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GÖRSEL SANAT ETKİNLİKLERİNE DAYALI FEN ÖĞRETİMİNİN ÖĞRENCİLERİN BAŞARILARINA VE TUTUMLARINA ETKİLERİ

THE EFFECTS OF TEACHING SCIENCE BASED ON VISUAL ART ACTIVITIES ON STUDENTS' ACHIEVEMENT AND ATTITUDES

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Özet

Bu çalışmanın amacı, görsel sanat etkinliklerine dayalı fen öğretiminin öğrencilerin fen başarısına ve görsel sanat etkinlikleri yoluyla fen öğretimine yönelik tutumlarına etkilerini incelemektir. Görsel sanat etkinlikleri, Fen ve Teknoloji dersindeki "Maddenin Tanecikli Yapısı" konusuna uyarlanmıştır. Bu araştırma ön test/son test yarı deneysel yönteme göre tasarlanmıştır. Araştırmanın katılımcıları, İzmir İlindeki bir ilköğretim okulunun 49 altıncı sınıf düzeyindeki öğrencilerinden oluşmaktadır. Veriler, konuya ilişkin "Fen Başarı Testi" ve "Sanatlar Yoluyla Fen Öğretimine Yönelik Tutum Ölçeği" ile toplanmıştır. Araştırmanın sonucunda görsel sanat etkinliklerine dayalı fen öğretiminin öğrencilerin başarılarında ve bu uygulamaya yönelik tutumlarında önemli bir artış sağladığı görülmüştür. Ayrıca, öğrencilerin maddenin tanecikli yapısı kavramını daha iyi öğrendikleri, sanatsal değerleri daha iyi anladıkları, derse yönelik ilgilerinin daha çok arttığı ve sanat yoluyla fen öğrenmeyi daha çok tercih ettikleri ortaya çıkmıştır.

Anahtar Kelimeler: Fen Öğretimi, Görsel Sanat, Kimya

Abstract

The aim of this study was to examine the effects of teaching science based on visual art activities on students' science achievement and attitudes towards teaching science through visual art activities. Visual art activities were adapted to the topics of Particulate Nature of Matter in Science and Technology Course. This research is in pre-test/post-test quasi-experimental design. The participants were 49 sixth grade students from a public school in Izmir, Turkey, 2007. The data were gathered by "Attitude Scale towards Teaching Science through Visual Art Activities" and "Science Achievement Test". Findings of this study showed that teaching science based on visual art activities was significantly affected students' science achievement and attitudes towards teaching science through visual art activities. In addition, students learnt concepts about Particulate Nature of Matter, understood the artistic values, started to interest in Science and Technology Course and chose learning science through visual art activities.

Keywords: Teaching Science, Visual Arts, Chemistry.

INTRODUCTION

Science education is to trend the interesting applications because of rapidly changing technological developments in the entire world. One of the key components of such orientation is art education. Art and science have some obvious links affecting each other. For instance, they both need experiments and discoveries towards external reality in order to solve mental conflicts about the world. Also they both have similar activities providing students with opportunities to use scientific concepts and theories. Teaching science through visual art activities can be an important key for students' educational objects due to common ways of art and science (Wenham, 1998, Campbell, 2004, Bahri, 2005). Learning through visual art activities develops students' individual interests, abilities and learning styles. Furthermore, it helps them to increase intuitive, creative, imaginative abilities and problem solving and inquiry skills (Gardner, 1971, Young, 1981, Alfert, 1986, Eisenkraft, Heltzel, Johnson and Radcliffe, 2006).

Learning science through visual art activities provide teachers and students express feelings and perceptions; show relationships and changes; stress explanations and predictions (Harrod, 1998; Nelson, 1999). Using scientific principles in visual art activities is a fascinating way and makes the quality of artworks to contribute. There are many visual art activities that are suitable for scientific investigation (Varga, 2003). For instance, these can be visual art activities such as marbling paper art, etching, photography, sculpture, fresco etc. They can be the mediation tools for societies to develop their cultures, and can contribute to social interaction and higher mental functions- necessary for science learning (Monzon and Vinuela, 2006). Artistic production through scientific principles is the cognitive functions of cultural tools and helps students to self-learning skills during the process of creation.

