

# STUDENTS' VIEWS OF SCIENTIFIC INQUIRY IN A CREATIVE DRAMA ACTIVITY

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## Introduction

Scientific literacy is one of the most important skills in the world. Gaining this ability has been one of the main objectives of education. Education in Turkey aims to provide students with the skills 21st century needs as well as their own potentials. Some of these skills students understand as knowledge rather than reading, knowing how to access knowledge, creating different ideas and finding solutions. The Ministry of National Education (MNE) of Turkey has begun to emphasize these skills in teaching programs since the 2000's. Particularly in the curriculum of science, it has been determined as the main objective to provide students with scientific literacy skills (MNE, 2013, 2017). In addition, countries such as the United States of America (AAAS, 2005), the United Kingdom (DFE, 2013) and Canada (OME, 2005) have also emphasized the development of scientific literate individuals in science programs.

Despite the fact, that the concept of scientific literacy was rooted centuries ago, the definition of this concept was not clearly made (Laugksch, 2000, Maienschein, 1999, Matthews, 1994). Pella, O'Hearn, and Gale (1966) view the concept of scientific literacy as an area of competence in which the sub-components for individuals also exist. They grouped these components into science and society, science ethics, nature of science, conceptual knowledge, science and technology and science and social sciences. It is stated that the nature of science, which is one of these steps, is the starting point for gaining scientific literacy skills (McComas, Clough, & Almazroa, 1998, Saka, Yaman, Tunç-Sahin, Pekbay, & Gerçek, 2012). Çokuysal (2010) stated that the basis of scientific literacy is the nature of science. Ağlarıcı and Kabapınar (2016), Bell and Lederman (2003) and Lederman (2007) have reported that one of the basic ways of scientific literacy training is possible with the teaching of the concept of nature of science. Also, McComas, Clough and Almazroa (1998) pointed out that the nature of science is among the social sciences that include science history, sociology, and philosophy.

Scientific literacy is emphasized in achieving the goal of scientific inquiry and education of nature of science, including the nature of science, scientific process skills, creative and analytical thinking, research-inquiry, science-technology-society-environment interaction. Bybee and Fuchs (2006)



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**Abstract.** *One of the most important objectives of the science education includes helping students to think about the nature of scientific inquiries like a scientist and keep this point of view in order to understand the events occurring around them. This research aims to (1) compare secondary school students' views -who have creative drama & conventional education- about scientific inquiry, (2) and whether the experimental and control group students' views about scientific research differ depending on gender after process. Pre-experimental design with control group was used in this research. The sample of this research consisted of 130 students of 6th grade secondary school in Samsun, Turkey. The data were collected by using VOSI-E questionnaire. Data collected with VOSI-E were analyzed using grouping standards, and students were classified as novice, transition and expert. The data were analyzed by descriptive statistics and nonparametric chi-square test. Research results show that when compared to conventional activities in terms of developing positive views about scientific inquiry, creative drama activities lead higher number of students to expert level. Also, it was found out that the number of students in expert category in experimental group was higher than those in control group at the end of education process.*

**Keywords:** *creative drama, views of scientific inquiry (VOSI), science curriculum.*

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reported that researchers in many studies addressing educational reforms emphasize scientific literacy skills of students. It is expected that science educators will be able to identify the approaches, methods and contexts they can use to improve this skill and gain them to students in a meaningful way (Çetinkaya, Turgut, Duru, & Ercan, 2015, p. 450). A scientific literate individual is expected to understand the existing problem in problem situations faced in daily life, look for an answer to the questions given to understand the mentioned problem situation, know how to access the information to find the answers to questions, determine how to use the information accessed and provide a solution to the problem situation. Saka *et al.* (2012) state that scientific literate individuals should provide an argument and discussion for any problem situation based on the evidence, support with evidence and implement these accordingly. In addition, MNE (2004) and National Research Council (NRC) (1996) stated that a scientific literate person should have the ability to evaluate scientific knowledge.

Lederman and Niess (1998) have listed the characteristics of a scientific literate individual as follows: should know and understand the nature of science, have scientific process skills, understand the content of science, know how to use knowledge in problems encountered in daily life, distinguish between evidence and thoughts in case of a problem, and understand the role of science and technology. Abd-El-Khalick, Bell and Lederman (1998) claim that the basic condition for a person to be scientifically literate depends on having these characteristics. Studies made show that students do not have some of the skills related to the nature of science and that they can learn these concepts at the conceptual level (Saka *et al.*, 2012). In the study conducted by Dindar and Demir (2006, p. 95), it is stated that the science questions directed to the students are generally in the sub level of cognitive field. This situation can be among the reasons for the inadequacy of the students concerning the nature of science, because science lessons are considered a field in which the students perceive the subjects as abstract (Balbağ & Karaer, 2016, p. 4, Gülçiçek & Güneş, 2004, p. 43, Lave & Wenger 1991, p. 48, Şen, Timur, Timur, & Özdemir, 2016, p. 398, Whitelegg & Parry, 1999, p. 68) and have difficulty in learning (Gürdal & Sağırılı, 2002, p. 215).

