Journal for the Education of Gifted Young Scientists
3(1) 1-12

http://jegys.org
DOI: 10.17478/JEGYS.2015110568

Research Article

Analysis according to Certain Variables of Scientific Literacy among Gifted Students that Participate in Scientific Activities at Science and Art Centers[1]

Emre KOMEK[2], Dursun YAGIZ[3] and Murat KURT[4]

Received: 26 January 2015 **Accepted:** 31 March 2015

Abstract

The purpose of this study is to analyze scientific literacy levels relevant to science and technology classes among gifted students that participate in scientific activities at science and art centers. This study investigated whether there was a significant difference in scientific literacy levels among gifted students according to the areas of their giftedness (science, mathematics, and social sciences) and the extent to which they participated in enrichment activities. The study also compared scientific literacy levels among the gifted students who participated in scientific activities at science and art centers and the students who received formal education and were not identified as gifted. Seventy-seven students from Afyon Aydın Doğan, Bayburt, Elazığ and Konya Science and Art Centers (as called BILSEM in Turkish) SACs constituted the sample of the study. *The Scientific Literacy Scale* developed by Keskin (2008) was used to determine scientific literacy levels among students. *The Enrichment Scale* was developed by the researchers to specify to what extent the respondents profited from enrichment activities. Arithmetic averages were calculated to determine scientific literacy levels and levels of enrichment strategies. Standard deviation, t-test, and variance analysis were used to establish the relationship between scientific literacy levels, areas of giftedness, and enrichment strategies. The findings of the study concluded that scientific literacy levels did not vary according to areas of giftedness, but they varied according to levels of participation in enrichment activities. The study also found higher scientific literacy levels among the gifted students compared to the students that attended formal education and were not identified as gifted.

Key words

scientific literacy, gifted and talented students, Science and Art Centers

To cite this article:

Komek, E., Yagiz, D., & Kurt, M. (2015). Analysis according to certain variables of scientific literacy among gifted students that participate in scientific activities at Science and Art Centers. *Journal for the Education of Gifted Young Scientists, 3*(1), 1-12. DOI: http://dx.doi.org/10.17478/ JEGYS.2015110568

[1]This study was written as a part of Emre KOMEK's master thesis, completed through Konya Necmettin Erbakan University Institute of Educational Sciences.

[2]Agri Ibrahim Cecen University Faculty of Education, Agri, Turkish Republic. E-mail: ekomek@agri.edu.tr
[3] Konya Necmettin Erbakan University Ahmet Kelesoglu Faculty of Education, Konya, Turkish Republic. E-mail: dyagiz@konya.edu.tr
[4]Agri Ibrahim Cecen University Faculty of Education, Agri, Turkish Republic. E-mail: mkurt@agri.edu.tr

INTRODUCTION

The amount of scientific information is rapidly growing in today's world, giving rise to a large number of new fields of study and scientific disciplines. In the coming years, there will be an enormous increase in the number of disciplines; thus even scientists, let alone ordinary people, will find it harder to have a good command of only a few disciplines. Moreover, in the modern world, which is dominated by technology and science that interact with each other very deeply, the more advanced technology and science are, the more powerful a country becomes. Therefore, a country's increasing investment in Research and Development (R&D) activities boosts advances in science and technology, and transforms into having greater sway in economic, political, and socio-cultural fields. Investment in R&D helps to transform country into an invention plant, and a science and technology base (Sahin, 2011). From a macro perspective, a country's R&D activities and expenses are positively correlated with its level of development (Azgun & Sevinc, 2011). From a micro perspective, on the other hand, technology, depending on R&D activities, facilitates individuals' lives, and individuals become acquainted with science and technology. Thus R&D activities are the life-blood of a country, they can even be considered as the heart of a country. R&D activities ensure that individuals become keener to learn and use science and technology, appreciate their value, and understand their limits, thus enabling them to become scientifically literate more rapidly.

Literacy is very decisive in communities' and civilizations' developments. The level of development of a country is expressed in terms of its literacy rate. However, the concept of literacy is insufficient in and of itself. Every field has its own literacy. Types of literacy such as mathematical literacy, computer literacy, ecological literacy, biological literacy, media literacy, economic literacy, and agricultural literacy (Ersoy, 1997; Kılınç and Salman; 2006, Teksoz et al., 2010; Altun, 2008; Gerek & Kurt, 2011) are used in modern world. In this age of information that cannot be dissociated from science and technology, *Scientific Literacy*, beyond basic literacy, is to be of particular importance.

