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Research Article

Investigation of relationship between creativity potential and scientific imagination of gifted children and comparing them with their peers

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Abstract

The aim of this study was to examine the relationship between the creativity and scientific imagination of gifted children in early childhood and to find out whether they differ from their typically developing peers. This study was designed in a correlational design, one of the quantitative research types. The research has two study groups. The first one is the group of gifted children determined by the homogeneous sampling method. The second group is the group of typically developing peers of gifted children determined by criterion sampling method. There were 30 children in each group, totaling 60 children aged between 71 months and 79 months. Gifted children are diagnosed using the Wechsler Intelligence Scale for Children (WISC-R) or the Stanford Binet Intelligence Test (IQ 130 and above). Within the scope of the study, data were collected through the Evaluation of Potential Creativity (EPoC) and the Scientific Imagination Inventory. Sample t test, Mann-Whitney U test, eta-square, logistic regression and Pearson correlation method were used to analyze the data obtained. As a result of the study, a significant relationship was found between EPoC sub-dimensions and Scientific Imagination Inventory sub-dimensions in the gifted, typically developing peers and the all group. In addition, significant differences were found between gifted children and their peers in the sub-dimensions of both data collection tools. Moreover, both some constructs from the EPoC sub-dimensions and some constructs from the Scientific Imagination Inventory sub-dimensions were found to be predictive of giftedness. There is no significant difference between the sub-dimensions of the EPoC and scientific imagination inventory sub-dimension scores according to the gender of the children in the gifted and typical development group.

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Introduction

The greatest source of strength of societies is the accumulation of trained and qualified people. It is generally believed that all the outstanding works of societies are created by gifted people with creative skills and imagination (Uzun, 2004). When the development of societies over the centuries from past to present is analyzed, it is understood that the individuals who lead them to move forward are usually among the gifted and talented individuals (Clark, 2013). It is emphasized that gifted individuals have characteristics and competencies such as creativity, productivity, leadership, capacity to understand more than their peers, advanced comprehension and observation (Clark, 2013; Davis et al., 2011). Therefore, gifted children should be given the opportunity to develop their talents and skills. Thus, enabling

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them to use their capacities efficiently is very important both for themselves and for the present and future of their countries (Ayvacı & Bebek, 2019; Cutts & Moseley, 2004).

The 21st century skills defined by organizations such as Partnership for 21st Century Skills (P21), International Society for Technology in Education (ISTE), Assessment and Teaching of 21st Century Skills (ATCS) are the subject of many studies. In general, these skills include learning and innovation skills, media and technology skills, life and career skills, exploratory thinking, communication and collaboration, ways of thinking, ways of working, working tools, creativity and innovation, and digital citizenship (Ananiadou & Claro 2009; Büyükyılmaz, 2022). Many of these skills also fall within the classification of life skills articulated by the World Health Organization (WHO), the United Nations Educational, Scientific, and Cultural Organization (UNESCO), the United Nations Children's Fund (UNICEF) and the Pan American Health Organization (PAHO) (Kaşkaya, 2018). When these skills are examined in depth, it is understood that many of them are related to the concepts of creativity and imagination. Considering the need for differentiation and enrichment in gifted education, 21st century skills and life skills should inevitably be addressed and examined in gifted education (Renzulli, 2012; Renzulli & Reis, 1997).

Imagination

Etymologically, the word imagination derives from the Latin word "imago" meaning image or mental representation. The act of imagining is often used in the sense of visualizing images. Imagination therefore means visualizing or picturing something in the mind (Jagla, 1994). In the dictionary of the Turkish Language Association, "imagination" is defined as "the ability of the mind to create imagination, imagination, imagery, fancy; the power to establish a connection between the elements of past experiences and present experiences; the ability to design an object without the object being in front of us" (TDK, 2023).

Imagination is a natural talent and needs to be developed in order to produce the creations necessary for social progress. Craft (2002) states that imagination can be a prerequisite for creativity. In this context, the individual utilizes his/her imagination in the process of solving a problem encountered in daily life. Individuals who use their imagination are more successful in dealing with life. Because thanks to imagination, which is a mental power, they can produce many designs and solutions for many social problems in their minds, turn them into dreams and test them. In this process, imagination offers the individual the opportunity to test before experience. This gives the individual insight into the risks and possibilities of the solution before implementing it (Aydın, 2022).