#### *Problem of Research*

The adoption of a student-centered approach in science education is expected to increase the achievement in education (Foster & Lock, 1987, p. 23). It is seen that the science programs (science, science and technology, sciences) prepared in Turkey since 2000 have adopted student centered education. According to Gürdal and Baysal (1996), in teaching a science lesson, alternative methods are used, where students actively participate and perform meaningful learning, rather than direct learning and memorization-based education, which is traditional teaching. Çepni (2014, p. 13), Gülçiçek and Güneş (2004, p. 37) and Wright and Perna (1992, p. 35) stated that the application of new science teaching strategies in classes increases the efficiency of teaching. For effectiveness of science education, the lessons should be dramatized and the activities for group studies should be included (Gürdal, Bayram, & Şahin, 1998). Demirci (1993) emphasizes that the science courses should be applied in daily life and in connection with concrete actions. Nolen (2003) stated that there is a positive relationship between the learning environment of the classroom and the achievement and satisfaction levels of science lessons. Odom, Stoddard, and La Nasa (2007) stated that the teaching of lessons with examples from daily life will contribute to the science achievement of students. The drama method has a content that aims to teach by endearing lessons to students. Studies in the literature point to creative drama activities as one of the methods that can be used to reveal creative aspects of children and motivate their curiosity (Gönen & Dalkılıç, 1998). Creative drama, dramatic experiences designed for the benefit of participants, provide an opportunity for participation in activities that require students to role play, to analyze roles, and to work cooperatively in creative tasks requiring emotional control (Freeman, Sullivan, & Fulton, 2003). Creative drama activities contribute to the gathering of individual differences in a single pot and to creating learning environments that appeal to their level of development with their accumulation as students grow up as science literates (Özdemir & Üstündağ, 2007).

Creative drama is an effective activity to increase science learning in social communication of students within the group (Hendrix, Eick, & Shannon, 2012). San (1991) describes creative drama as "playful" processes where individuals review their observations, emotions and experiences by reconstructing old cognitive patterns, by using techniques such as improvisation and role playing. According to Kahyaoğlu, Yavuzel, and Aydede (2010), although there are significant and positive effects of creative drama activities on science learning, there are not many studies in the literature on the use of creative drama as teaching activities in science education and new studies are needed in this area. The aim of this study is to compare the view of scientific inquiry of secondary school students participating in creative drama including teaching of basic elements of scientific knowledge and the scientific



inquiry view of secondary school students not participating in such activities and to determine whether there is a difference between them.

To fulfil the research aim, the following research questions were set:

1. Is there a difference between the distribution of the opinions of students regarding the nature of science in the experimental and control groups?
2. Is there a difference in the distribution of the opinions of students regarding the nature of science according to their gender?
3. How is the distribution of students in the experimental and control groups according to the sub-dimensions of view of scientific inquiry?

## Methodology of Research

### *General Background*

The design of this research was a pre-experimental control group design. In this design, only the experimental group is subjected to processing and the test is applied to both groups after the process is complete. In this design, pre-testing is either unnecessary or impossible (Gay & Airasian, 2000). One creative drama class was the experimental group, while the conventional class was the control group.

The research was conducted for 3 weeks from April 21<sup>st</sup> to May 5<sup>th</sup>, 2016. Creative drama activities were applied to the experimental group for twelve hours, four hours each week. For the applications to be made in the schools, twelve activities, including scientific knowledge, nature of science, scientific process skills and achievements in scientific inquiry were prepared. These selected activities have a content that is existing in the literature or has been applied and accepted in different studies (Adıgüzel, 2010, Ataman, 2013, Üstündağ, 2011). Implementation process and purposes of the activities used in the workshop study are briefly as follows: first of all, a name study was carried out for the leader to get to know the group and then a Science Basket game was played in order to be familiar with the terms of experiment, knowledge, data, hypothesis, observation, model and scientific knowledge in terms of scientific process skills to be gained. The game of Find Your Home was played with the aim of warming up and increasing the commitment. To emphasize the importance of observing people in a scientific investigation, the game of Who's the Killer? was played. Animal Pairs game was played with the aim of gaining awareness that everything has a different behavior and acts in accordance with this behavior, and especially for observation. For the purpose of making observation like a scientist, making inferences, creating hypotheses, improvisation and role playing with Yes-No activity was made; and for the purpose of learning to verify the accuracy of data collected, Correct-Incorrect activity was made. To apply observations, data, hypotheses, concepts by making enactments regarding how a community lives, the game of I am Making an Observation was played, and also the concepts of enactment, role-playing and improvisations were taught. I Am a Scientist activity was conducted for the purpose of experiencing observing, collecting data, forming a hypothesis from collected data, presenting data and modeling processes. With I Am Making a New Invention, activities for making a discovery of an invention and revealing like a scientist were made. Students have enacted the inventions they developed by presenting them with the See You in Congress activity. Then, all the processes were evaluated. These activities were applied to the students in each school by using creative drama activities for each group in groups for 3 hours. In the group activities, the students gave their answers individually and independently of each other. Detailed information about the activities is included in Appendix 1.