Integration of science and arts can offer various teaching opportunities for students. Teaching science through visual art activities help students learn creative experiences. Art and science have similar activities providing students with opportunities to use scientific concepts and theories (Joubert, 2002; Feldman, 2003). In teaching science through visual art activities, students improve scientific thinking skills and inquiry methods. In addition, they enjoy associating scientific principles with daily life (Shaw, 1999; Robson, Hickey and Flanagan, 2005). Art works can undertake a crucial role in order to restore social negative attitudes towards science resulting from industrial disasters and damages (Lerman, 2005). Teaching science through visual art activities can be strong tools of social control and social change. Furthermore, the perceptions of society towards science can be raised with visual art activities in science and technology course in a positive way. Besides, an increase in the students' attitudes towards teaching science through visual art activities can be expected. A student having a positive attitude can improve his/her creativity more easily.

The aim of this study was to investigate the effects of teaching science based on visual art activities on students' science achievement and attitudes towards teaching science through visual art activities during teaching of concepts about "Particulate Nature of Matter" in science and technology course. In this context, teaching activities of these concepts were supported by visual art activities in accordance with constructivist learning and teaching approach of Science and Technology Teaching Program of 2005. Visual art activities in teaching science consist of art activities such as marbling paper art, candlestick production, copying of a statue or ornament, wood burning art, preparing zinc template art.

METHODOLOGY

Research Design

In this study, pre-test/post-test quasi-experimental design with control group, involving a 2 (group) x 2 (time) factoria l design wa s used. In the quasi-experimental design, there are equal groups called experimental and control groups consisting of one or more group. During research, new models towards purposes of research are applied for experimental group, but these models are not applied to control group. Consequently, the effects of newly applied models on experimental group with pre-tests and post-tests along research are investigated (Kaptan, 1998; Karasar, 2004, Balcı, 2005; Çepni, 2007). Teaching science concepts related to "Particulate Nature of Matter" in 2005 Turkish Science and Technology Curriculum through visual art activities were given to the experimental group. However, the control group received the teaching of the same concepts without visual art activities. In Table 1, Visual Art Activities are presented with science concepts related to Particulate Nature of Matter in 2005 Turkish Science and Technology Curriculum.

Table 1. The Relation of Science Concepts with Visual Art Activities

Visual Art Activities	Concepts in Science and Technology Curriculum (Topic: Particulate Nature of Matter)	Chemical Concepts
Marbling Paper Art	-The matter has very small particles which cannot be seen by the naked eye. It can be divided into many small parts.	Solubility, Surface Tension, Density, Adsorption, Inorganic Materials, Extraction, Filtration
Origami Art	-Physical Change.	-
Three-Dimensional Artwork (Making a Candle stick)	-The matter has very small particles which cannot be seen by the naked eye. It can be divided into many small parts. Physical Change.	Melting, Freezing, Matter and Heat, Density, Solubility
Three - Dimensional Artwork (Plaster Moulding and Relief Art)	-Physical Change. -Chemical Change.	Melting, Freezing, Matter and Heat, Solubility and Heat, Metals,
Wood Burning Art	-Physical Change. -Chemical Change.	Chemical Burning,
Etching Art (Zinc Template Preparation)	-Physical Change. -Chemical Change.	Acid-Metal Reaction, Corrosion, Acid and Bases, Metal Coating, Solubility

With visual art activities such as the marbling art and three-dimensional artwork, students can learn that matter is composed of very small particles, it can be divided into many small parts and also it contains very small matters which cannot be seen by naked eye. By using visual art activities such three-dimensional artwork (copying an ornament using plaster molding and relief art), wood burning art, etching art (preparing zinc template), students can understand the difference between the chemical change and the physical change. These activities were adapted by some subjects of science and technology course. Some science concepts were stressed in process of making these visual art activities in science and technology course. These activities were developed for this study (Işıngör, Eti and Aslıer, 1986; Özdem, 1990; Sungur, 1994; Başkan, 1996; Rochelle, 1998; Artut, 2004; Kavici, 2005; Yılmaz, 2005; Çapar, 2006).

