]." (Color Riot Activity- S1)

"I don't know ... but I'm bored [= Find it boring]." (Spaghetti Table Activity- S1)

"I had difficulty in thinking [= Difficulty in generating ideas]." (Pollock Orbit Activity- Ö1)

In the *Opinion on Activities category*, there are codes related to the specific expressions of the students about the activities. The positive and negative polarization observed for the views on the application process can also be seen in this category. When the positive opinions about the activities are examined, it is highlighted that the participants find the activities easy to do, tend to do new activities, gain awareness that these activities are a tool for their future professions, and express the development of interdisciplinary process awareness as "making STEAM". The attribution of "doing STEAM", which is one of the valuable findings of the study, can be accepted as evidence that the STEAM approach is understood by the participants.

When the negative opinions about the activities were examined, it was defined that the students gained the concept of main-intermediate color given in the activity and had difficulty in the process of creating intermediate colors from these main colors. For this reason, the participants defined the activities as bad. Sample expressions of the participants' views on the activities are as follows:

"If we become an engineer in the future [= Preparation for the profession], it was an activity that will work for us. (S18)

"I had difficulty in creating colors in all of activities [= Difficulty in creating color]. (S12)

"It was very enjoyable [= Finding it enjoyable] activities." (S19)

"I loved doing STEAM [= Doing STEAM]. I want to do these activities again. " (S11)

"Can you come next year? Let's do it again [= Desire to do a new activity] "(S17)

"I did not have difficulty in doing the activities [= Not having difficulty] ... I can do it again [= Desire to do a new activity]" (S13)

"I have difficulty in making colors [= Difficulty in creating color]. but I had fun [= Finding it fun]. " (S21)

4. Discussion and Conclusion

This study consists of activities developed in the STEAM approach based on the integration of Art into Science, Technology, Engineering and Mathematics disciplines. It is aimed to determine the effect of the Visual Arts Education delivered via these activities on the attitude towards the disciplines that constitute this approach and to determine the opinions about the STEAM approach application process. In this context, STEAM attitude scale and semi-structured interview were used. When the research findings are examined, the attitudes of the groups towards STEAM and its sub-disciplines are at an average level before the application. Participants have an attitude that is far from expected in terms of interest in Art, activeness in participation in artistic activities, understanding of /sense-making to art, and making an effort to seek aesthetic values or to achieve these measures. They have used Science and Mathematics in life instead of keeping them as knowledge; the same is true for using the combination of Engineering and Technology in an intellectual way. The research was performed with middle school students. In some studies conducted in these age groups in the literature, there are studies indicating that low attitude can be seen in cases where the integration of different disciplines is used, and interdisciplinary attitudes begin to become clear in secondary education (Maltese & Tai, 2011). It is thought that the middle level attitude obtained as a result of the research is due to this reason. When the focus of the study is focused specifically on Art, a similar inference can be made with studies indicating that this lack of attitude towards Art education stems from the education system, teachers-students, socio-cultural environment and school administrators (Özsoy, 2003; Yazar, Arslan & Şener, 2014).

When the post-test scores of the experimental group before and after the visual arts education based on the STEAM approach were examined, a significant difference was found in favor of the post-test. This finding can be interpreted as the practice is beneficial in realizing/developing attitudes towards STEAM disciplines. In the literature, there are studies showing that education with STEM disciplines creates a positive difference in areas such as self-efficacy, problem solving skills, innovative thinking and creativity (Yakman, 2008; Wai, Lubinski & Benbow, 2010; Kwona, Namb & Lee, 2011; Sousa & Pilecki, 2013; Jin, Chong & Cho, 2013; Kim, Ko, Han & Hong, 2014; Henriksen, 2014; Jeong & Kim, 2015; Gülhan & Şahin, 2016; Rolling, 2016; Sochacka, Guyotte & Walther, 2016; Ayvacı & Ayaydın, 2017; Cook, Bush & Cox, 2017; Cook & Bush, 2018). Studies conducted in the field of STEAM approach, which is one of the current interpretations of STEM, show that there is an increase in perception, creativity and attitudes towards these disciplines (Gülhan & Şahin, 2018a; Gülhan & Şahin 2018b; Kim, Nam & Lee, 2014; Kim, Ko, Han & Hong, 2014; Kong & Ji, 2014; Kong & Huo, 2014; Özkan & Umdu-Topsakal, 2017; Özkan & Umdu-Topsakal, 2021). It is known that the desired change in self-efficacy can be achieved as individuals become successful in art activities and know that the product they produce is appreciated (Katz, 1998). The use of the discipline of art, which is the core of the research, together with different disciplines and the development of science, technology, engineering and mathematics attitudes within this structure, which is thought to be far from other disciplines, is a valuable finding. The change made by the study at this point is the main point to be considered. Teaching art education with an interdisciplinary approach increases the attitude towards other disciplines and arts.