### *Sample*

This research was carried out with 132 students in three public schools which are determined by convenience sampling method in the Central Black Sea Region in Turkey. The education system in Turkey includes 4 year-primary school; 4 year-secondary school and 4 year-high school. Secondary school students are expected to have a 35-hour course in a week. Science education course takes 4 hours in a week (HEMC, 2017). As seen in Table 1, research was conducted on a total of 132 students, 67 experimental (3 groups) and 65 control (3 groups), studying in these schools. The selection of the classes of the students was planned according to the school's curriculum. Two students in the study group were excluded from the analysis of the data because they responded incompletely to the measurement tool, although they participated in the experimental process. The control group



was selected from the classes of the same schools that were processed experimentally. The practices in control group were applied to students who were going to the same schools with experimental group but not included in experimental study. There were made no practices related to instruction of scientific inquiry in control group. Students in control group continue their education as stated within framework of their official instruction program. Science education curriculum centers on research-inquiry based instruction curriculum prepared by National Ministry of Education (Turkey) and it is defined as student-centered. The studies in literature review indicate that education in Turkey happens as conventional rather than student-centered (Yalçın İncik & Tarriseven, 2012; Soran, Akkoyunlu, & Kavak, 2006).

**Table 1. Demographic information about experimental and control groups.**

Group	Gender	f	%	Total f	Total %
Experimental	Female	37	56.9	65	50.0
	Male	28	43.1		
Control	Female	24	36.9	65	50.0
	Male	41	63.1		

#### *Instrument and Procedures*

VOSI-E questionnaire was developed by Lederman & Ko (2003) and based on VOSI questionnaire, which was developed by Schwartz, Lederman, and Lederman (2008). VOSI-E emerges students' views on four aspects of scientific inquiry, which is all investigations beginning with a question, there is no single scientific method, scientists collect empirical data to answer their questions, and data and prior knowledge are used to answer questions. Science education experts' views were taken for validity of questionnaire, then it was applied with a group of students; and final form of questionnaire was developed by making some small changes. All respondents were interviewed (range from 15-45 minutes), using the written responses as a guide and a random selection of about 20% was usually sufficient to establish confidence in reliability of data interpretation. Analysis of collected data from this questionnaire is similar to the guidelines of Lederman, Schwartz, Lederman, Matthews, and Khishfe (2002) for the VNOS instrument. The VOSI-E adapted to Turkish and validity studies was made by Saka *et al.* (2012).

The assessment tool has been translated into Turkish by two different education specialists in the field in terms of structure and language validity. Whether the items in the scale cover the variables towards the scientific research has been determined by taking the opinions of these experts. Then the scale has been examined by 4 teachers and the final shape of the scale was given. The items in the assessment tool have been analyzed to determine for which feature they have been prepared by literature review. According to these analyses, it is concluded that the questionnaire composed of 7 questions has been prepared to determine the following five features of science: a) Using multiple methods in scientific research, b) scientific information is based on the data, c) the difference between an experiment and an observation, d) subjectivity and imagination in scientific studies, e) the difference between the data and the evidence (Schwartz *et al.*, 2008). The questions in the questionnaire are presented in Table 2.

#### *Data Analysis*

The data were analyzed according to the scientific inquiry dimensions and analyzed according to the five characteristics revealed by Schwartz *et al.* (2008). These five features are the number of methods used in scientific inquiry, the collected data based on scientific knowledge, knowing the difference between experiment and observation in scientific knowledge process, recognizing the difference between subjectivity and imagination in a scientific study, knowing the difference between data and evidence collected for scientific knowledge, respectively. According to these characteristics, student answers of VOSI-E questionnaire were analyzed by three raters. The raters scored between 1 and 3 for each question answered. Classification was made by taking average grades for each student. The overall score was determined from 7 questions students answered in assessment tool. These scores range from 7 (the lowest) to 21 (the highest). The scores between 17-21 were classified as "expert"; 12-16 as "transition"; and 7-11 as "novice" (Saka *et al.*, 2012). In addition, the method used by Schwartz *et al.* (2008) was



used to determine the level of reliability of the data collected from the questionnaire. The researchers processed by determining the inter-rater reliability for the data they collected.