The Sample Activity toward Teaching Science Based on Visual Art Activities: Marbling Paper Art

With the marbling paper art, students can learn that matter is composed of very small particles, it can be divided into many small parts and also it contains very small matters which cannot be seen by eye. In this activity, students were asked to fill the water into the half of the plate. "What happens if cellulose, which is used for gluing papers, is poured to the plate contained water up to the half?" was asked to students and wanted them to write their answers. We expected from students to derive that matters can be separated into small particles. Then, students wrote their own observations after mixing cellulose with water and compared them with their predictions. Here, since students can be roughly handled to adjusting water's consistency needed in marbling paper art, teacher should help students to do it. After that, students were asked for filling thinner into some plastic cups up to one cm from bottom to the top. Then, we asked "What happens if oil-paint is poured to the thinner?" and wanted them to pour various paints into the glasses containing thinners and write their observations. With this question, we expected from students to infer that matters are composed of many small particles. We asked students that "What happens if paints were dropped from brush to the solution of cellulose?" and said them to write their predictions. Then, they dropped some paints to the solution of cellulose and drew different figures with the brushes' back. We wanted them to lay a paper on the figures and to wait for answer to the question of "What kind of changes will be on the paper?" We said them to write their opinions, to drag the paper carefully and to observe the paper. Teacher should be a very good guide in all processes and provide students' predictions, observations, comparisons and inferences to be done well. Teacher should be very careful in doing experiment, especially when he/she prepares solution of thinner and cellulose. Students, using marbling paper art, realized that matters can be divided into invisible small parts by way of experiments, cross-examined the consecutive divisibility of matters and finally comprehended that all kinds of matter are composed of invisible small particles hard to be divided. In addition, students gain some basic abilities owing to this activity such as observation, classification, prediction, building up hypothesis, using experimental materials and etc.

Participants

The participants were sixth grade students from a public primary school in Izmir, Turkey, 2007. This school was determined among fifteen public primary schools where Turkish Science and Technology Course were developed in Izmir. This public school had seven classes in the sixth grade. Thus, the student performances of seven classes were evaluated over teacher scores of the previous year's science and technology course. At the end, two classes which had closer performance scores were randomly assigned to the experimental (n=24; Girl=13, Boy=11) and the control group (n=25; Girl=10, Boy=15).

Data Collection Tools

In this study, data was gathered by two measurement tools called "The Attitude Scale towards Teaching Science through Visual Art Activities" and "Science Achievement Test". "The Attitude Scale towards Teaching Science through Visual Art Activities" aimed at determining the students' attitudes

towards the use of visual art activities in Science and Technology Course. This instrument was composed of twenty eight items regarding attitudes in four point Likert type (Appendix 1). It had mainly four dimensions. These were named as the following: "Sense to Science and Technology Course" (nine items' chronbach alfa = 0.87), "Sense to Art and Visuality" (seven items' chronbach alfa = 0.77), "Sense to Science and Technology Learning" (six items' chronbach alfa = 0.78) and "Sense to Teaching Science through Visual Art Activities" (six items' chronbach alfa = 0.77). The Chronbach Reliability Coefficient of "the attitude scale towards teaching science through visual art activities" was found to be 0.92.

