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Scientific imagination of gifted and non-gifted middle school students

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ABSTRACT
In this study, it is aimed to examine the scientific imagination of gifted and non-gifted 5th and 8th grade students. For this purpose, the study was carried out with 12 students including 3 gifted and 3 non-gifted students at both grade levels. The data of the study were collected with the instruments named "draw scientific imagination" and "explain scientific imagination". The results of the study revealed that gifted students had higher scientific imagination scores than non-gifted students at both levels, and 8th grade gifted students had more scientific imagination scores than 5th grade gifted students. In all sub-dimensions of scientific imagination, gifted students score more than non-gifted students. Non-gifted 8th grade students have lower scientific creativity scores than 5th grade students. In other sub-dimensions, 8th grade non-gifted students have higher scores than 5th grade students. It may be suggested that school programs should be supported by activities that develop scientific imagination so that the scientific imaginations of non-gifted students do not go backwards after the 5th grade. It may be recommended that additional programs applied to gifted students should be extended to non-gifted students.

Keywords: Scientific imagination, scientific creativity, scientific sensitivity.

INTRODUCTION

Imagination has a huge impact on human thinking, speaking and life experiences. It is always the imagination that people discover the world and the universe they live in, find solutions to problems, pursue their interests, take measures against future situations, and make plans (Farah & Ayoubi, 2020; Wang, Ho, & Cheng, 2015). When a human being encounters an unknown situation, he can use his imagination to make progress. When this imagination is used for scientific studies, new scientific discoveries may emerge. The basis of scientific discoveries is the use of a rich imagination (Ho, Wang, & Cheng, 2013). Scientists use imagination and creativity at every stage of the discovery process while doing research. Similarly, the students use their creativity and imagination in their research activities (Ozdemir & Dikici, 2017). The most important characteristic of creative individuals is that they have strong imagination. Imagination plays a very important role in creativity (LeBoutiller & Marks, 2003).

SCIENTIFIC IMAGINATION

Scientific imagination is the creative thinking ability that emerge to solve problems by combining scientific concepts, phenomena, experiences and scientific knowledge with feelings and emotions (Egan, 1992; Warnock, 1977; White, 1990). Scientific imagination is a purposive process and a mental activity aimed at creating new ideas. This mental activity cannot be prevented by any rules and current modes of thought (Wang, Ho, Wu, & Cheng, 2014). In their study, Mun, Mun, and Kim (2015) discussed scientific imagination in three dimensions: scientific sensitivity, scientific creativity, and scientific productivity. In this study, these three dimensions were adopted as scientific imagination criteria.

Scientific sensitivity refers to the driving force that allows students to imagine. It encourages students to engage in imaginative activities using scientific concepts, knowledge, and phenomena. The sub-dimensions of scientific sensitivity are 'emotional understanding' and 'experience of imagining'. The emotional understanding is the ability to understand scientific concepts and phenomena by including emotions in the learning process in addition to reasoning mechanisms. Scientific imaginations are closely related to the feelings and emotions of human beings. The experience of imagining is to build unusual and extreme imaginations about scientific topics. These are often unusual and extreme scientific imaginations that seem to be far from reality (Mun et al., 2015).

Scientific creativity is expressed as the stage in which students use their imagination. Imagination and creativity are often closely related and increase each other's value (Ren et al., 2012). According to Torrence (1990), fluency, flexibility, and original thinking are central to creativity. According to Hu and Adey (2002), these

characteristics of general creativity can be called scientific creativity when combined with scientific problems, experiments, activities, scientific knowledge, and skills. Fluency is about generating more than one idea about a subject. Scientifically creative people can come up with many ideas in solving scientific problems. For example, scientifically creative people can imagine the use of a brick in more than one area (Hu & Adey, 2002). Flexibility is to produce different ideas about the same stimulus and to use different approaches. The more ideas can look at the solution of a problem from different perspectives, the greater the flexibility is (Hu & Adey, 2002). Students with very low level of flexibility think with fixed patterns and cannot go out of these patterns. Students with a high level of flexibility can change their perspectives and produce solutions out of existing patterns. Originality includes the ability to produce new and rare ideas. The idea that is produced is as original as the less people can think of (Hu & Adey, 2002). Original ideas are the ideas that have not yet been discovered and are waiting to come to light. Scientifically creative people are expected to produce original and rare ideas on scientific issues. The criteria of fluency and flexibility for scientific creativity presented by Hu and Adey (2002) were unified as one category and categorized as diversity by Mun et al. (2015). In this study, the scientific creativity criteria are considered as fluency, flexibility, and originality expressed by Hu and Adey (2002).

Scientific productivity is the stage of transforming scientific imaginations into new products. This stage separates the scientific imagination from fantasies. Scientific productivity can be expressed as the ability to produce new ideas. Mun et al. (2015), divided scientific productivity into two sub-dimensions. These are "creation and reproduction" and "scientific sense of reality". In this study, the title of creation and reproduction is considered as two separate titles, namely scientific productivity is divided into three sub-dimensions. These dimensions are described as follows with reference to Mun et al. (2015).

Creation; scientific imagination becomes more meaningful if it is used to produce something new. The step of creation envisages the original product being built from scratch. At this stage, a new object or a new method can be introduced.

Reproduction; this stage is the redesign of existing objects or methods, and the rebuilt of them with contribution of originality.