The answer of each student was analyzed by three raters and entered into data coding form. One of the researchers is engaged in science education while the other researcher continues his doctoral studies in the field of class education while the third researcher is a teaching member in the field of science education. The formulas suggested by Miles and Huberman (2002) were used in determining the percent of correspondence of the data that these researchers encoded together. The consistency level of the researchers' codes was found as 97%. In the research, three different raters scored the answers of 130 students by discussing each students' answer until there was a consensus for the answers. Since it is taken into consideration that the correspondences of 70% and above are adequate in such coding (Yıldırım & Şimşek, 2011), it is decided that the reliability level of the encoded data was sufficient. Scores were entered into the data analysis table by coding according to the criteria developed by Schwartz *et al.* (2008).

**Table 2. Grouping standards for VOSI-E.**

Question	Novice	Transition	Expert
1. What kinds of work do scientists do?	There is only one true scientific method and mentions that only one type of work is done.	It mentions two kinds of scientific processes or activities.	It begins the scientific process with a question or describes the scientific work in many ways and relates it to science.
2. Explain how scientists do their work.			
3a. Is the information given in the question text scientific? Why?	It's not scientific because it mentions that the only way to do science is experimenting.	It mentions that there could be both experimentation and observation.	It's scientific, but it mentions that it cannot be experimental. Or, it mentions that observation is description, inferring from observations is establishing a relationship.
3b. Is it an experiment according to the given in the question text? Why?	It is an experiment.	It is not an experiment.	It is not an experiment because it is an observation.
4a. Will the same result be achieved using the same process according to the given in the text?	Yes.	Undecided.	No.
4b. Explain why or why not	If he is following the same process, he will reach the same conclusion.	They get different results from the same data.	Scientists reach different conclusions using the same data because everyone has different opinions, thoughts. The reasons for this are... (subjectivity, social structure, creativity, imagination).
4c. What information do scientists use to explain this reason for why this happened?	They explain by observation.	They explain by scientific data.	He mentions evidence, proof and scientific data.

The score obtained by taking the average of the total scores of the students received from the questionnaire was accepted as their opinion score related to the scientific inquiry, as scoring criteria from 1 to 1.66 "novice", from 1.67 to 2.33 "transition" and from 2.34 to 3.33 "expert" were determined.

The chi-square test of homogeneity has been conducted to determine whether there is a significant difference between the categories which have been created by taking the answers of students to VOSI-E survey into consideration. The chi-square analysis of homogeneity is a test of hypothesis examining whether there is a significant difference between two or more nonparametric groups of variables (Cox & Key, 1993). A table, covering the groups of variables and consisting of rows and columns is created in this analysis. The influence of each of these groups on explaining a hypothesis in the table is examined. Therefore, the expected frequencies and the observed frequencies are compared (Kalaycı, 2010).

In Table 4, the expected frequency according to the distributions of the students in the experimental and control groups is determined as one cell each in less than the value 5 (16,7%). This analysis has been used due to the fact, that this situation does not affect the reliability of the results of chi-square analysis (Cramer & Howitt, 2000).



## Results of Research

The data collected from the views of participant students on scientific inquiry are presented below using descriptive analyzes.

**Table 3. Categories of students in the experimental and control group for scientific inquiry.**

Group	Statistic	Novice	Transition	Expert	Row Total
Experimental	Count	9	40	16	65
	Exp. Val.	13.5	38.5	13.0	65.0
	Std. Res.	-1.2	.2	.8	
	Adj. Std.	-1.9	.5	1.3	
Control	Count	18	37	10	65
	Exp. Val.	13.5	38.5	13.0	65.0
	Std. Res.	1.2	-.2	-.8	
	Adj. Std.	1.9	-.5	-1.3	
Column Total		27	77	26	130
Total %		20.8	59.2	20.0	100.0
Chi-square		<b>Value</b>	<b>df</b>	<b>p</b>	
		4.50	2	.105	

*Exp. Val.=Expected Value, Std. Res.= Standardized Residual, Adj. Std.=Adjusted Standardized*

In Table 3, the categories of students participating in activities related to creative drama activities and education of nature of science, and students not participating in these activities, were given. As seen in the table, there are 65 students each in the experimental and control groups. Nine of the students in the experimental group were in the novice, forty in the transition and sixteen in the expert category, while eighteen novices, thirty-seven transitions and ten experts were in control group. When the control and experimental groups were compared, it was concluded that the percentages of students at transition and expert category were higher compared to the control group. The percentage of novice students was higher in the control group compared to the experimental group. According to the results of the chi-square test of homogeneity, it is clear, that there is no significant difference between the distributions of the students in the experimental and control groups in terms of homogeneity ( $p > .05$ ). In Table 4, the categories of the students according to the results of the VOSI-E questionnaire according to gender were examined.