Science Achievement Test consisting of twenty five multiple choice items was used to determine the students' learning level about the "Particulate Nature of Matter". During the development of the test, totally 21 objectives were determined for "Particulate Nature of Matter (16)" and "Chemical-Physical Change (5)"in the sixth grade science and technology course. Initially, 40 test items which were prepared by the researches were equally distributed over knowledge, comprehension and analysis levels of cognitive domain for each objective in a table of specification. Science Achievement Test was assessed and revised by 9 science education experts, 3 educational science experts in Dokuz Eylül University and 3 science teachers in primary public school of İzmir. After revision, the trial form of science achievement test consisting of the 40 multiple choice items was given to 10 sixth graders from a primary public school in order to test the structure validity and the reliability of test. Afterwards, the test items were corrected accordingly upon the reactions of students. The final form of science achievement test consisting of the 40 multiple choice items was distributed 174 seventh graders in Vali Rahmi Bey Primary Public School in İzmir. After conducting the item analysis, the final form of the test consisted of the 25 multiple choice items which had 17 items about "Particulate Nature of Matter" and 8 items about "Chemical-Physical Change". The test included 11, 13 items and 1 item for knowledge, comprehension and analysis levels of cognitive domain respectively. The Reliability Coefficient of Science Achievement Test about particulate nature of matter was found to be 0.84.

Data Collecting Process

Tablo 2. Process of Treatment

Groups	Pre-Test	Topic	Treatment	Post-Test
Experimental	1.Science Achievement Test 2.Attitude Scale towards Teaching Science through Visual art activities	Particulate Nature of Matter	2005 Turkish Science and Technology Curriculum + Visual Art Activities	1.Science Achievement Test 2.Attitude Scale towards Teaching Science through Visual art activities
Control			2005 Turkish Science and Technology Curriculum	

A week before the treatment, the Science Achievement Test and the Attitude Scale were administered to both groups in a two course-hour period in order to assess their backgrounds towards topic and their attitudes towards teaching science through visual art activities. After pre-tests, the instructional treatment continued for an eight-week period in four course hour a week for both groups which is the indicated instructional period of time given for "particulate nature of matter" in Turkish Science and Technology Curriculum (MEB, 2005). The experimental group was taught the subjects based

on visual art activities while the control group was taught the subjects only through science and technology curriculum (M.E.B., 2005). At the end of the treatment, the Science Achievement Test and the Attitude Scale were given to groups.

Data Analysis

The data from Science Achievement Test and Attitude Scale towards Teaching Science through visual art activities were analyzed by using SPSS. Frequencies (n), means (M), standard deviations (SD), analysis of variance (ANOVA), and multiple analyses of variance were calculated. To test for changes over time, 2 x 2 (group x time) repeated measures ANOVA and MANOVA were performed with groups (experimental and control) as the between-subjects factor and time (pre-test and post-test) as the within-subjects factor. An alpha level of 0.05 was used for all statistical tests.

FINDINGS

The results of the study were presented by two dependent variables. These are the science achievement test and the attitude scale towards teaching science through visual art activities. The scores of pre-test and post-test towards the science achievement test were evaluated by using 2 x 2 (Group x Time) repeated measures ANOVA to compare the developments of the experimental and control groups. In the same way, the scores of pre-test and post-test towards the attitude scale were assessed by conducting the similar analysis to show the changes of their attitudes and sub-attitudes in the same attitude scale. In order to check whether the assumptions of ANOVA were met, preliminary assumptions testing for normality, linearity, homogeneity of variance-covariance matrices were conducted. No significant violation was found.