The concept of scientific literacy that was first introduced by Hurd in1958 has been in use in the relevant literature for nearly the last 50 years (Laugksch, 2000). According to Hurd, science and technology are the most prominent characteristics of the modern world, which suggests that scientific literacy is a requirement for modern people. In today's world, developing countries, and Turkey in particular, should catch up with the latest technology through education and sciences, aim to ensure widespread access to science by breaking the monopoly of a certain group or community over science, and raise scientifically literate individuals (Turgut, 2005:3).

The mission of the current Science and Technology Curriculum is to educate all individuals to be scientifically literate. Though scientific literacy is a goal to be reached for everyone, as defined by the science and technology curriculum, it is a significant competence that should be acquired by gifted and talented students who constitute around 2% of a population, and are regarded as guides of a civilization and a community. Thus emerges the concept of scientific literacy of gifted and talented students who can be called *prospective scientists*, and mentors of a society, because the level of scientific literacy among gifted and talented students is expected to be high. Gifted individuals are interested in science and are highly curious.

High quality science teaching plays an essential role in ensuring advanced scientific literacy among gifted students. Science teaching should encompass meaningful and lasting practices, and problems that are associated with daily life. As it is known, complaints have concentrated on rote learning in our education systems, and the practicality of information in daily life has been questioned. According to Gurdal (1991) and Sahin (1994), rote learning, and the lack of critical and creative thinking skills are important problems in science teaching. Theoretical information that cannot be directly applied to real life, and dead facts that do not contribute to human beings' happiness are taught in schools (Yetisir, 2007:2). Whereas according to Aktepe & Aktepe (2009), the main objective of science teaching should be to help students develop scientific thinking instead of providing all the relevant information available. It is possible for a student to develop scientific thinking only by being raised as scientifically literate.

There are steps taken towards resolving the aforementioned problems in science teaching, and enabling the adaptation of sciences to natural and real life rather than artificial laboratory environments. The relevant body of research suggests that students can learn sciences outside of school as much as they do in school. Students are constantly faced with the sciences in various forms outside of school. Take TV shows for example, where they provide scientific teaching methods and scientific information through explicit and implicit scientific concepts. Weekend tours to museums and national parks provide an opportunity to learn for both students and adults. Informal science educators consider out-of-school science education as free and optional, because it is voluntary, and creates a generally free, social learning environment. Thus formal and informal science education should be combined, and rendered permanent (Liu, 2009:307).

Informal science education or out-of-school science education generate learning environments for students by ensuring enriched sciences, providing means to explore nature and collect social and concrete experiences (Simsek, 2011:4). It also positively influences students' attitudes towards science, renders science more attractive and entertaining, and makes more connections with daily life.

There are no studies that analyzes science teaching and thus scientific literacy among gifted students; rather there are studies that examine (Lee & Choi, 2003; Tereci, Aydin & Orbay, 2011) or provide insight into the nature of science and attitudes towards science that are regarded as sub-dimensions of scientific literacy.

Research Question

What is the level of scientific literacy among gifted students who benefit from the Science Activities Units in Science and Art Centers, and does this level differentiate according to certain variables?

Sub-Problems

- Are there significant differences between the levels of scientific literacy among students gifted in science, mathematics, and social sciences, who attend the Science Activities Units in Science and Art Centers?
- Do the levels of scientific literacy among gifted students who participate in the Science Activities Units in Science and Art Centers differentiate according to the extent to which they benefit from enrichment strategies?
- Is there any significant difference in terms of the level of scientific literacy between gifted students who participate in the Science Activities Units in Science and Art Centers, and students who are not defined as gifted and attend formal education?

Objective of the Study

The study aims to analyze, according to certain variables, scientific literacy levels of gifted students who participate in the Science Activities Units in Science and Art Centers, and who specialize in a certain area of giftedness. These variables are;

Areas of giftedness (Science, Mathematics, Social Sciences),
The extent to which they benefit from enrichment strategies, and
Whether they participate in the Science Activities Units in Science and Art Centers.