Scientific sense of reality; it is the stage of deciding whether things can be actualized or not. Is there really the equivalent of an imagination? This question points to the difference between scientific imagination and fantasy. Scientific imagination should be able to help determine whether imagination can be actualized through scientific sense of reality based on scientific knowledge.

GIFTEDNESS AND SCIENTIFIC IMAGINATION

Giftedness, unlike peers, is about creating something special. Gifted students, who have a combination of creativity, motivation, and mental superiority, have different characteristics from their normal peers (Ogurlu, Kahraman, & Kayaalp, 2021). When the historical development is examined, it is seen that the concept of gifted starts with gifted intelligence. For example, Terman (1925) used the intelligence test to identify the gifted students. The concept of gifted individual, which is determined by tests that measure mathematical reasoning, has expanded over time to include superiority in areas other than mathematical reasoning. With the work of Torrance in the 1960s, creativity was added to the concept of gifted. After Torrance, creativity has become the most important component in identifying gifted students (Şengil-Akar, 2017). Recent research suggests that creativity in giftedness is a key concept and that creativity must be taken into account in the assessment of gifted people (Kim, Roh, & Cho, 2016). Gagne (2005) considers the concept of gifted as an individual with a special ability above the norms of society in at least one area. The three-ring model of giftedness put forward by Renzulli (1986) for the concept of gifted, which includes the definitions of Torrance and Gagne, is in the shape of a venn diagram consisting of three clusters that intersects with each other and called as 1-aptitude above average, 2-creativity, and 3- motivation. Giftedness is a characteristic that is unique to a particular area. When this particular area is considered as science, giftedness becomes the expression of scientific giftedness (Şengil-Akar, 2017). Gifted students have curiosity and motivation towards scientific issues. These students ask open-ended questions by observing their environment through scientific processes, explore scientific events, and become interested in any scientific discipline (Camci-Erdogan, 2019). Considering the characteristics of giftedness and scientific imagination, it can be foreseen that scientifically gifted students should have more characteristics of scientific imagination.

RESEARCH PROBLEM

In this research the answer to the following question was sought:

1- What is the difference between the scientific imagination of gifted and non-gifted students at grade 5 and 8?
2- What is the difference between the scientific imagination of gifted students at grade 5 and 8?
3- What is the difference between the scientific imagination of non-gifted students at grade 5 and 8?

RESEARCH FOCUS

This study focuses on comparing the scientific imaginations of fifth and eighth grade students and comparing the scientific imaginations of gifted and non-gifted students at both grade levels.

RESEARCH AIM AND RESEARCH QUESTIONS

In this research, the scientific imagination test was created by synthesizing the "Scientific Creativity Test" developed by Hu & Adey (2002) and the "Scientific Imagination Inventory" developed by Mun et al. (2015). A similar study to this research was conducted by Mun et al (2015) in Korea 4-8. class students. Mun et al (2015) conducted their studies with 662 non-gifted students. Mun et al (2015), which is the only study in the literature similar to this study, did not include gifted students in their study. In this study, it is important in terms of investigating whether giftedness is an effective feature in terms of scientific imagination. In this research, it is aimed to examine the scientific imagination of gifted and non-gifted 5th and 8th grade students.

RESEARCH METHODOLOGY

General Background

This research was designed as a comparative case study to determine the scientific imagination of gifted and non-gifted students. Comparative case studies involve the analysis and synthesis of the similarities, differences and patterns across two or more cases that share a common focus or goal in a way that produces knowledge that is easier to generalize about causal questions – how and why particular programmes or policies work or fail to work (Goodrick, 2014). In this research, scientific imaginations of 3 gifted and 3 three non-gifted from fifth grade that is the first grade at middle schools in Turkey and 3 gifted and 3 three non-gifted from eighth grade that is the last grade at middle schools in Turkey are compared.

Sample / Participants / Group

This research was conducted in 2017 in Konya Meram Science and Art Center with middle school students. The gifted students included in the study were identified by the experts in charge of the Ministry of National Education and diagnosed as gifted. These students are given support training outside the school time at the center called BİLSEM (Okulu, Oguz-Unver, & Arabacioglu, 2019). The gifted and non-gifted students in the research are studying at the same school. The study was carried out with a total of 12 students attending 5th and 8th grades (3 gifted and 3 non-gifted students from each grade level) and determined by convenience sampling method on a voluntary basis.

Instrument and Procedures

Draw Scientific Imagination Document (DSID). Students were given three different A4 sheets of paper to answer by drawing the following three questions. Students were asked to draw on one side of each of these papers. While forming the questions in the draw scientific imagination document, studies on creative thinking and scientific imagination in the literature, especially Hu and Adey (2002) and Mun et al. (2015), were taken as basis. After the questions were formed, the opinions of two proficient faculty members in the field of gifted education and two proficient faculty members in the field of science education were obtained and the questions were finalized. The questions posed to the students are given below.

1- Question 1 (Q1): How do you think our world would be like if there was no gravitational force?

2- Question 2 (Q2): How do you think our world would be like if the sun disappeared at once?

3- Question 3 (Q3): Imagine that you are a person who traveling on a spaceship. During this journey you discovered a new planet. What kind of planet do you think this planet is?

Explain Scientific Imagination Document (ESID). The backside of the white papers that were used as draw scientific imagination document was used as explain scientific imagination document. In this document, students were asked to explain their drawings that they drew on the draw scientific imagination document to answer the three given questions.