**Table 4. Categories of students about view of scientific inquiry by gender.**

Group	Gender	Statistic	Novice	Transition	Expert	Row Total
Experimental	Female	Count	3	25	9	37
		Exp. Val.	5.1	22.8	9.1	37.0
		Std. Res.	-.9	.5	.0	
		Adj. Std.	-1.5	1.1	-.1	
	Male	Count	6	15	7	28
		Exp. Val.	3.9	17.2	6.9	28.0
		Std. Res.	1.1	-.5	.0	
		Adj. Std.	1.5	-1.1	.1	
Total	Count	9	40	16	65	



Group	Gender	Statistic	Novice	Transition	Expert	Row Total
Control	Female	Count	3	18	3	24
		Exp. Val.	6.6	13.7	3.7	24.0
		Std. Res.	-1.4	1.2	-.4	
		Adj. Std.	-2.1	2.3	-.5	
	Male	Count	15	19	7	41
		Exp. Val.	11.4	23.3	6.3	41.0
		Std. Res.	1.1	-.9	.3	
		Adj. Std.	2.1	-2.3	.5	
Total	Count	18	37	10	65	
Total	Female	Count	6	43	12	61
		Exp. Val.	12.7	36.1	12.2	61.0
		Std. Res.	-1.9	1.1	-.1	
		Adj. Std.	-2.9	2.5	-.1	
	Male	Count	21	34	14	69
		Exp. Val.	14.3	40.9	13.8	69.0
		Std. Res.	1.8	-1.1	.1	
		Adj. Std.	2.9	-2.5	.1	
Total	Count	27	77	26	130	
Chi-square			<b>Value</b>	<b>df</b>	<b>p</b>	
		<b>Experimental</b>	2.55	2	.279	
		<b>Control</b>	5.56	2	.062	
		<b>Total</b>	9.08	2	.011	

As seen in Table 4, it was identified that the number of female students in the experimental group was higher than the number of male students in transition and expert categories by gender. In the control group, although the number of novice male students is more than the number of novice female students, it is seen that the number of expert male students is more than the number of expert female students. However, it was determined that the students in the experimental group and the control group were mostly in transition category. It is seen that both male and female students in the group, in which the experimental study was performed, have higher expert category than the control group. When in chi-square analysis, both experimental and control groups are compared separately, it is determined that there is no significant difference between the distributions of the students according to the opinions of female and male students about scientific research ( $p > .05$ ). In addition, it is stated that there is no significant difference between the distributions of the female or male students in two different groups either. However, it is determined that there is a significant difference between homogeneity of the female and male distributions when there is no group separation ( $\chi^2=9.08, p < .08$ ).

The findings of data analyzed according to the characteristics of number of methods used in the scientific inquiry, collected data based on scientific knowledge, knowledge of the difference between experiments and observations in the scientific knowledge process, awareness of subjectivity and imagination in a scientific study, knowledge of the difference between the data and evidence collected for scientific knowledge, which are sub-dimensions of VOSI-E questionnaire are given in Table 5.



**Table 5. Views of participant students on scientific inquiry according to the sub-dimensions of the VOSI-E questionnaire.**

Group	Characteristic	Novice		Transition		Expert	
		f	%	f	%	f	%
Experimental Group	Multiple method in scientific inquiry 1	7	10.8	39	60.0	19	29.2
	Multiple method in scientific inquiry 2	6	9.2	33	50.8	26	40.0
	<b>Average of %</b>		10.0		55.4		34.6
	The importance of data in scientific knowledge	10	15.4	22	33.8	33	50.8
	Difference between experiment and observation	22	33.8	17	26.2	26	40.0
	Subjectivity and imagination in scientific study 1	24	36.9	16	24.6	25	38.5
	Subjectivity and imagination in scientific study 2	30	46.2	13	20.0	22	33.8
	Difference between data and evidence	31	47.7	30	46.2	4	6.2
	<b>Average of %</b>		41.6		22.3		36.2
Control Group	Multiple method in scientific inquiry 1	24	36.9	28	43.1	13	20.0
	Multiple method in scientific inquiry 2	16	24.6	36	55.4	13	20.0
	<b>Average of %</b>		30.8		49.2		20.0
	The importance of data in scientific knowledge	17	26.2	6	9.2	42	64.6
	Difference between experiment and observation	35	53.8	14	21.5	16	24.6
	Subjectivity and imagination in scientific study 1	31	47.7	4	6.2	30	46.2
	Subjectivity and imagination in scientific study 2	29	44.6	10	15.4	26	40.0
	Difference between data and evidence	40	61.5	21	32.3	4	6.2
	<b>Average of %</b>		46.1		10.8		43.1