Significance of the Study

According to Tannenbaum's psychosocial theory, talent is proportional to a society's needs, and the readiness of society to appreciate it. Based on this theory, talent falls into four categories:

- Scarcity talent
- Surplus talent
- Quota talent
- Anomalous talent

Scarcity talents are talents that are in short supply in a society. There is always need for talents that will render the world more livable and safer. Which talents are considered as such? Apart from scientific literacy, it is possible to give a few examples to scarcity talent. Genuine scientific literacy is classified in the category of scarcity talent, because scientific literacy, along with science talent, are leading talents in social development and change (Uzun, 2004). Keller (1980) notes that it is very important in a country to identify youngsters who are gifted in science (Curebal, 2004:23)

Science talent is associated with the level of scientific literacy. This study investigates the level of scientific literacy that predicts science talent, and indirectly aims to contribute to predicting prospective scientists who can promote a developing and changing society. According to PISA results, Turkey's level of scientific literacy is below average, and there are no students from Turkey who have attained the highest scientific literacy level (MoNE, 2010). This study is significant in analyzing the reasons for this underachievement, and thus will contribute to the relevant literature, as there has been no such study so far.

As stated above, R&D activities and expenses are parallel to country's level of development. R&D activities require high giftedness and creativity. In this sense, ensuring the participation of gifted individuals in R&D activities boosts the development of a country. As Tereci, Aydin & Orbay (2011) note, R&D units are led by gifted and talented individuals. It is significant for the country's future to study scientific literacy among gifted students of scarcity talents who are identified as prospective scientists of tomorrow's R&D activities.

According to a review of literature, Lee and Choi (2003) analyzed to what level gifted students understand the nature of science. Orbay et al., (2010) investigated gifted students' attitudes towards science; however, no study has dwelled on the level of scientific literacy among gifted students. Thus this study will contribute to literature.

METHOD

This section provides information on the survey population, method, data collection, and data analysis.

Research Model

This study uses quantitative methods. A relational screening model was used in the study as the differentiation of literacy levels among students according to variables and descriptive basis was used. According to Karasar (1991:79), general screening models are applied to a survey population completely, or to a group, example or sample to be taken out of population in order to pass a general judgment on a population that is made up of numerous elements.

Survey Population and Sample

The survey population is composed of the students who participate in the Science Activities Units in 59 Science and Art Centers under the Ministry of National Education (MoNE), and who participate in special talent development programs, and 7th and 8th grade students from public schools under MoNE in the province of Afyon. The sample consists of the students who visit Science Activities Units in Aydın Dogan Science and Art Center in the province of Afyon, Science and Art Centers in the provinces of Konya, Bayburt, and Elazığ, and who participate in special talent development programs. Science and Art Centers are the institutions where the gifted students are educated (Kunt & Tortop, 2013).

Fifty-five 7th and 8th grade public school students that were not identified as gifted were elected enable the comparison of scientific literacy levels with gifted and talented students from Afyon.

41.56% of the students stated that they were talented in science, 26% of them mathematics and 32.44% of them social sciences.

While 63.6% of the students noted that they had mentors, 36.4% stated they did not.

Table 1. Distribution of the gifted students that attend SACs, and the students that were not identified as gifted according to grade

SACs	6th grade	7th grade	8th grade
Gifted	19	28	30
Not identified as gifted	-	26	29
Total	19	54	59

Table 2. Distribution of gender according to grade

Gender	6th grade	7th grade	8th grade	Total
Male	9	30	25	64
Female	10	24	34	68
Total	19	54	59	132

Table 3. Distribution of number of students according to area of giftedness and province

	Number of students talented in science	Number of students talented in mathematics	Number of students talented in social sciences
Afyon Aydın Doğan SACs	8	4	3
Bayburt SACs	8	-	-
Elazığ SACs	9	5	8
Konya SACs	7	11	14
Total	32	20	25

Limitations of the Study

This study is limited to the following;

- Gifted students that participated in Special Talent Development programs offered in Konya, Aydın Doğan (Afyon), Bayburt and Elazığ Science and Art Centers,

- Independent studies, field trips, and after school programs under the enrichment strategy as one of the education strategies aimed at gifted students.

Data Collection Tools

Though there are numerous tools to measure the sub-dimensions of scientific literacy in the relevant literature, there are not that many tools to measure scientific literacy as a whole. The Scientific Literacy Scale developed by Keskin (2008) was used in this study. The Scientific Literacy Scale was applied to 246 7th and 8th grade students by Keskin (2008), and its reliability coefficient was calculated as 0.81. The scale was administered to 80 6th, 7th, and 8th grade students by researchers, and its reliability coefficient was found as 0.83. The questions included in the Scientific Literacy Scale are include17 characteristics that should be possessed by scientifically literate individuals. There are one, two, or three questions related to each item.