Reliability and Validity

Expert opinion was sought for the validity of the study. A total of four faculty members, two science educators and two special educators who were experts in their fields, were consulted to determine whether the questions were appropriate to the level of the group and to measure scientific imagination of the group.

In this research, student drawings in the “draw scientific imagination” document were evaluated by a total of three different science teachers including the researcher. Without knowing which students the papers belong to, the raters scored the papers, which were given in a mixed way, one by one and independently of each other by referring to the Scientific Imagination Scoring Table. Pearson Correlation analysis was performed to determine the correlation between the scorings of different raters and the correlation coefficient between raters was calculated. Since each student in two groups received 3 activity sheets, a total of 36 activity sheets were scored by the raters. The correlation coefficient between rater 1 and rater 2 was 0.91 ($n = 36$, $p < 0.05$), and the

correlation coefficient between rater 1 and rater 3 was 0.86 (n = 36, p <0.05). These results indicate that the researcher's (Rater 1) scoring is significantly correlated with the other raters' scorings. Therefore, the researcher's scoring was taken as the basis for the analysis of the data. In the explain scientific imagination document, some of the explanations written by the students were analyzed in two different time periods and the consistency between the two was examined. After obtaining expert opinion that the analyses are consistent, the analysis process of the "explain scientific dream" document was completed.

Data Analysis

The data obtained from the study were analyzed by document analysis method. The data obtained from the documents were described according to predetermined criteria and the descriptions were supported with visual or verbal quotations. The "draw scientific imagination" document was analyzed according to the previously created categories.

Draw scientific dream document was analyzed by scoring according to criteria of scientific creativity (fluency, flexibility, and originality), scientific productivity (scientific reality, creation, derivation), scientific sensitivity (emotional understanding, imagination experience). Data were interpreted according to the findings. Scientific Imagination Scoring Table was used in the analysis of the data. While creating the scoring table, scoring system created by Hu & Adey (2002) for scientific creativity was used in scientific creativity that is a sub-dimension of scientific imagination. The scientific sensitivity criterion is taken from Mun et al. (2015). The main idea of the scientific productivity criterion is again taken from Mun et al. (2015), but in this section their description of creation and derivation were divided into two categories. The scientific productivity described by Mun et al. (2015) as two categories were transformed into three categories as scientific reality, creation, and derivation.

The opinions of two science education faculties who have previously worked in the field of scientific creativity and a special educator faculty who has studies in the field of thinking skills have been taken as to whether the scoring table will measure the scientific imagination. Scientific Imagination Scoring Table which is shaped by literature and expert opinions is given in table 1 below.

Table 1: Scientific Imagination Scoring Table

		SCIENTIFIC CREATIVITY			SCIENTIFIC SENSITIVITY		SCIENTIFIC PRODUCTIVITY		
	SUB-CONTENT	FLUENCY	FLEXIBILITY	ORIGINALITY	EMOTIONAL UNDERSTANDING	IMAGINATION EXPERIENCE	SCIENTIFIC REALITY	CREATION	DERIVATION
Question 1 How do you think our world would be like if there was no gravitational force?	Scientific Imagination	+1 point for each answer produced	+1 point for each proposed alternative answer 1. Living things 2. General life and physics laws 3. Planet and nature 4. Human and life 5. Social life 6.Transportation, vehicles and inventions	+2 points for answer encountered in less than 5% (less than 2 people) +1 point for answer encountered in less than 5% to 10% (2 to 3 people)	+1 point for each individual feeling used 1. Happiness 2. Sadness 3. Enthusiasm 4. Passion 5. Hope 6. Fear	+1 point for every different thought about far-from-reality phenomena 1. Thinking something that exists as if it does not 2. Thinking something that does not exist as if it does 3. Treating a certain thing as if it were human 4. Considering a certain object as human 5. Thinking Unconventionally the overall process of production	+1 point for situations where the things they imagined are actually possible	+1 point for asset usage that has never been seen before	+1 point for the use of a new asset by combining or fragmenting existing assets
Question 2 How do you think our world would be like if the sun disappeared at once?	Scientific Imagination	+1 point for each answer produced	+1 point for each proposed alternative answer 1. Living things 2. General life and physics laws 3. Planet and nature 4. Human and life 5. Social life 6.Transportation, vehicles and inventions	+2 points for answer encountered in less than 5% (less than 2 people) +1 point for answer encountered in less than 5% to 10% (2 to 3 people)	+1 point for each individual feeling used 1. Happiness 2. Sadness 3. Enthusiasm 4. Passion 5. Hope 6. Fear	+1 point for every different thought about far-from-reality phenomena 1. Thinking something that exists as if it does not 2. Thinking something that does not exist as if it does 3. Treating a certain thing as if it were human 4. Considering a certain object as human 5. Thinking Unconventionally the overall process of production	+1 point for situations where the things they imagined are actually possible	+1 point for asset usage that has never been seen before	+1 point for the use of a new asset by combining or fragmenting existing assets
Question 3 Imagine that you are a person traveling on a spaceship. During this journey you discovered a new planet. What kind of planet do you think this planet is?	Scientific Imagination	+1 point for each answer produced	+1 point for each proposed alternative answer 1. Planet history 2.Structure of the planet 3.Aliens 4.Utilization 5.Living space	+2 points for answer encountered in less than 5% (less than 2 people) +1 point for answer encountered in less than 5% to 10% (2 to 3 people)	+1 point for each individual feeling used 1. Happiness 2. Sadness 3. Enthusiasm 4. Passion 5. Hope 6. Fear	+1 point for every different thought about far-from-reality phenomena 1. Thinking something that exists as if it does not 2. Thinking something that does not exist as if it does 3. Treating a certain thing as if it were human 4. Considering a certain object as human 5. Thinking Unconventionally the overall process of production	+1 point for situations where the things they imagined are actually possible	+1 point for asset usage that has never been seen before	+1 point for the use of a new asset by combining or fragmenting existing assets