When the distributions according to the answers given by experimental and control groups are examined, it was found out that students in experimental group who participated in creative drama activities were "novice" in questions 6 and 7; "transition" on questions 1 and 2; and "expert" in questions 3, 4 and 5. The students in the control group were found out to be "novice" (questions 4, 5, 6 and 7) in 4 questions, "transition" (questions 1 and 2) in 2 questions and "expert" (question 3) in 1 question. When answers given by students to each question are examined, it is noteworthy that the students in the experimental and control groups mainly gave answers at the expert category in the "importance of data in scientific knowledge" sub-dimension. The sub-dimensions in which students answered at the lowest average and novice category were "the difference between data and evidence" for the experimental and control group. Although the percentages of students at the expert category in the experimental group were generally higher than those of the control group, the percentage of students in the control group was higher in the sub-dimension of "importance of data in scientific knowledge" than in the experimental group and were found to be equal in the "difference between data and evidence" sub-dimension. When the percentages of the novice students in each sub-dimension were examined, it was seen that the experimental group gave less novice category answers than the control group students.

## Discussion

The results of this research, in which creative drama activities on the views of students on scientific inquiry are examined, demonstrate that the applications cause an improvement in the expert categories of students on the dimensions of scientific inquiry. It was revealed by Moss, Abrams and Robb (2001) that an education given on science can cause significant changes in the opinions of students after a training with high school students. The findings of this research also show that the students in the experimental group had an increase in the understanding of science compared to the control group at the end of the application made with the creative drama activities on the understanding of science. There are many studies that suggest that teachers and prospective teachers generally





have inadequate opinions on the dimensions of science (Abd-El-Khalick, & Boujaoude, 1997, Aslan, Yalçın, & Tasar, 2009, Gallagher, 1991, King, 1991). In this research, the change in the views of students was not related to each dimension of the scientific inquiry but it was found that they had a higher ratio than the students in the control group in their views on five dimensions of scientific understanding.

Examining the literature, there are studies in which various versions of the VOSI survey have been used in order to determine the opinions of the students regarding the nature of science. In a study conducted by Leblebiçioğlu, Abik, Capkinoglu, Metin, Dogan, Cetin and Schwartz in 2017, the changes in the opinions of the students regarding the nature of science were examined by applying VOSI-S survey to the students at the beginning, at the end and following a science camp. The result of this study shows that the opinions of the students about the nature of science have greatly changed after the science camp. Bell, Blair, Crawford and Lederman (2003) have revealed the change of the opinions of the students regarding the nature of science by applying VNOS-B survey to the students before and after an eight-week practical program in laboratories where students work together with scientists. Aydeniz, Baksa and Skinner (2011) have also determined that the students have gained positive opinions regarding the nature of science after the laboratory application. Similar to the above-mentioned studies, this study has shown that there are positive improvements in the opinions of the students regarding the nature of science as a result of the studies conducted in teaching environment designed for teaching the nature of science.

The results of the research reveal that the students in the experimental and control groups show a predominant clustering of transition category. In the study conducted by Saka *et al.* (2012), it is stated that the majority of the students are in the transition-expert categories. When the findings were examined in terms of opinions of students on the dimensions of science, it is seen that the experimental group gave more expert category answers compared to the control group. This was considered as creative drama activities having a positive effect on the opinions of students on the dimensions of scientific inquiry. Ødegaard (2003) pointed out that the activities of creative drama prepared on the nature of science affect students just like laboratory applications. In the study conducted by Coşkun, Akarsu and Kariper (2012), it has been determined that educational games containing scientific stories bring about a significant difference in the achievement of the students in favor of the experimental group. Students have the opportunity to grasp the reality of the scientific application process as they indirectly experience the processes of scientists creating information through creative drama. This, in turn, raises the level of knowledge and insight towards the nature of science. The results of this research are in parallel with the studies of Coşkun, Akarsu, and Kariper (2012) and Ødegaard (2003).