Imagination is one of the key skills that distinguishes scientists from others. When coming up with new theories, scientists use the ability to imagine and visualize physical phenomena and then 'play' with possible outcomes. Kim et al. (2009) claimed that scientific imagination greatly influences thinking, especially intuitive thinking in science. Scientific imagination helps scientists to look at nature beyond the existing framework, brings to the fore the reality based on scientific knowledge, and influences the precise goals and topics of the researcher. Curiosity and diverse experiences are the driving force of scientists' imagination (Kaynar, 2018; Kim et al., 2009).

Scientific imagination encompasses scientific knowledge, creativity, creative thinking and productivity. Scientific qualities have a great influence on scientific results and the abilities of scientists. However, since the scientific imagination is part of the general imagination, it bears the characteristics of the general imagination. As a result, scientific imagination is defined as the ability to think creatively to create or solve problems based on an understanding of scientific concepts or phenomena, past experiences and scientific knowledge (Egan, 1992; Kaynar, 2018; Mun et al., 2013; 2015; Warnock, 1977; White, 1990).

Scientific imagination has three characteristics. First of all, it contains the characteristics of the general imagination. Imagination is related to cognitive abilities such as memory and logic (Barrow, 1988; Egan, 1992). Along with these, it affects emotional feelings, it can be aroused under such feelings (Egan, 1992; Warnock, 1977; White, 1990). It is also closely linked to previous experiences (Vygotsky, 2004). Second, scientific imagination is closely linked to creativity. Scientific imagination involves creative reconstruction based on past experiences and scientific knowledge (Warnock, 1977). These features form the basis for new scientific discoveries, as demonstrated by most scientists (Shepard,1988).

Similarly, students who are scientifically imaginative are expected to come up with original and creative ideas. Finally, the scientific imagination is different from fiction in that it has generative properties and is used powerfully when creating something new. In addition, one's sense of reality must be generally consistent with reality based on newly acquired scientific knowledge as a result of scientific imagination (Kaynar, 2018; Mun et al., 2013; 2015).

Creativity

When the research on creativity is examined, it is seen that there are many definitions that look at creativity from different perspectives. The concept of creativity in Western languages is "kreativitaet, creativity". It comes from the Latin word "creare". This word means "to give birth, to create, to bring into being" (San & Güleryüz, 2004).

According to Torrance and Myers (1970), creativity is the ability of a person to adapt to a new situation and create a unique and constructive way to adapt to the new situation. Guilford (1987), who has important studies in this field, considers creativity as a part of cognitive skills and sees it as changing the expanding thought with different options. According to the theory developed by Sternberg and Lubart (1995), creativity consists of 6 elements: intelligence, thinking style, knowledge, motivation, environment and personality. According to San (1985), creativity is defined as creating new products with existing information, obtaining an original product by combining information, making connections that have not been established before, and finding different solutions to problems. According to another explanation, creativity is a compilation of many cognitive processes such as perception, comprehension, fluency, sensitivity, consciousness, openness to innovation, intuition, and flexibility (Atay, 2009). Plucker and Beghetto (2004) define creativity as the interaction between the ability and process of an individual or group to produce a result or product that is both new and useful. Torrance (described creative thinking as a power that increases one's mental functions.

Torrance (1963) described creative thinking as a power that increases one's mental functions. He sees creative thinking as a process of intuition, intuiting gaps and disturbing elements, making hypotheses about them, testing them, comparing the results and finding another hypothesis and testing it again (Argun, 2012). Eckhoff (2011) states that creative thinking is a process that interacts with one's sociocultural environment and thoughts. Üstündağ (2003) defined creative thinking as "the establishment of a relationship between objects or thoughts that have not been related before". Atasoy et al. (2007) consider creative thinking as a part of divergent thinking and imagination. Lew & Cho (2013) consider finding new solutions to everyday problems by coming up with functional ideas as an important component of creative thinking ability. Creativity at the individual level is seen as related to solving problems in daily life. Creativity at the societal level means scientific discoveries, life-enriching humanities or innovations in social programs (Sternberg & Lubart, 1999). According to Vygotsky (2004), creativity exists when a person imagines, combines, changes and creates something new.