RESEARCH RESULTS

In this section, the scientific imagination scores of the students participating in the research according to the criteria in the Scientific Imagination Scoring Table are tabulated. Then, the quotations from the Draw Scientific Imagination Document and Explain Scientific Imagination Document are given.

Scientific Imagination of 5th Grade Students

In this section, the scores obtained from the drawings made by gifted and non-gifted 5th grade students according to Q1, Q2, and Q3 are presented in tables. The scores of gifted fifth grade students on the scientific imagination and its sub-dimensions are given in table 2.

Table 2: Scientific Imagination Scorings of Gifted 5th Grade Students

Gifted 5th Grade Students			Student 1			Student 2			Student 3			
			Q 1	Q 2	Q 3	Q 1	Q 2	Q 3	Q 1	Q 2	Q 3	Total
SCIENTIFIC IMAGINATION	Scientific creativity	Fluency	11	17	12	14	26	12	9	23	7	131
		Flexibility	4	4	4	5	5	2	3	4	3	34
		Originality	0	0	6	2	2	4	0	8	2	24
		Q score	15	21	22	21	33	18	12	35	12	189
		Scientific creativity sub-dimension scores	58			72			59			189
	Scientific sensitivity	Emotional understanding	3	3	3	3	3	1	3	2	2	23
		Imagination experience	2	3	4	4	3	3	2	2	4	27
		Q score	5	6	7	7	6	4	5	4	6	50
		Scientific sensitivity sub-dimension scores	18			17			15			50
	Scientific productivity	Scientific reality	4	1	2	8	7	3	1	4	2	32
		Creation	2	0	3	1	0	0	0	0	2	8
		Derivation	0	0	1	0	0	1	0	0	0	2
		Q score	6	1	6	9	7	4	1	4	4	42
		Scientific productivity sub-dimension scores	13			20			9			42
	Total Q score		26	28	35	37	46	26	18	43	22	281
	Sub-dimension total score		89			109			83			281

When table 2 is examined, gifted 5th grade students received 131 points in fluency, 34 points in flexibility, and 24 points in originality and three students received a total of 189 points in scientific creativity; 23 points in emotional understanding and 27 points in imagination experience and three students received a total of 50 points in scientific sensitivity; and 32 points in scientific reality, 8 points in creation, and 2 points in derivation and three students received a total of 42 in scientific productivity. The highest scientific imagination score of the gifted 5th grade students was 109 and the lowest score was 83. The total scientific imagination score of three gifted students is 281. Scientific imagination scores of non-gifted 5th grade students are given in table 3.

Table 3: Scientific Imagination Scorings of Non-Gifted 5th Grade Students

Gifted 5th Grade Students			Student 1			Student 2			Student 3			
			Q 1	Q 2	Q 3	Q 1	Q 2	Q 3	Q 1	Q 2	Q 3	Total
SCIENTIFIC IMAGINATION	Scientific creativity	Fluency	6	13	14	8	4	5	6	16	7	79
		Flexibility	3	4	4	3	1	2	3	3	1	24
		Originality	4	1	2	0	0	2	0	0	2	11
		Q score	13	18	20	11	5	9	9	19	10	114
		Scientific creativity sub-dimension scores	51			25			38			114
	Scientific sensitivity	Emotional understanding	1	2	1	2	1	0	2	2	1	12
		Imagination experience	1	2	4	1	1	1	1	2	2	15
		Q score	2	4	5	3	2	1	3	4	3	27
		Scientific sensitivity sub-dimension scores	11			6			10			27
	Scientific productivity	Scientific reality	2	1	2	1	1	3	1	1	2	14
		Creation	0	0	1	0	0	1	0	0	1	3
		Derivation	0	0	0	0	0	1	0	0	0	1
		Q score	2	1	3	1	1	5	1	1	3	18
		Scientificproductivity sub-dimension scores	6			7			5			18
	Total Q score		17	23	28	15	8	15	13	24	16	159