There are 34 multiple-choice questions in the Scientific Literacy Scale, with three options and a blank option (one of the answer choice that is for extra explanation) for those who would like to write down extra comments. Extra opinions written down in the fourth blank d option by respondents were evaluated by the researcher according to one of other three choices that gave the closest meaning. As for the scoring, correct answers received one point, and incorrect answers received zero points. Each score range was fixed as 0.33. Respondents who scored between 0 and 0.33, 0.34 and 0.67, and 0.68 and 1 were evaluated to have low, medium, and high scientific literacy levels respectively.

"Area of giftedness" was included in the Scientific Literacy Scale to determine in which field students were more gifted. Science, mathematics, and social sciences were classified under the area of giftedness. Science included sub-branches such as physics, chemistry, biology, space, and technology. Mathematics included sub-branches such as geometry and computers. Social sciences included sub-branches such as literature, history, geography, English, and Turkish. Though music and athletics are normally listed under fine arts, they were classified under social sciences as they were not high in number. As for the special talent development programs, Science and Art Centers implement multi-staged education programs. Below is a list of the education programs that are implemented:

- Orientation program,
- Supportive education,
- Program aimed at distinguishing individual talents,
- Special talent development program,
- Project creation/management program.

As part of the special talent development program that leads to the top level project creation program, it is ensured that participants acquire advanced information and skills in a certain discipline (Celikdelen, 2010). This program helps to identify fields in which students are gifted, and for students to develop the capacity to generate a project in his/her area of giftedness at the end of this stage. While applying the scale, students were asked to write down the fields in which they were gifted, and the students in the special talent development program were involved after consultations with SACs administrators. Moreover, fields of student's giftedness were verified through project topics addressed by those preparing projects as part of the ZEMES scale.

The enrichment scale was developed by the researchers. It focuses more on informal science education, and encompasses yes-no questions about field trips, independent studies, and after-school programs that are offered as part of the enrichment strategy. The scale aims to identify whether students attend the abovementioned enrichment activities by specifying those that they attend. The content validity of the scale was evaluated to be adequate by three field educators (two science educators and an educator of gifted students). There are 22 questions in the enrichment scale. As for scoring, "yes" answers received one point, and "no" answers and those without "yes" or "no" received zero points. Three score ranges were defined to determine the levels to which students benefited from enrichment programs. Zero to seven points referred to a low level of participation in enrichment programs, eight to fourteen points referred to a medium level of participation, and fifteen points and above referred to a high level of participation.

Data Analysis

After collected, data were analyzed by means of the SPSS 18.0 software package.

A variance (one-way) analysis was performed in order to compare scientific literacy levels according to students' areas of giftedness and the extent to which they benefited from enrichment programs, and averages were calculated to determine scientific literacy levels.

A t-test was applied in order to establish the relationship between scientific literacies according to whether students profited from mentoring strategy. Frequency and percentage calculations were used in determining students' relationships with their mentors, and how often and where they would meet their mentors.

A t-test was administered in order to compare scientific literacy levels of the gifted students who visited Science and Art Centers and those who were not identified as gifted, and averages were calculated to analyze each dimension of scientific literacy.

FINDINGS

Scientific Literacy Level According to the Area of Giftedness

Table 4 presents the averages calculated according to the responses given by the respondents to each dimension and their areas of giftedness.

Table 4. Average scores of the scientific literacy dimensions according to students' areas of giftedness

Dimensions	Area of giftedness		
	Science	Mathematics	Social Sciences
Dimension 1	0.76	0.75	0.76
Dimension 2	0.67	0.68	0.67
Dimension 3	0.67	0.66	0.67
Dimension 4	0.49	0.49	0.49
Dimension 5	0.56	0.55	0.56
Dimension 6	0.71	0.69	0.71
Dimension 7	0.59	0.56	0.59
Dimension 8	0.76	0.76	0.76
Dimension 9	0.68	0.70	0.69
Dimension 10	0.54	0.56	0.55
Dimension 11	0.77	0.79	0.77
Dimension 12	0.81	0.79	0.80
Dimension 13	0.88	0.87	0.88
Dimension 14	0.72	0.74	0.73
Dimension 15	0.55	0.58	0.56
Dimension 16	0.75	0.73	0.74
Dimension 17	0.95	0.95	0.95

According to Table 4, 32 students that were defined as gifted in science attained high scientific literacy levels (0.75). Twenty students that were defined as gifted in mathematics reached high scientific literacy levels (0.69). Twenty-five students that were defined as gifted in social sciences attained high scientific literacy levels (0.7). Table 5 demonstrates average scientific literacy levels and standard deviations according to students' areas of giftedness.