Imagination and Creativity

Mellou (1995) states that creativity and imagination are interrelated and that the fundamental relationship between them is that they are both reality-based in providing alternatives and possibilities for innovation and original changes. Rowe (2004) states that imagination is an important part of creativity as a powerful tool that helps to understand and visualize alternatives. Creativity is always said to involve imagination. The ability to imagine is used to separate from the present, to create unfamiliar and new connections, to play with ideas, to internalize perceptions and to explore different possibilities (Duffy, 2006). According to Ogilvie (1998), one becomes creative when the use of imagination increases the production of multiple ideas and thoughts. Imagination capacity is directly related to spatial perception, visual memory, problem solving, divergent thinking and creativity (Pérez-Fabello & Campos, 2007). Imagination is the impulsive force behind creativity and the use of imagination allows children to make unconventional connections (Beetlestone, 1998). Imagination is a necessary part of the human creative process (Williams & Walker, 2003). Based on these, it can be said that the wider the imagination of an individual, the more creative the individual can be (Gündoğan, 2011).

Imagination has been found to be one of the strongest predictors of creativity skills in research (Bolen & Torrance, 1978; Çankaya et al., 2012). With the help of creative imagination, the individual enables ideas with high potential to be realized to be designed and transformed into products. In this context, imagination and creativity are effective in the emergence of many original and need-responsive innovations in the field of design, which aims to ensure the harmony of the individual with life and to make the life of the individual easier (Aydın, 2022; Er Bıyıklı & Gülen, 2018).

An individual's ability to dream and to realize one's dreams is primarily dependent on a rich imagination. According to Vygotsky (2004), the critical period in supporting the development of individuals for a rich imagination is preschool and primary school. The preschool period, when creative potential is at the highest level (Aral et al., 2002), is also the period when imagination is at the highest level (Ayaydın, 2011). Similarly, Gündoğan et al. (2013) found an inverse relationship between the rate of imagination development and the age of the individual. For this reason, it is important to support the development of imagination in children, especially starting from preschool education, by eliminating standardized activities and offering rich experiences with activity-based, enriched play options and playgrounds (Aydın, 2022).

According to Duffy (2006), the need to encourage and value the imagination and creativity of young children is important not only for the future of society but also for the present. By encouraging creativity and imagination, children's ability to understand and explore the world can be enhanced by increasing opportunities to find new meanings and make new connections. Considering that creativity is indispensable for social progress and imagination is the impulsive power of creativity, the earlier efforts to include imagination in education are initiated, the brighter the future of society will be.

Society always needs creative and imaginative people who tackle problems with creative solutions and can imaginatively combine disconnected ideas and skills (Duffy, 2006). Developing the creativity skills of gifted and talented children is also important in terms of contributing to the future of humanity, and in terms of making great discoveries and inventions (Clark, 2013; Bütün, 2017). If we analyze how geniuses and famous scientists made their discoveries, we see that they tried to connect things that were not related (Michalko, 2008). Gifted individuals with creativity skills and imagination contribute to both the society they live in and all countries, in short, to humanity in terms of creating original works with these skills (Bütün, 2017; Çağlar, 2004). It is especially important to develop the creativity of gifted children and to support their imagination. Otherwise, the development of creativity skills of students with high levels of ability cannot be ensured. As a result, while these individuals can contribute to the country and humanity with the developments that they can reveal by using their talents and creativity together, they will not be able to do so and these abilities will atrophy.

The Current Study

The aim of this study was to examine the relationship between the creativity and scientific imagination of gifted children in early childhood and to find out whether they differ from their typically developing peers. In this context, the following five questions were sought to be answered in the research.

- Is there a significant relationship between the creativity potential scores of gifted children and their typically developing peers and their scientific imagination inventory scores?
- Is there a significant difference between the creativity potential scores of gifted children and their typically developing peers?
- Is there a significant difference between the scientific imagination inventory scores of gifted children and their typically developing peers?
- Is there a significant difference in creativity potential scores and scientific imagination inventory scores according to gender?
- What is the effect of the sub-dimensions of the Creativity Potential Test and the sub-dimensions of the Scientific Imagination Inventory on children's likelihood of being gifted?