	Sub-dimension total score	68	38	53	159

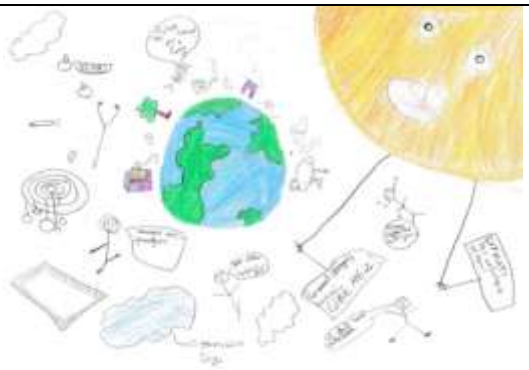
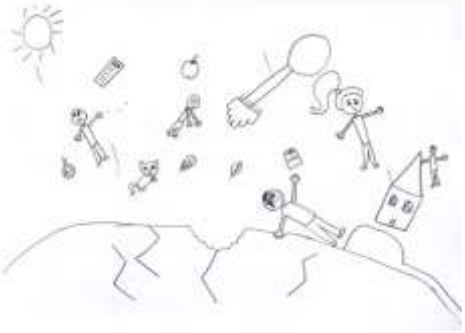
When table 3 is examined, it is observed that non-gifted 5th grade students received 79 points in fluency, 24 points in flexibility, and 11 points in originality and three students received a total of 114 points in scientific creativity; 12 points in emotional understanding and 15 points in imagination experience and three students received a total of 27 in scientific sensitivity; and 14 points in scientific reality, 3 points in creation, and 1 point in derivation and three students received a total of 18 points in scientific productivity. The highest scientific imagination score of non-gifted 5th grade students is 68 points and the lowest score was 38 points. The total scientific imagination score of three non-gifted students is 159.

Scientific imagination of gifted and non-gifted fifth grade students for Q1

The first gifted student (G1) received 26 scientific imagination points on the Q1, while second student (G2) received 37 and third student (G3) received 18 (see Table 2). The total scientific imagination points of gifted students on the Q1 were 81. The first non-gifted student (N1) received 17 scientific imagination points on the Q1, while second student (N2) received 15 and third student (N3) received 13 (see Table 3). The total scientific imagination points of non-gifted students on the Q1 were 45.

At the 5th grade level, the drawings of the gifted (G1) and non-gifted student (N1) in the draw scientific imagination document and their explanations in the Explain Scientific Imagination Document for the Q1 are given below.

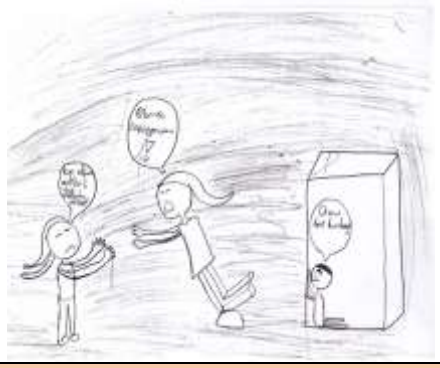
Table 4: DSID Drawings and ESID Explanations for the Q1 of Gifted and Non-Gifted 5th Grade Students

	
Drawing of G1 from 5th grade on Q1(DSID-G1.1)	Drawing of N1 from 5th grade on Q1(DSID-N1.1)
Nothing could stand on the ground. Thus, there would be no frictional force. We couldn't walk, we couldn't write, we wouldn't need toilets, we wouldn't take a bath, we couldn't wash our hands, we'd sleep but it would be a little hard. Everyone in the picture I drew is in a hurry and fear. There's gravity right now, and I don't think it will ever disappear again. (ESID-G1.1)	Blood from our wounds would fly, everyone would find themselves in the sky, land would be removed from the ground, garbage would pollute the air, it would negatively affect human life. Briefly, it would be a problem. (ESID-N1.1)

Scientific imagination of gifted and non-gifted fifth grade students for Q2

The first gifted student (G1) received 28 scientific imagination points on the Q2, while second student (G2) received 46 and third student (G3) received 43 (see Table 2). The total scientific imagination points of gifted students on the Q2 were 117. The first non-gifted student (N1) received 23 scientific imagination points on the Q2, while second student (N2) received 8 and third student (N3) received 24 (see Table 3). The total scientific imagination points of non-gifted students on the Q2 were 55. At the 5th grade level, the drawings of the gifted (G2) and non-gifted student (N2) in the draw scientific imagination document and their explanations in the Explain Scientific Imagination Document for the Q2 are given below.

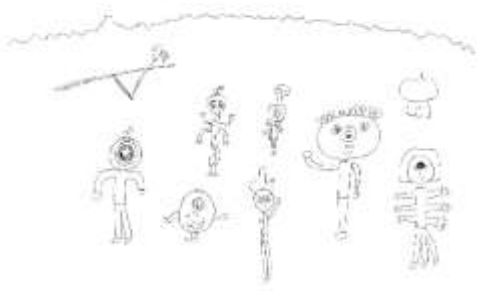
Table 5: DSID Drawings and ESID Explanations for the Q2 of Gifted and Non-Gifted 5th Grade Students

	
Drawing of G2 from 5th grade on Q2(DSID-G2.2)	Drawing of N2 from 5th grade on Q2(DSID-N2.2)
I think our world would be uninhabitable. Very bad things would happen. For example, as I have done in the picture, we could fall on a stone because the place was dark and the person who was in a closed area would remain closed while the sun was disappearing. This is a terrible thing. (ESID-G2.2)	Without the sun, it would be dark. No sun. Life wouldn't be good. Flowers would fade. (ESID-N2.2)

Scientific imagination of gifted and non-gifted fifth grade students for Q3

The first gifted student (G1) received 35 scientific imagination points on the Q3, while second student (G2) received 26 and third student (G3) received 22 (see Table2). The total scientific imagination points of gifted students on the Q3 were 83. The first non-gifted student (N1) received 28 scientific imagination points on the Q3, while second student (N2) received 15 and third student (N3) received 16 (see Table 3). The total scientific imagination points of non-gifted students on the Q3 were 59. At the 5th grade level, the drawings of the gifted (G3) and non-gifted student (N3) in the draw scientific imagination document and their explanations in the Explain Scientific Imagination Document for the Q3 are given below.