Tablo 3. Descriptive statistics for dependent variables

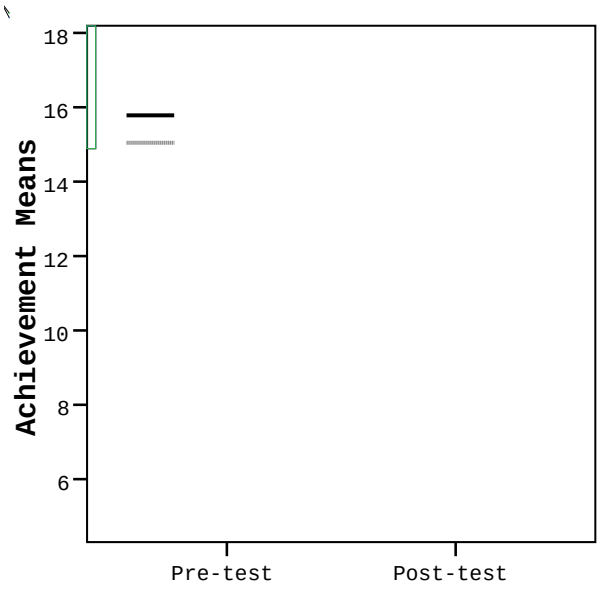
	Experimental Group (n=24)		Control Group (n=25)	
Instruments	Pre-test	Post-test	Pre-test	Post-test
Science Achievement Test	5.17 (2.75)	16.54 (4.58)	5.16 (2.98)	13.32 (5.34)
Attitude Scale towards Teaching Science through Visual art activities	83.13 (12.59)	100.13 (10.91	83.04 (9.35)	84.96 (8.63)
-1.Dimension: Sense to Science and Technology Course	28.50 (4.63)	33.42 (3.73)	27.76 (3.75)	28.36 (4.09)
-2. Dimension: Sense to Art and Visuality	20.04 (3.63)	25.00 (3.60)	20.60 (2.14)	19.96 (2.03)
-3.Dimension: Sense to Science and Technology Learning	18.29 (4.19)	22.13 (2.69)	18.60 (2.60)	18.96 (2.67)
-4.Dimension: Sense to Teaching Science through Visual art activities	16.29 (2.10)	19.58 (2.17)	16.08 (3.29)	17.68 (1.22)

Values in parentheses are standard deviations

The Effects of Teaching Science Based on Visual Art Activities on Students' Science Achievement

The repeated measures ANOVA was used to determine any significance between the mean scores of experimental and control group on the pre and post Science Achievement Tests. The results of a 2 x 2 (Group xTime) repeated measures ANOVA predicated achievement differences between the experimental and control groups. A statistically significant main effect for group was found, $F(1,47)=9.05$, $p=0.004$ $\eta_p^2=0,164$. The ANOVA indicated that the experimental group had more effective performance than the control group across pre- and post-treatment. A significant main effect for time, $F(1,47)=336.34$, $p=0.000$ $\eta_p^2=0.877$, showed that scores for both groups improved from Time 1 (pre-test) to Time 2 (post-test). The analyses also supported a statistically significant Time x Group interaction, $F(1,47)=9.11$, $p=0.004$ $\eta_p^2=0.162$. This interaction was interpreted by a plot of the mean scores. Figure 1 shows the mean pre-/ post-treatment change per group across time on the Science Achievement Test. Although both groups indicated an increase over time, this change was significantly higher for the experimental group than it was for the control group. Effect sizes were measured through partial Eta Squared (η_p^2). Partial Eta Squared effect sizes were considered to be small for $\eta_p^2 \leq 0.01$, medium for $\eta_p^2 \leq 0.06$, and large for $\eta_p^2 \geq 0.14$ (Stevens, 1992 cited Sezgin-Selçuk, Şahin and Ün-Açıkgöz, 2009). In this context, the rate of partial population variance emphasized by the Time x Group interaction can suffice as large in this study.

Figure 1. Mean Scores of the Experimental and Control Groups on the Pre-test and the Post-test of the Science Achievement Test

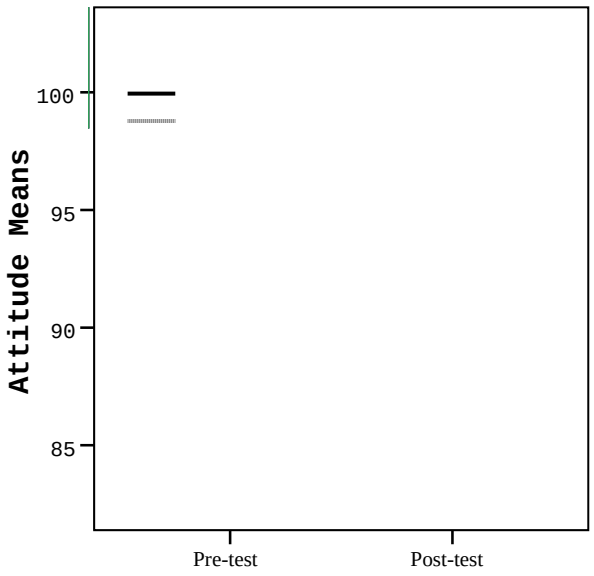


The Effects of Teaching Science Based on Visual Art Activities on Students' Attitudes towards Teaching Science through Visual art activities