Method

Research Model

This study was designed in a correlational design, one of the quantitative research types. Correlational research is research in which the relationship between two or more variables is examined without intervening in these variables in any way. This examination may give the researcher an idea that there may be a cause and effect relationship, but it cannot be interpreted as cause and effect (Gall et al., 2007). With this research, the creativity and scientific imagination of gifted children and their typically developing peers will be compared and the relationship between them will be examined.

Participants

The research has two study groups. The first one is the group of gifted children. The second is the group of typically developing peers of these gifted children. Gifted children are children who apply to the Research and Practice Center of a State University in the Marmara Region of Türkiye through their teachers or parents with the idea that they may be gifted and are diagnosed as gifted. Gifted children are diagnosed using the Wechsler Intelligence Scale for Children (WISC-R) or the Stanford Binet Intelligence Test (IQ 130 and above). The typically developing peers of these children were selected from among the children attending a state-affiliated kindergarten in the city center where the highest number of children identified as gifted attend. There were 30 children in each group, totaling 60 children. The homogeneous sampling method was used to include gifted children in the study, and the criterion sampling method was used to select their typically developing peers. In determining the second group, some criteria were set to ensure that they had similar characteristics with gifted children other than diagnosis. These were as follows: not having been diagnosed as gifted before or not referred with the idea that they may receive a diagnosis, being in the same class with a gifted child in the first group, and volunteering to participate in the study. The average age of the children included in the study was 74 months. The youngest child is 71 months old, and the oldest child is 79 months old. The age of the children was similar in both groups. In addition, the gender distribution of children in both groups is equal. There are 30 children in each group, 15 girls and 15 boys in total.

Data Collection Tools

Under this heading, the data collection tools used in the research are given in detail. Data were collected from both gifted children and typically developing children using two instruments. The first of these is the Evaluation of Potential Creativity Test (EPoC), which aims to assess children's creativity potential. The other is the Scientific Imagination Inventory to assess children's scientific imagination.

Evaluation of Potential Creativity (EPoC)

The Test for the Evaluation of Potential Creativity, published by Lubart, Besançon and Barbot in 2011, consists of two parallel forms, form A and form B. Each form consisted of 8 items related to two expression domains: graphic and verbal. These eight items were designed to represent two ways of thinking: Divergent-exploratory and convergent-integrative. The 8 items in each form of the EPoC test are grouped into 4 groups, indicating the 4 sub-dimensions of the test for measuring creativity potential. These are; Graphic Divergent-Exploratory Thinking (DG), Verbal Divergent-Exploratory Thinking (DV), Graphic Convergent-Integrative Thinking (IG) and Verbal Convergent-Integrative Thinking (IV). The scores obtained in each of the 4 sub-dimensions of the test are classified at seven levels: Very high, high, upper normal, average, lower normal, weak and very weak (Lubart et al., 2011).

Convergent- Integrative thinking is the production of the most original and single production possible from many different elements. It is stated that synthesizing feature is also used in this way of thinking. This is stated as the opposite of divergent-exploratory thinking. By evaluating both areas, the multifaceted nature of creativity potential can be reflected (Lubart et al., 2011). These active components of creativity are measured in the EPoC test by engaging the child in a production process. At the same time, the EPoC test asks the child to generate ideas and compositions both verbally and graphically.

The EPoC test can be used in children aged 5-12 years. The standardization study of the test was carried out in France. In addition, translation and standardization studies are being carried out to ensure that EPoC can be used in different countries (Barbot et al., 2016; Kanlı, 2018). EPoC testing is used in many countries. The test was translated into 5 different languages: French, English, German, Turkish and Arabic. The English version of the test was developed in 2012 by the International Center for Innovation in Education (Lubart et al., 2013). The English version was developed by Taisir Subhi Yamin. A Turkish language translation was made by Ahmet Aksu and a Turkish validity and reliability study was conducted by Dereli (2019). The EPoC test takes approximately 30-60 minutes to administer, depending on the performance of each child.

The validity and reliability study within the scope of the Turkish adaptation of the EPoC was conducted by Dereli (2019), and according to the compatibility indices obtained, it was revealed that the model showed a good fit to the structure (GFI=.90, CFI=.93, TLI=.85, SRMR=.047). The four factor structure of the creativity scale is confirmed. In the reliability study of the EPoC test, the reliability coefficient of the whole scale was found to be 0.70. As a result of these analyses, the scale was found to be valid and reliable (Dereli, 2019). In this study, the reliability value for the whole scale was obtained as 0.740.