Table 6: DSID Drawings and ESID Explanations for the Q3 of Gifted and Non-Gifted 5th Grade Students

	
Drawing of G3 from 5th grade on Q3 (DSID-G3.3)	Drawing of N3 from 5th grade on Q3 (DSID-N3.3)
My planet would be round, there would be an oxygen machine and oxygen wouldn't be exhausted. There would be six-eyed "i" monsters (who say "i" at the end of each word) and gold or other resources wouldn't be exhausted on this planet. (ESID-G3.3)	Its name would be Uzanus. There would be different living things. The planet itself has been there for 100 years. Food wouldn't grow. (ESID-N3.3)

Scientific Imagination of 8th Grade Students

In this section, the scores obtained from the drawings made by gifted and non-gifted 8th grade students according to Q1, Q2, and Q3 are presented in tables. The scores of gifted eighth grade students on the scientific imagination and its sub-dimensions are given in table 7.

Table 7: Scientific Imagination Scorings of Gifted 8th Grade Students

Gifted 5th Grade Students			Student 4			Student 5			Student 6			
			Q 1	Q 2	Q 3	Q 1	Q 2	Q 3	Q 1	Q 2	Q 3	Total
SCIENTIFIC IMAGINATION	Scientific creativity	Fluency	12	26	17	12	23	19	11	29	22	171
		Flexibility	4	6	5	6	6	4	4	6	5	46
		Originality	2	4	9	6	6	0	0	6	14	47
		Q score	18	36	31	24	35	23	15	41	41	264
		Scientific creativity sub-dimension scores	85			82			97			264
	Scientific sensitivity	Emotional understanding	3	6	0	3	3	3	2	4	2	26
		Imagination experience	2	3	4	3	3	4	2	3	22	46
		Q score	5	9	4	6	6	7	4	7	24	72
		Scientific sensitivity sub-dimension scores	18			19			35			72
	Scientific productivity	Scientific reality	6	3	3	3	3	0	5	8	8	39
		Creation	0	4	2	4	2	3	0	1	3	19
		Derivation	0	3	0	1	5	3	0	1	1	14
		Q score	6	10	5	8	10	6	5	10	12	72
		Scientific productivity sub-dimension scores	21			24			27			72
	Total Q score		29	55	40	38	51	36	24	58	77	408
	Sub-dimension total score		124			125			159			408

When table 7 is examined, gifted 8th grade students received 171 points in fluency, 46 points in flexibility, and 47 points in originality and three students received a total of 264 points in scientific creativity; 26 points in emotional understanding and 46 points in imagination experience and three students received a total of 72 points in scientific sensitivity; and 39 points in scientific reality, 19 points in creation, and 14 points in derivation and three students received a total of 72 in scientific productivity. The highest scientific imagination score of the gifted 8th grade students was 159 and the lowest score was 124. The total scientific imagination score of three gifted students is 408. Scientific imagination scores of non-gifted 8th grade students are given in table 8.

Table 8: Scientific Imagination Scorings of Non-Gifted 8th Grade Students

Gifted 5th Grade Students			Student 4			Student 5			Student 6			
			Q 1	Q 2	Q 3	Q 1	Q 2	Q 3	Q 1	Q 2	Q 3	Total
SCIENTIFIC IMAGINATION	Scientific creativity	Fluency	8	9	6	9	9	9	7	12	7	76
		Flexibility	1	3	3	2	3	3	2	5	2	24
		Originality	0	0	0	2	0	0	0	3	0	5
		Q score	9	12	9	13	12	12	9	20	9	105
		Scientific creativity sub-dimension scores	30			37			38			105
	Scientific sensitivity	Emotional understanding	1	1	0	1	0	0	2	2	1	8
		Imagination experience	1	3	5	1	2	2	2	3	3	22
		Q score	2	4	5	2	2	2	4	5	4	30
		Scientific sensitivity sub-dimension scores	11			6			13			30
	Scientific productivity	Scientific reality	2	1	1	3	1	5	1	2	4	20
		Creation	2	0	6	0	0	3	1	0	1	13
		Derivation	0	0	1	0	0	2	1	0	0	4
		Q score	4	1	8	3	1	10	3	2	5	37
		Scientific productivity sub-dimension scores	13			14			10			37

	Total Q score	15	17	22	18	15	24	16	27	18	172
	Sub-dimension total score	54			57			61			172

When table 8 is examined, it is observed that non-gifted 8th grade students received 76 points in fluency, 24 points in flexibility, and 5 points in originality and three students received a total of 105 points in scientific creativity; 8 points in emotional understanding and 22 points in imagination experience and three students received a total of 30 in scientific sensitivity; and 20 points in scientific reality, 13 points in creation, and 4 point in derivation and three students received a total of 37 points in scientific productivity. The highest scientific imagination score of non-gifted 8th grade students is 61 points and the lowest score was 54 points. The total scientific imagination score of three non-gifted students is 172.