Table 5. Averages and standard deviations according to students' areas of giftedness

Area of giftedness	N	Average	Standard Deviation
Science	32	0.7537	0.14130
Mathematics	20	0.6941	0.19237
Social Sciences	25	0.6988	0.19292
Total	77	0.7204	0.17306

A variance (one-way ANOVA) analysis was performed in order to determine whether students' scientific literacy levels differentiate according to their areas of giftedness. Prior to variance analysis, Levene's test was used to assess variance homogeneity, and concluded that variances could be considered as homogenous (Levene's statistics (2.74)=0.75 p=0.47). Results of the variance analysis, as shown in Table 6, revealed that students' levels of scientific literacy did not vary according to the fields in which they were defined as gifted.

Table 6. Results of the variance analysis according to students' areas of giftedness

	Squares total	Squares av.	Standard dev.	F	p
Inter groups	0.061	0.030	2	1.017	0.367
Intra group	2.215	0.030	74		
Total	2.276		76		

Scientific Literacy Levels According to the Extent to which Students benefit from Enrichment Activities
An enrichment scale which contains 22 item was designed to determine whether students' scientific literacy levels varied according to the degree they profited from enrichment activities. Zero to seven points referred to a low level of participation in enrichment programs, eight to 14 points referred to a medium level of participation, and 14 points and above referred to a high level of participation. Gifted students who profited from enrichment activities at a low level attained a medium level of scientific literacy (0.62) with a standard deviation value of 0.24. Gifted students who profited from enrichment activities at a medium level attained high level of scientific literacy (0.74) with a standard deviation value of 0.13. Gifted students who profited from enrichment activities at a high level attained high level of scientific literacy (0.76) with a standard deviation value of 0.19. It was concluded that the students benefited from enrichment activities at a nearly medium level. A variance analysis was performed to determine whether scientific literacy among the respondents varied according to these three levels. The pre-analysis homogeneity test showed that the variances could not be admitted as homogenous (Levene's statistic (2.74)=5.38, p=0.07). Thus a variance analysis was performed. The results demonstrated that at least one level of enrichment differed from other levels ($F_{(2)}$=4.08, p=0.02). Post-hoc analyses concluded that the second level was significantly higher than the first level, whereas the third level was not significantly different than the first and second levels.

Table 7. Average and standard deviation values according to enrichment level

Enrichment level	N	Average	Standard deviation
1.00	18	0.622	0.243
2.00	54	0.748	0.130
3.00	5	0.764	0.192
Total	77	0.720	0.173

Scientific Literacy Level According to whether Students Attended the Scientific Activities Unit

Table 8. Comparison according to the sub-dimensions of the students that were defined as gifted and those that were not defined as gifted

Dimensions	Gifted	Formal Education (not identified as a gifted)
Dimension 1	0.76	0.76
Dimension 2	0.68	0.74
Dimension 3	0.67	0.43
Dimension 4	0.49	0.49
Dimension 5	0.56	0.54
Dimension 6	0.70	0.67
Dimension 7	0.58	0.59
Dimension 8	0.76	0.69
Dimension 9	0.69	0.66
Dimension 10	0.55	0.26
Dimension 11	0.78	0.68
Dimension 12	0.80	0.62
Dimension 13	0.87	0.74
Dimension 14	0.73	0.47
Dimension 15	0.56	0.67
Dimension 16	0.74	0.69
Dimension 17	0.95	0.83

In Dimension 1, the average value of the students that were defined as gifted was 0.76, and the average value of the students that were not identified as gifted was 0.76, as well. It is possible to state that both groups of students attained high levels in this dimension.

In Dimension 2, the average value of the students that were defined as gifted was 0.68, and the average value of the students that were not identified as gifted was 0.74. It is possible to state that both groups of students attained high levels in this dimension.