Scientific Imagination Inventory

In order to measure scientific imagination in the study, three questions developed by Kaynar (2018) within the scope of his master's thesis titled "Scientific imaginations of gifted and non-gifted students" and the inventory for the evaluation of these questions will be used. Children are asked to draw by asking these questions. These questions are as follows:

- How do you think our world would be without the force of gravity?
- What do you think our world would be like if the sun suddenly disappeared?
- Imagine that you are a person traveling in a spaceship. During this journey you discover a new planet. What do you think this planet is like?

The scientific imagination inventory developed by Kaynar (2018) consists of the sub-dimensions of *Scientific Creativity* (Fluency + Flexibility + Originality), *Scientific Sensitivity* (Emotional Understanding + Imagination Experience) and *Scientific Productivity* (Scientific Reality + Creation + Reproduction). Kaynar (2018) consulted the opinions of two faculty members who are experts in the field for the suitability of the questions within the scope of the inventory to the group level, to measure scientific imagination, and for the reliability and validity of the scoring key. Pearson Correlation analysis was used to determine the correlation value between the evaluations of different raters regarding the reliability of the study. The study was evaluated by raters. The correlation coefficient between Rater 1 (researcher) and Rater 2 was 0.91 ($n=72$, $p<0.001$), and the correlation coefficient between Rater 1 and Rater 3 was 0.86 ($n=72$, $p<0.001$). Since there was a statistically significant relationship between the researcher's scoring and the scores of the other raters, the researcher's scoring was taken as the basis for the analysis of the findings Kaynar (2018). The Scientific Imagination Scoring Table was used to score the drawings Kaynar (2018). Within the scope of this study, each of the drawings obtained from 60 children were scored by three different faculty members within the scope of the Scientific Imagination Scoring Table. The first one is a researcher, the second one is a faculty member working in the department of art and craft education, and the third one is a faculty member working in the department of mathematics and science education.

Inter-rater agreement, which is one of the measures of reliability, is a measure of reliability that is applied in situations where more than one observer, independently of each other, tries to measure the same things. In this type of measurement, a single value is found for each situation by averaging the measurements made by the individual observers. The closer the observation results are to each other, the higher the reliability. In addition, as the number of observers increases, reliability also increases at certain rates (Karasar, 1995). In this study, the data obtained from the Scientific Imagination Inventory were independently evaluated by three raters. A total of 180 drawings made by the children were given to three raters and asked to score them. When the correlations between the scores given by the raters to the drawings were examined, it was seen that there were significant relationships.

Table 1. Scientific imagination inventory scores descriptive statistics

Sub-scales	Mean	Sd	Intraclass Correlation Coefficient
Fluency	14,57	6,04	0,910
Flexibility	4,77	1,61	0,920
Originality	2,13	1,33	0,927
Emotional Understanding	1,83	1,04	0,921
Imagination Experience	1,83	1,47	0,932
Scientific Reality	1,57	1,25	0,938
Creation	0,57	0,74	0,942
Reproduction	0,35	0,55	0,946

The scores for each sub-item of the Scientific Imagination Inventory were scored by three expert raters. Intraclass correlation coefficient was used for the agreement between raters and the agreements between experts were obtained as 0,910 for fluency and 0,946 for reproduction, respectively.

Data Collection Procedure

Within the scope of this study, data were first obtained from the group of gifted children. In the spring semester of the 2022-2023 academic year, data were obtained by applying the EPoC and the Scientific Imagination Inventory tools to children who were identified as gifted at the Research and Practice Center within the university. Then, a group of gifted children and a group of typically developing children were formed, taking into account the fact that they may have similar environmental conditions other than diagnosis. For this purpose, a state kindergarten in the city center, where the highest number of gifted children attended, was selected. In this school, according to the criteria determined within the scope of the research, the children of the parents who volunteered to participate in the study were administered the Evaluation of the Potential Creativity Test (EPoC) and the Scientific Imagination Inventory tools and data were collected. Data collection tools were administered individually to gifted children and their typically developing peers.