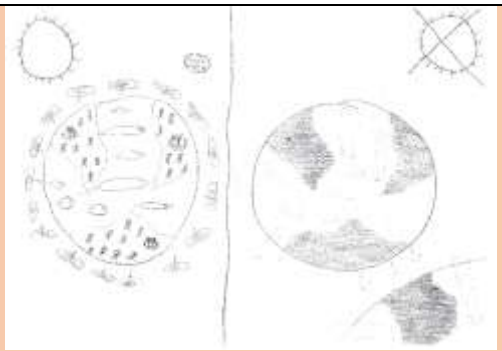
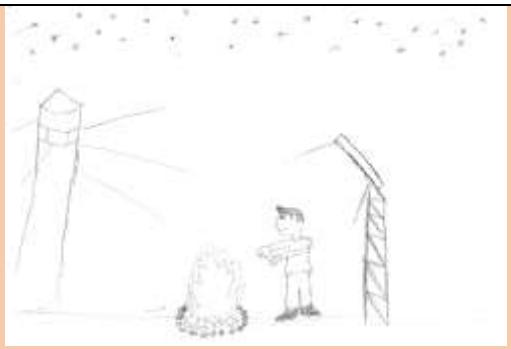
Scientific imagination of gifted and non-gifted eighth grade students for Q1
The first gifted student (G4) received 29 scientific imagination points on the Q1, while second student (G5) received 38 and third student (G6) received 24 (see Table 7). The total scientific imagination points of gifted students on the Q1 were 91. The first non-gifted student (N4) received 15 scientific imagination points on the Q1, while second student (N5) received 18, and third student (N6) received 16 (see Table 8). The total scientific imagination points of non-gifted students on the Q1 were 49. At the 8th grade level, the drawings of the gifted (G4) and non-gifted student (N4) in the draw scientific imagination document and their explanations in the Explain Scientific Imagination Document for the Q1 are given below.

Table 9: DSID Drawings and ESID Explanations for the Q1 of Gifted and Non-Gifted 8th Grade Students

	
Drawing of G4 from 8th grade on Q1 (DSID-G4.1)	Drawing of N4 from 8th grade on Q1 (DSID-N4.1)
Even polar bears would fly. Maybe the couple who never met, penguin and polar bear would meet. The ships would overflow the oceans together. Volcanoes would flush automatically from the volcanic mountains. Leaning tower of Pisa would either be corrected or already broken. Bullets could slow down. The layers of Earth, the ones on the surface would be tore. The fish would fly. We couldn't play SMT 1 with my friend because we couldn't throw an eraser. The oceans would overflow, and the sun would go out. Rain forests would lose their names because it wouldn't rain. The clouds would disappear. They would never be formed. The air would disappear in the universe. Messi couldn't hit the ball. He'd lose his job. The satellites would go farther away from the orbit. They couldn't send a signal. The Netherlands could have avoided flooding. (ESID-G4.1)	I did this picture to show that without gravity it is almost impossible to do the easiest jobs we could do when there is gravity (ESID-N4.1).

Scientific imagination of gifted and non-gifted eighth grade students for Q2
The first gifted student (G4) received 55 scientific imagination points on the Q2, while second student (G5) received 51 and third student (G6) received 58 (see Table 7). The total scientific imagination points of gifted students on the Q2 were 164. The first non-gifted student (N4) received 17 scientific imagination points on the Q2, while second student (N5) received 15 and third student (N6) received 27 (see Table 8). The total scientific imagination points of non-gifted students on the Q2 were 59. At the 8th grade level, the drawings of the gifted (G5) and non-gifted student (N5) in the draw scientific imagination document and their explanations in the Explain Scientific Imagination Document for the Q2 are given below.

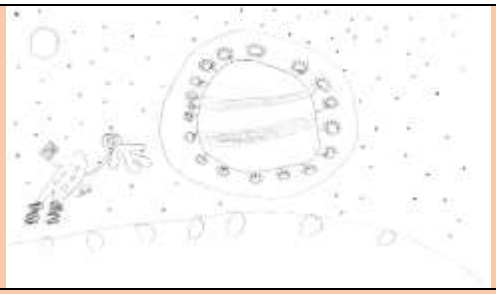
Table 10: DSID Drawings and ESID Explanations for the Q2 of Gifted and Non-Gifted 8th Grade Students

	
Drawing of G5 from 8th grade on Q2 (DSID-G5.2)	Drawing of N5 from 8th grade on Q2 (DSID-N5.2)
Glaciers formed in the oceans. There would be no water to drink. It would be always dark because there would be no light. Living things on land and water would not survive. Since the Sun had no gravitational force, we would be dragged in the space. There would not be man-made satellites orbiting the Earth and our natural satellite, the moon. (ESID-G5.2)	Everywhere would be dark, there would be no moon, the lights stay on all the time, there would be fires in certain areas (to warm up), and electricity bills in the world would be very high. (ESID-N5.2)

Scientific imagination of gifted and non-gifted eighth grade students for Q3

The first gifted student (G4) received 40 scientific imagination points on the Q3, while second student (G5) received 36 and third student (G6) received 77 (see Table 7). The total scientific imagination points of gifted students on the Q3 were 153. The first non-gifted student (N4) received 22 scientific imagination points on the Q3, while second student (N5) received 24 and third student (N6) received 18 (see Table 8). The total scientific imagination points of non-gifted students on the Q3 were 64. At the 8th grade level, the drawings of the gifted (G6) and non-gifted student (N6) in the draw scientific imagination document and their explanations in the Explain Scientific Imagination Document for the Q3 are given below.