A 2 x 2 (Group x Time) repeated measures MANOVA was run to investigate the effects of teaching science based on art activities on students' attitudes towards teaching science through visual art activities in science and technology course. Results showed a statistically significant main effect for group, $F(1,47)=98.55$, $p=0.005$ $\eta_p^2=0.154$, for attitude towards teaching science through visual art activities as a

multivariate component. Univariate ANOVA revealed that the experimental group held more positive attitude towards teaching science through visual art activities in dimension of "sense to science and technology course", $F(1,47)=8.59$, $p=0.005$ $\eta_p^2=0.154$, in dimension of "sense to art and visuality", $F(1,47)=10.20$, $p=0.003$ $\eta_p^2=0.178$, in dimension of "sense to science and technology learning", $F(1,47)=3.39$, $p=0.072$ $\eta_p^2=0.067$, and in dimension of "sense to teaching science through visual art activities", $F(1,47)=4.81$, $p=0.033$ $\eta_p^2=0.093$, than did the control groups pre- and post-treatment. Both the time main effect, $F(1,47)=42.22$, $p=0.000$ $\eta_p^2=0.473$, and the Time x Group interaction, $F(1,47)=26.82$, $p=0.000$ $\eta_p^2=0.363$, were statistically significant. The proportion of partial population variance showed by the Time x Group interaction may be considered large, $\eta_p^2=0.363$. Figure 2 indicates the interaction between time and group. Although both groups indicated an increase over time, this change was the most in the experimental group. In this context, it can be claimed that teaching science concepts through visual art activities affected students' attitudes more meaningfully to science and technology course, to art and visuality, to science and technology learning and to teaching science through visual art activities. In conclusion, it also affected students' attitudes towards the use of the integration of science and visual art activities in a positive way.

Figure 2. Mean Scores of the Experimental and Control Groups on the Pre-test and the Post-test of the Attitude Scale towards Teaching Science through Visual Art Activities



DISCUSSION

An artwork is the worth of thousands words. If artworks have a strong expression as visuality, it can support learning science concepts. For this purpose, in teaching science and technology course through visual art activities, its effects on students' science achievement levels and students' attitudes towards learning science through visual art activities were investigated. In conclusion, teaching science concepts through visual art activities provided the rate of a great increase in both students' achievement levels towards science concepts and their attitudes towards this implication in science and technology course. In

this content, this important increase overlaps with results of study organized by Hanson (2002). He tried a program for increasing students learning in mathematics and science through the integration of visual art activities. He used pre- and post-test assessment in treatment and studied with thirty students. Hanson expressed that students' achievement towards subject increase concepts seventy-two percent in mathematics, ninety percent in science and sixty-eight percent in art. In this study, students' achievement towards science concepts changed concepts fifty-seven percent in science. Hollenbeck and Reiter (2004) studied integration science with visual art activities and surveyed students' attitudes about the integration of science and art with items consisting of sub-titles such as organization, objectives, ideas, and life skills, interesting, important and appropriate. As a result of Hollenbeck and Reiter's study, ninety-six percent of students said that the course organization was excellent or very good. Eighty-two percent of the students reported that the course met its intended objectives and sixty-seven percent expressed that they were interested in the course. In this study, the change rate of students' attitudes towards teaching science through visual art activities was fifty-nine percent. Similarly the rate of increase in achievement levels with the rate of increase in attitudes of students reminded us that there is a strong relation between students' achievement and attitudes. If students' attitudes about courses are changed positively, it can lead increase in their motivations and higher achievements. Also, the educational objectives related to attitudes are organized in most of the educational curricula at present day (Senemoğlu, 2004). The aim of Science and Technology Curriculum (M.E.B., 2005) is to develop students' attitudes together with acquisitions such as scientific theories, scientific process skills, creativity and imagination (Çepni, 2005; Bayrak and Erden, 2007). In conclusion, this study showed that integrating art education with other disciplines can provide a success to students' skills with active participating to course (Hudson and Hudson, 2007; Quinn and Calkin, 2008). When the instructional implications of science education were used for art education, the developments in the scientific skills towards inquiry and problem solving skills of students were observed (Heid, Estabrook and Nostrant, 2009). The instructional implications of this study which was tested in Science and Technology Course can also be repeated and compared with Visual Art Activities course.