The view of scientific inquiry of both female and male students were mainly found to be under the categories of novice and transition. Likewise, considered as one of the pioneers in the field, the study by Miller (1983) claimed that there was no statistically significant difference. Although the number of male students in terms of scientific inquiry was more than that of female students, it was determined that the ratio of students of both genders among all students was very low. As can be seen in the results of this research, only 20% of the male and female students are in the expert category. This result means that the scientific understanding of the students has improved over time, but the rate is low. The study by Saka *et al.* (2012) indicated that the ratio of male students at the novice level was higher than that of female students. PISA results also generally show that female students have a higher average score in concepts concerning scientific inquiry (Thomson & De Bortoli, 2008).

## Conclusions

According to research findings related to classification of scientific inquiry, it was found out that the percentage of students in expert and transition categories in experimental group who participated in creative drama activities is higher than those in control group. It was determined that more than half of the students in the experimental and control group were at the expert category and the number of expert students in the control group was higher compared to the experimental group in the sub-dimension of the difference between data and evidence in scientific data. However, the number of students at the novice category in the experimental group was less than the control group.

When the answers given by the students to the questions in the research are examined, it is concluded that they especially confused the concepts of "experiment" and "observation" and "data" and "evidence". It is seen that many students in both the experimental and control groups use these concepts in the same sense. However, it was determined that the students in the experimental group distinguished the experimental and observation concepts at a higher level than the students in the control group, and the number of experts in this group was significantly



higher than the control group. According to this result, it can be argued that the education given with creative drama activities is effective in reducing this confusion of the students regarding the concepts.

A number of suggestions are presented based upon research results:

1. At the end of this research, there were positive increases in the opinions regarding the concepts of creative drama activities and the elements of science. Repeating of creative drama activities with different samples is recommended in the teaching of science elements.
2. The research was conducted with post-test experimental design with control group. This is one of the limitations of the research. In similar studies to be made in the future, it is suggested to perform pre-testing in order to identify intra-group changes.
3. The research is limited to the answers of 130 students. In the future studies, it is suggested to conduct applications with wider samples in order to increase the generalizability.
4. It has been determined that creative drama activities are partly influenced by the opinions of students on data and evidence concepts that are part of the scientific process. New drama activities can be designed, and studies can be made to learn such abstract concepts with more effectiveness.
5. Research can be conducted to determine whether the students' confusion of basic concepts such as data and evidence are misconceptions and creative drama activities can be designed to eliminate such misconceptions.
6. The fact that the ratio of expert and transition answers in the experimental group is higher than the control group suggests that creative drama activities have led to effective results in the teaching of elements of scientific inquiry. Similar research can be evaluated with different measurement tools and the results can be compared.

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2. This research was partially presented at 3<sup>rd</sup> International Dynamic, Explorative, and Active Learning (IDEAL) Conference 1-3 September 2016, Samsun/Turkey.

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## Appendix 1. Creative drama plans

**Venue/Place** Creative Drama Hall

**Subject:** To reveal thoughts on science and how science is performed.

**Group:** Study group

**Time:** 180 minutes

**Methods/Techniques:** Creative Drama (Role play, improvisation)

**Tools-Equipment:** Marker pens, construction paper, crayons, science basket play cards, Animal Pair cards

### A. PREPARATION/WARM-UP

**Activity 1: Name Study:** The aim of this activity is that the leaders learn the names of the participants and know the group. The leader and the participants form a circle. In the circle, first the leader tells his or her name respectively. Then, he or she tells an adjective that starts with the first letter of his or her name and makes a gesture suitable for this adjective. My name is Belgin, I am like honey (Bal in Turkish). My gesture is eating honey with the spoon. Afterwards, the person on the right of the leader says: „Her name is Belgin, she is like honey“ and everyone repeats the appropriate gesture. Then, that person continues the process in a way suitable for his or her name. In this way, everyone in the group tells their names.

**Activity 2: Science Basket:** The aim of this game is that the students recognize the terms of experiment, knowledge, data, hypothesis, observation, model and scientific knowledge. The students arranged in the form



of a circle. Then, the words experiment, knowledge, data, hypothesis, observation and model are written on A4 papers. The students wait next to each paper. It goes into the middle. It says any of these words written on the papers and ensures that those students switch places with the ones who have the same words. While the persons are switching places, at the same time it tries to take their places. The person left without a place becomes it. If it uses the expression **scientific knowledge** except for these words, everyone in the circle has to switch places.

**Activity 3: Find your Home:** The aim of this game is; warming up, observation, follow-up and increasing the group's dynamic. The leader asks the participants to form groups in pairs. The pairs link arms. The arms of the pairs on the outer side placed on the waist in a way that form a nest. One of the two persons in the middle becomes it. It tries to catch the one that escapes. Without being touched, the escaping person takes the arm of one of the two persons in the nest. The partner on the other arm of the person, whose arm was taken, becomes free and starts running.