In Dimension 3, the average value of the students that were defined as gifted was 0.67, and the average value of the students that were not identified as gifted was 0.43. It is possible to state that both groups of students attained medium levels in this dimension.

In Dimension 4, the average value of the students that were defined as gifted was 0.49, and the average value of the students that were not identified as gifted was 0.49, as well. It is possible to state that both groups of students attained medium levels in this dimension.

In Dimension 5, the average value of the students that were defined as gifted was 0.56, and the average value of the students that were not identified as gifted was 0.54. It is possible to state that both groups of students attained medium levels in this dimension.

In Dimension 6, the average value of the students that were defined as gifted was 0.70, and the average value of the students that were not identified as gifted was 0.67. It is possible to state that the students that were identified as gifted attained high levels, while those that were not defined as gifted attained medium levels in this dimension.

In Dimension 7, the average value of the students that were defined as gifted was 0.58, and the average value of the students that were not identified as gifted was 0.59. It is possible to state that both groups of students attained medium levels in this dimension.

In Dimension 8, the average value of the students that were defined as gifted was 0.76, and the average value of the students that were not identified as gifted was 0.69. It is possible to state that both groups of students attained high levels in this dimension.

In Dimension 9, the average value of the students that were defined as gifted was 0.69, and the average value of the students that were not identified as gifted was 0.66. It is possible to state that the students that were identified as gifted attained high levels, while those that were not defined as gifted attained medium levels in this dimension.

In Dimension 10, the average value of the students that were defined as gifted was 0.55, and the average value of the students that were not identified as gifted was 0.26. It is possible to state that the students that were identified as gifted attained medium levels, while those that were not defined as gifted attained low levels in this dimension.

In Dimension 11, the average value of the students that were defined as gifted was 0.78, and the average value of the students that were not identified as gifted was 0.68. It is possible to state that both groups of students attained high levels in this dimension.

In Dimension 12, the average value of the students that were defined as gifted was 0.80, and the average value of the students that were not identified as gifted was 0.62. It is possible to state that the students that were identified as gifted attained high levels, while those that were not defined as gifted attained medium levels in this dimension.

In Dimension 13, the average value of the students that were defined as gifted was 0.87, and the average value of the students that were not identified as gifted was 0.74. It is possible to state that both groups of students attained high levels in this dimension.

In Dimension 14, the average value of the students that were defined as gifted was 0.73, and the average value of the students that were not identified as gifted was 0.47. It is possible to state that the students that were identified as gifted attained high levels, while those that were not defined as gifted attained medium levels in this dimension.

In Dimension 15, the average value of the students that were defined as gifted was 0.56, and the average value of the students that were not identified as gifted was 0.67. It is possible to state that both groups of students attained medium levels in this dimension.

In Dimension 16, the average value of the students that were defined as gifted was 0.74, and the average value of the students that were not identified as gifted was 0.69. It is possible to state that both groups of students attained high levels in this dimension.

In Dimension 17, the average value of the students that were defined as gifted was 0.95, and the average value of the students that were not identified as gifted was 0.83. It is possible to state that both groups of students attained high levels in this dimension.

Average and standard deviation values were calculated based on the data from the scientific literacy test applied to the students who received formal education and those who participated in scientific activities. Scientific literacy levels were found to be medium (0.65) and high (0.72) respectively, and standard deviation values were established to be 0.11 and 0.17, respectively. A t-test was applied in order to determine whether the difference in averages was significant, in other words, to determine whether there was a significant difference in scientific literacy levels among students that received formal education and were not identified as gifted, and the students that participated in scientific activities and were defined as gifted. The homogeneity test concluded that the variances could not be admitted as homogenous (F=5.86, p= 0.017). The results of the t-test, based on the assumption that the variances were not equal and according to the significance level of 0.05, showed that the students who received special education reached higher scientific literacy levels compared to those who attended formal education and were not identified as gifted ($t_{(126.57)}$=2.68, p=0.008).

Table 10. Average and standard deviation values of the students that were identified as gifted and those that were not identified as gifted

	N	Average	Std. Deviation
Non-gifted students	52	0.6537	0.10976
Gifted students	77	0.7204	0.17306

DISCUSSION

Level of Scientific Literacy According to Area of Giftedness

According to the relevant results, all students in all areas of giftedness showed high levels of scientific literacy. The average level of scientific literacy among the students that were defined as gifted in science proved to be higher (0.75) than those gifted in mathematics (0.69) and in social sciences (0.70). A variance analysis (one-way) that was performed to determine whether levels of scientific literacy varied according to areas of giftedness did not suggest any variance.