CONCLUSION and IMPLICATIONS

This study showed that teaching science based on visual art activities is a more effective activity on students' attitudes towards teaching science through visual art activities considering their science achievements. However, it indicated that "the sense to arts and visuality" is improved more significantly than other dimensions of attitude scale. While developing these dimensions, science teaching based on visual art activities may be planned again by considering socio-cultural factors such as learning environments, family factors and students' necessities. Furthermore, this study should be extended to apply different topics of science and technology, and to investigate the effects of visual art activities on students' creativity, scientific skills and critical thinking skills. In this context, it should be adapted to Science and Technology Curriculum, and be extended to all primary schools in Turkey. For this purpose, pre-service seminars about teaching science through visual art activities should be given to science and technology teachers. Visual art activities should be used in other courses such a s math, biology, geography, astronomy etc.

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APPENDIX 1. The Attitude Scale towards Teaching Science through Visual Art Activities

THE RATE OF PARTICIPATION ⟶	**EA (4)**	**A (3)**	**D (2)**	**ED (1)**
1. Teaching science through visual art activities makes me lose my interest to science and				

technology course.				
2. Science and visual art activities should be used common in science and technology course.				
3. I may have difficulty learning science concepts while using visual art activities in science and technology course.				
4. Quality artworks develop with learning concepts through visual Art Activities in science and technology course.				
5 .If teaching science through visual art activities is used in course, it makes me decrease my interest to course.				
6. If I learn science concepts through visual art activities in science and technology course, they interferes my lessons.				
7. Science and Technology Course should be related to visual art activities.				
8. Visual art activities in Science and Technology course makes me understand more about artistic elements my around.				
9. I don't like science and technology course, so I don't think about using visual art activities in this course.				
10. Learning concepts through visual art activities in science and technology course don't help me after my graduation.				
11. I understand some concepts in science and technology course better through visual art activities.				
12. Visual art activities in science and technology course cause the lack of course time cause.				
13. Using visual art activities in science and technology course support arts.				
14. Visual art activities in science and technology course don't support scientific attitudes.				
15. If Visual art activities is not integrated with science and technology course, learning becomes more effective.				
16. Visual art activities in science and technology course decrease my interest in course decrease.				
17. Famously artworks need scientific concepts learned in science and technology course.				
18. I never use what I learn with visual art activities in science and technology course.				
19. Using visual art activities with experiments in science and technology course make profit for students.				
20. Using visual art activities in science and technology course prevents developments of students' scientific skills.				
21. Visual art activities prevent to learn subjects in science and technology course prevents developments of students' scientific skills.				
22. Science and Technology course based on visual art activities colorizes my daily life.				
23. I dislike science and technology course when visual art activities are used in course.				
24. Concepts learned with visual art activities help me to understand other disciplines.				
25. I dislike visual art activities, so I never think about using these arts while learning them in science and technology course.				
26.Visual art activities and science and technology course completely different.				
27. Learning science and technology course through visual art activities help us to understand more about nature.				
28. Visual art activities should not be used in science ad technology course.				

EA(4): Exactly Agree, A(3): Agree, D(2):Disagree, ED(1):Exactly Disagree