**Activity 4: Who's the Killer:** The aim of this game is to emphasize the importance of observation. The leader meets with the participants in the circle. Everyone closes their eyes with the movement of the leader. The leader touches the shoulder of anyone he or she wishes in the group and that person opens his or her eyes. Those with open eyes are the decision makers and they choose someone from the group by making eye contact without speaking. Afterwards, all participants open their eyes with the signal of the leader. The leader tells the participants that the decision makers eliminated the X person. The eliminated person leaves the group. The leader asks the question: Who do you think the decision-makers, who eliminated the X person, are? „ Everyone votes including the decision-makers. Everyone in the group takes a guess about who the decision makers are. The leader writes the guesses. The person who receives the highest amount of votes is given some time to defend himself or herself about not being the decision maker. He or she gets eliminated if he or she cannot convince the majority. If the person, who has received the highest amount of votes, is not one of the decision makers then it means that the wrong person will have been eliminated. If the first decision maker is found, the game continues to find the second one. The game is restarted when the second decision maker is identified.

**Activity 5: Animal Pairs:** The aim of this game is to ensure that a person understands the importance of being aware of his or her environment and making observation. The leader asks the participants to walk freely in the activity area and meanwhile he or she gives each participant a card with animal picture on it. After all the cards are handed out, everyone reads their cards without showing them to each other and put them in their pockets. The leader says: „With the clap of my hands, you close your eyes and start walking around by making the sound of the animal that is written on the card in your hand. Your aim is to find your partner who makes the same noise with you.“ The game starts with the clap of the leader. The last animal pair to find each other gets eliminated.

## B. ROLE PLAYING

**Activity 6: Yes-No Activity:** The aim of this game is to enable the **participants** to make observations, make inferences, discover and produce hypotheses like a scientist. In this activity, the behaviors of the scientists trying to learn the rules of a newly discovered primitive society will be impersonated.

First of all, four persons among the participants are asked to get out of the classroom as scientists. Attention is paid to the fact that the selected scientists are made up of smiling and straight-faced scientists with different genders. It is said that those who stay in the classroom are the member of the new society and it is explained that the rules of this society are as follows:

Rule No.1: They only communicate with the words „yes“ or „no“.

Rule No.2: They only give reaction or response to the people with the opposite gender.

Rule No.3: The society will only answer to the scientists who ask questions with a smiling face.

It is explained to the scientists waiting outside that a new community has been discovered and it is necessary for them to learn as much as possible about this community. Later, the scientists are invited to the classroom and they are requested to ask questions to learn about the new community and write down the answers that they receive.

**Activity 7: Correct-Incorrect:** The aim of this game is to bring the abilities of collecting data, hypothesizing and making observation. The scientist team enters the classroom and starts to do research on the society. The persons in the new society play their roles silently. Meanwhile, the scientists make observations. Later, the scientists collect information about the members of the community by asking questions to them. After asking questions for ten to fifteen minutes, they make an inference about the community by sharing their observations with the other scientists. Scientists explain why they make such inferences. The community and the scientists discuss about the rightness and wrongness of their inferences.



**Activity 8: I am Making an Observation:** The aim of this game is to bring the abilities of collecting data, hypothesizing and making observation. The questions „what is science?“, „how does science work?“ and „how do scientists work?“ are discussed by the researchers with the whole group after discovering the rules of the new community. Once the discussion is finished, the participants are requested to express what they have learned from this activity regarding science, scientist, scientific information and scientific process in verbal and written ways.

**Activity 9: I am a Scientist:** The aim of this game is to bring the abilities of collecting data, hypothesizing, presenting data and creating model. Before the activity starts, the students are requested to think like a scientist who will make a new product. The students think about what invention they will make for a certain amount of time. Later, the students are divided into groups of three persons. Each group comes together to discuss about their inventions with their friends. They make an effort to convince the other two members of the group that their invention is more important. After each group decides which invention they will make, they move on to the activity phase.

**Activity 10: I am making a new invention:** The aim of this game is **to enable the participants** to invent and introduce a new product. Each group has determined an invention at the previous activity. They are given a work sheet and requested to write and draw the invention they chose in detail.

**Activity 11: See you in congress:** The aim of this game is to defend an opinion or idea and to have scientific discussion. The students are told that they will attend a scientific congress and they are asked to explain their invention to other scientists. The scientists listening to them are requested to ask what they want to know about this invention. This way a scientific congress environment is created. Here those who made the invention promote their products whereas the others decide whether the invention is appropriate by asking questions and make discussions. The inventors defend their inventions based on the scientific facts.

### C.EVALUATION

**Activity 12: Evaluation Activities:** At the end of the process VOSI-E questionnaire is filled out by the students.

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