Table 11: DSID Drawings and ESID Explanations for the Q3 of Gifted and Non-Gifted 8th Grade Students

	
Drawing of G6 from 8th grade on Q3 (DSID-G6.3)	Drawing of N6 from 8th grade on Q3 (DSID-N6.3)
Its color is red and white. No water. ZEPKE star is born here from the west. In the 2nd picture, KULUT winds here work from the north side of the planet. It is both strong and untimely. The winds create grooves and cracks on the surface of the planet. A six thousand-year-old planet. Since it was newly formed, the days are on average of 49 hours 26 minutes 35 seconds. Every year it goes down for a few seconds. Those gases make up the air. Component X (54%) is a compound that has never been seen in the world. When burned, the energy it generates is seven times the oxygen. Helium gas, which is released in the air, is the energy source of the "tiknos" creatures hanging in the air that do not resemble plant and animal characteristics. At the same time, TİKNOS creatures produce their own food by taking light from ZEPKE star which is in orbit similar to the photosynthesis of plants. (ESID-G6.3)	This planet is an enclosed planet with 2 streams flowing through and have plants near them. (ESID-N6.3)

Comparison of scientific imagination of 5th and 8th grade gifted and non-gifted students
In Turkey, students in middle school begin taking science class in the 5th grade and keep taking it 4 hours per week until the end of 8th grade each year. Therefore, entry and exit points are given in table 12 comparatively.

Table 12: Scientific Imagination Scorings of Gifted and Non-Gifted Students by Grade Level

	Grade level			
Scientific imagination sub-dimensions	5th grade gifted	5th grade non-gifted	8th grade gifted	8th grade non-gifted
Fluency	131	79	171	76
Flexibility	34	24	46	24
Originality	24	11	47	5
Sub total (Scientific creativity)	189	114	264	105
Emotional understanding	23	12	26	8
Imagination experience	27	15	46	22
Sub total (Scientific Sensitivity)	50	27	72	30
Scientific reality	32	14	39	20
Creation	8	3	19	13
Derivation	2	1	14	4
Sub total (Scientific productivity)	42	18	72	37
Total (Scientific imagination)	281	159	408	172

When the scientific imagination scores of both gifted and non-gifted students are examined, it is seen that the scientific imagination scores of 8th grade students increase. At the same time, 5th grade gifted students have higher scientific imagination scores than 8th grade non-gifted students. 8th grade gifted students received higher scores on all sub-dimensions of the scientific imagination than 5th grade gifted students. This does not apply to non-gifted students. 5th grade non-gifted students have higher scientific creativity scores than 8th grade non-gifted students. In terms of the sub-dimensions of scientific sensitivity and scientific productivity, 8th grade non-gifted students have higher scores than 5th grade non-gifted students.

DISCUSSION

The aim of this research was to examine the scientific imagination of 5th and 8th grade gifted and non-gifted students. In this study, it was found that 5th and 8th grade gifted students had higher scientific imagination scores than non-gifted students. Yıldız, Baltacı, Kurak, and Güven (2012), in their study which they examined problem-solving strategies of 8th grade gifted and non-gifted students, revealed that there are differences between gifted and non-gifted students in terms of drawing, different perspectives, and using the strategy. These characteristics, which are seen in favor of gifted students at 8th grade, may be one of the reasons why gifted students have higher scientific imagination scores. In this study, it was found that 8th grade gifted students had higher scientific imagination scores than 5th grade gifted students and 8th grade non-gifted students had higher scientific imagination scores than 5th grade non-gifted students. As the grade level of the students increases, their scientific knowledge increases. The increase in scientific knowledge may have led to an increase in students' scientific imagination scores. However, this result is in contradiction with the findings of Wang, Ho, & Cheng (2015) that there is no significant difference between grade level and gender and scientific imagination.
Gifted students had higher scientific imagination scores on all sub-dimensions of Scientific Imagination than non-gifted students. Especially in the scientific creativity sub-dimension, this became more evident. In identifying gifted students, creativity comes into prominence as the most important characteristic (Şengil-Akar, 2017). Creativity also forms the basis of the concept of scientific creativity that forms the scientific imagination. The reason why gifted students had high scientific imagination scores and scientific creativity scores that is the sub-dimension of scientific imagination may be that gifted students are individuals with creativity. This finding supports the findings of Hu and Adey (2002) that scientific creativity increases with age in middle school students. However, this does not apply to non-gifted students. Fifth grade non-gifted students have higher scientific creativity scores than 8th grade non-gifted students. In other words, while the scientific creativity of gifted students increased from 5th grade to 8th grade, there was a decrease in the score of non-gifted students. This is in contradiction with the above findings of Hu and Adey (2002). There was no improvement in the scientific creativity of non-gifted students from 5th grade to 8th grade.

CONCLUSIONS AND IMPLICATIONS

The most important finding of this study emerged in relation to scientific creativity, which is a sub-dimension of scientific imagination. The most striking result of this research is the decrease in scientific creativity among non-gifted students from 5th grade to 8th grade. In other words, the scientific creativity of students who aren't diagnosed with giftedness and do not receive a special education goes backwards.Based on this finding, it can be

suggested to review the education system provided in schools in terms of scientific creativity and imagination. It may be suggested that normal curricula be revised and restructured in a way to develop scientific creativity and imagination.

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