In one study, Dilek, Yılmaz & Oral (2000) compared levels of scientific literacy among candidate teachers in social sciences and sciences. Their study found both groups' levels of scientific literacy similar, and did not reveal any significant difference (Suren, 2008).

Orbay et al., (2010) investigated whether attitudes towards science of gifted and talented students who visited Science and Art Centers varied according to gender, area of giftedness, and level of education. Students were defined as gifted in two areas: science and arts. The results of the study did not suggest any significant difference between their attitudes towards science, and were parallel with the results of this study.

This study concluded that levels of scientific literacy did not vary according to area of giftedness, because scientific literacy is related to social skills in addition to scientific and mathematical skills. Due to its social dimension, the students gifted in social sciences attained similar levels of scientific literacy to those gifted in science and mathematics.

Another reason for similar levels of scientific literacy among all three groups could be that the same processes take place in the selection of areas of giftedness. In other words, different criteria of selection do not apply to each area of giftedness. Every student that achieves in general talents tests shapes their own areas of giftedness, because there is no such model which helps reveal and develop a certain talent. The relevant studies in the literature show similar results.

Level of Scientific Literacy According to Level of Enrichment Activities

Enrichment is a strategy that is applied to the education of gifted students, and aims to move beyond the content of the standard curriculum, to deepen and diversify education by introducing enriched opportunities and curriculum. Content, as well as teaching methods, can be diversified. There are process-based, content-based, and product-based enrichment types (Sak, 2010:138). Independent studies, field trips, and after-school programs as part of informal education were analyzed in our study.

Since there are no studies in the relevant literature that investigate the levels of scientific literacy among gifted students, informal education dimension that embraces independent studies and field trips as enrichment strategies, and attitudes and the nature of science as sub dimensions of science literacy were analyzed.

According to the relevant results, the level of scientific literacy among the students who benefitted from enrichment activities at a medium level was higher than the level of scientific literacy among those who benefited from enrichment activities at a low level. On the other hand, the level of scientific literacy among the students who benefitted from enrichment activities at a high level was slightly higher, without any significant difference, than the levels of scientific literacy among those who benefited from enrichment activities at low and medium levels.

In one study, Keskin (2008) found a significant difference between levels of scientific literacy according to reading periodicals and availability of computer at home. According to the recommendations by Keskin's (2008) study, introducing student-centered activities that are connected to environment and daily life in science and technology classes could help students achieve higher levels of scientific literacy. As per the recommendations in the very same study, students should be encouraged to examine technological designs, to visit museums, to stage stories of scientists' inventions, to follow scientific periodicals and documentaries, and to design technological equipment through their creativities (Keskin, 2008:91).

In one study conducted with 330 gifted high school students, Stake & Mares (2001) found a significant difference in students' attitudes towards science following a four-week, summer science enrichment program (Ogretme, 2001). Thus, there was positive change in the attitudes towards science of the students who participated in the enrichment program. A study by Suren (2008) established a significant relationship between the level of scientific literacy and following and reading scientific periodicals.

Yakar (2010) determined that respondents' levels of scientific literacy varied significantly according to how frequent they used Internet and visited libraries, how they watched TV, whether they could write down names of a few national and international periodicals, and names of a few scientists. According to Akdur (2002), science education should be student-centered and based on scientific activities. Erbas (2005) identified a positive correlation between the number of books at home, availability of out-of school private classes and scientific literacy. Sahin & Say (2010) did not establish any significant difference in levels of scientific literacy according to whether respondents read scientific periodicals, visited museums, and had libraries. Neber & Aikins (2002) stated that exploration-based science education for gifted students would be effective.

The relevant studies in the literature demonstrated that the extent to which students profited from enrichment activities influences their levels of scientific literacy. This study focused on the informal education dimension of the enrichment strategy. Informal science education seems more appealing, entertaining, and creative to students, and contributes to enhanced questioning skills, thus resulting in higher scientific literacy levels.

Level of Scientific Literacy According to Participating in Scientific Activities

While the level of scientific literacy among the gifted students who participated in scientific activities was high (0.72), the level of scientific literacy among the students who were not identified as gifted and who received only formal education was medium (0.65). Thus, the students defined as gifted attained higher levels of scientific literacy compared to those who were not identified as gifted.