In order to determine the positive change/developments of the application, the post-tests of the experimental group who received art education with the STEAM approach were compared with the control groups who continue normal education process. According to the results of the covariance analysis, in which the pre-tests were assigned as covariance, the attitude change between the experimental and control groups was found significant at the final of the six-week process. It has been determined that the education given with the STEAM approach causes an increase in the attitudes of individuals towards science, mathematics, 21st century skills, engineering, technology and art. This finding also supports the change in attitude of the experimental group before/after the application.

In order to make inferences about the application process of STEAM approach in visual arts education, the opinions of the experimental group were consulted. These opinions are of great importance for research. Participants' views on the process differ in terms of positive and negative and activities, and positive opinions predominate. They stated that the students with positive views liked the activities and the process, that they could think freely during the design process, that they transform what they imagined into a tangible form, that they did not have difficulty while doing their activities, and that they knew that they took part in an educational process. In addition, they made art-science and art-engineering relational groupings. It is noteworthy that the participants especially associate art with these two disciplines within STEAM disciplines. This situation was interpreted as Mathematics and Technology could not be noticed as easily as other disciplines or they may have found a more implicit place in STEAM. Especially the awareness of the discipline of Art, in other words, it is a valuable finding to mention the name of Art together with other disciplines. In this sense, it can be said that the study creates artistic thought formations in the consciousness of the participants. This perception development in the attitude towards art is one of the important results of the study, since it is positioned at the top of Yakman’s (2008) STEAM. When the specialized opinions about the activities were examined, it was determined that almost all of the participants liked the activities and wanted to repeat this process. Participants expressed themselves with positive opinions during the process. It is known that as individuals become successful in art activities and know that the product they produce is appreciated, their self-efficacy increases (Katz, 1998). On the other hand, it is not enough for individuals to take a curriculum in which only mathematics and science courses are overestimated in their education process to ensure their progress in any field (Buyurgan & Buyurgan, 2012). In this context, artistic achievements and self-efficacy developed by the research are valuable. The STEAM approach-based training process has done exactly that. Students who made three-dimensional studies to realize their ideas in each course and whose development was supported during the process adopted the process and wanted to continue. There are also negative opinions about the application. One student who took part in the application stated negative opinions about the whole process. The student, who participated in the process with the voluntary participation of his/her parents and himself, did not want to leave the process. He/she was involved in the process, but stated that he/she did not like this application because he/she had difficulty in application and could not create the colors exactly.

5. Recommendations

Art education aims to give individuals an aesthetic perception. In this direction, the aim of art education in our education programs is to raise individuals with artistic perception and awareness skills. It can be concluded from the research findings that our teaching programs are not achieving their intended outcomes. Our Visual Arts course curriculum and in-class applications should be avoided from being two-dimensional studies or solely color information. In this period when our 2023 Education Vision is targeted, the importance given to the evolution of other courses to catch up with the age should also be given to art education. It is known that the “Design-Skill Workshops”, which are also referred to in the vision document at the Basic Education level, are steps towards ensuring the integration into education life. If applications taking into account the aesthetic dimensions and artistic principles are added to these workshops, the desired originality can be achieved.

STEAM consists of many different disciplines and there is no teaching branch integrated into these disciplines. It is not entirely possible for a Visual Arts Teacher or an educator who teaches a STEAM course to teach all STEAM disciplines within the framework of his/her course. For this purpose, an educator with a title of “science expert” who supported the research process was needed in the study and this educator was awailable during the research. In our education system, teacher support that can be awailable in the classroom in different lessons cannot be provided either in theory or in practice. If success is desired in interdisciplinary education, the most basic solution that can be made is to spiralize different branch courses at the same grade level. A STEAM activity can be done in different lessons by teachers with different branches and perspectives, at parallel times and in collaboration.

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