PISA addresses scientific literacy at six levels. The highest 5th and 6th levels mean that students can make an invention or introduce innovations to science and technology, thus it is probable that students at these levels are gifted and talented. According to the results of PISA 2009 survey, 1.1% of the students in our country attained the 5th level, but no student could reach the 6th level. These results suggested that our gifted and talented students did not achieve high levels of scientific literacy, and did not receive adequate education.

According to Aktepe & Aktepe (2009), gifted and talented students were likely to be more scientifically literate compared to standard students. This study provided a similar conclusion.

In a study by Suren (2008), 5th grade students that were not defined as gifted showed an average scientific literacy level of 0.59, which is similar to the average level of 0.65 in our study.

A study by Lee & Choi (2003) evaluated views of the students gifted in science on the nature of science. Students that are gifted in science and are future professionals are expected to be adequately equipped with opinions on the nature of science that will form a basis for their prospective scientific careers. They assessed the views on the nature of science by 47 students at 8th grade that were identified as gifted in science and those that were not. As a result, gifted students showed higher levels of understanding in the nature of science in numerous ways compared to standard students. The study suggested that students began to understand the nature of science at early ages.

According to Tereci et al., (2011), visits to schools, and participation in students' projects and lectures on interesting topics by professional scientists could have a positive impact on students' attitudes towards science. Parallel to the results of the relevant studies in the literature, students that were defined as gifted showed higher levels of scientific literacy compared to those that were not identified as gifted.

CONCLUSIONS and RECOMMENDATIONS

All students in all areas of giftedness (sciences, mathematics and social sciences) showed high levels of scientific literacy. The study did not find any significant difference between scientific literacy levels according to the areas of giftedness.

Gifted students who profited from enrichment activities at a low level attained a medium level of scientific literacy (0.62) with a standard deviation value of 0.24. Gifted students who profited from enrichment activities at a medium level attained a high level of scientific literacy (0.74) with a standard deviation value of 0.13. Gifted students who profited from enrichment activities at a high level attained a high level of scientific literacy (0.76) with a standard deviation value of 0.19. Therefore, the study established a significant difference between scientific literacy levels among the students who participated in enrichment activities at a medium level and those who participated in enrichment activities at a low level. It did not determine any significant difference between scientific literacy levels among the students who participated in enrichment activities at a high level and those who participated in enrichment activities at a medium level. The students who profited from enrichment activities at a medium level demonstrated higher scientific literacy levels.

It was concluded that the students benefited from enrichment activities at a nearly medium level.

While the level of scientific literacy among the gifted students who participated in scientific activities was high (0.72), the level of scientific literacy among the students who were not identified as gifted and who attended only formal education was medium (0.65). Thus, the students defined as gifted attained higher levels of scientific literacy compared to those who were not identified as gifted.

The study concluded that the students from Konya benefited from enrichment activities at higher levels compared to those from other provinces (Afyon, Bayburt, Elazig) due to Konya's geographical location (closer to metropolises) and to the availability of more out-of-school learning opportunities.

Recommendations for researchers and policy makers, educators are given in the following;

- As part of enrichment activities for students, there should be visits to informal science education environments such as museums, science centers, and zoos.
- Science can be taught anywhere, thus in-service trainings or seminars could be organized for teachers.
- Students should be encouraged to attend summer programs such as summer camps or children's universities.
- Areas in which students are gifted and talented should be identified, and these students should be included in talent development programs.
- The percentage of students gifted in fine arts is low in Science and Art Centers. Artists and academics of fine arts should visit these centers. Students gifted in fine arts should be identified.
- Due to the low number of students that were identified as gifted in fine arts, they were evaluated with those gifted in social sciences. It is possible to determine adequate numbers of students gifted in fine arts, and to conduct a study to compare scientific literacy levels among students from all areas of giftedness.
- Action plans should be developed to enhance science literacy among gifted and talented students. These action plans may focus on increasing the number of science camps and children's universities, on developing and following profiles of all gifted students.
- There should be increased number of tools that measure scientific literacy on an integral basis.
- Out-of-school learning environments should be extended to the every corner of the country. Informal science education environments such as science centers, zoos, and planetariums should be opened in metropolises in Eastern Anatolia, in particular.

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