Data Analysis

In the data analysis within the scope of this study, the normality of the scale scores was first examined with skewness and kurtosis. If the values obtained are in the ±2 range, it shows that the score distribution is normal (George & Mallery, 2010). The independent sample t test was used to compare the scores of both instruments according to the groups, and the Mann-Whitney U test was used to compare the scores according to gender in each group. The reason for using this non-parametric method is that the number of data is not sufficient in the groups. Tabachnick & Fidell (2013) recommend the use of parametric methods in each group (N>30). For significant differences, the effect size was analyzed with eta square. Eta squared ($\eta 2$) indicates the proportion of the total variance in the dependent variable explained by the independent variable (Büyüköztürk, 2006; Pallant, 2007). Cohen (1988) defined this value as 0.01=small effect, .06=medium effect and .14=large effect. In addition, children in typical development were coded as the reference group (0) and children in the gifted group (1), and logistic regression analysis method was used to determine the probability of being gifted according to the scale dimensions. Finally, Pearson's correlation method was used to determine the significant relationship between the scores of EPoC and the Scientific Imagination Inventory. For statistical analyses, $p<.05$ significance level was compared.

Results

In this section of the study, the findings obtained for the five sub-questions of the research are presented separately. Table 2 shows the normality distributions of the scores obtained from the data collection tools.

Table 2. EPoC and scientific imagination inventory normality statistics

Subscales	Gifted Children		Typical Development	
	Skewness	Kurtosis	Skewness	Kurtosis
Score DG	-0,705	-0,027	0,463	-0,299
Score IG	-0,639	-0,816	0,342	-0,166
Score DV	1,023	1,394	0,746	0,223
Score IV	0,822	0,84	0,174	-0,794
Fluency	0,018	-0,604	0,8	0,308
Flexibility	0,067	-0,476	0,699	-0,286
Originality	-0,173	-0,879	0,266	-0,623
Emotional Understanding	0,152	-0,605	0,449	0,06
Imagination Experience	0,533	0,205	1,056	0,672
Scientific Reality	0,62	-0,334	0,934	0,191
Creation	0,804	-0,465	0,583	-1,784
Reproduction	0,324	-0,115	0,428	-0,236

The skewness and kurtosis values for all of the sub-dimension scores of both the EPoC and the scientific imagination inventory were within the range of ±2 in both gifted and typically developing child groups and showed a normal distribution.

First Sub-question of the Research

Table 3. Pearson correlation values between EPoC scores and scientific imagination scores

		Fluency	Flexibility	Originality	Emo. Und.	Imag. Exp.	Scie. Rea.	Creation	Reproduction
Gifted	DG	0,323	,707**	,793**	,724**	,750**	,620**	,522**	0,233
	IG	,553**	0,18	0,102	0,066	0,213	0,029	0,175	0,251
	DV	0,132	,382*	,473**	0,354	,395*	,396*	0,351	0,041
	IV	0,3	0,05	0,242	0,112	,372*	0,36	,449*	,397*
Typical	DG	,903**	,653**	,864**	0,332	,457*	0,18	,670**	,725**
	IG	0,156	0,215	0,272	0,193	0,002	0,138	0,146	0,021
	DV	0,262	0,079	0,167	-0,201	-0,004	-0,301	0,119	0,187
	IV	-0,021	0,321	0,303	,369*	0,279	0,346	0,223	0,049
All	DG	,801**	,711**	,800**	,511**	,825**	,679**	,571**	,388**
	IG	,582**	,329*	,304*	0,19	,411**	,317*	,266*	0,224
	DV	0,024	0,112	0,187	-0,055	0,017	-0,1	0,141	0,095
	IV	,433**	,276*	,374**	,266*	,507**	,500**	,453**	,322*

***p<.01; *p<.05*

The relationship between both types of scores was analyzed by Pearson correlation method. In gifted children, a positive and significant correlation was found between the scores of the DG and the scores of flexibility, originality, emotional understanding, imagination experience, scientific reality and creation. There is a positive and significant relationship between score IG and only fluency scores. A positive and significant relationship was found between score DV and flexibility, originality, imagination experience and scientific reality. A positive and significant relationship was found between Score IV and imagination experience, creation and reproduction.

In the group of children with typical development, a positive and significant correlation was found between the scores of the DG and the scores of fluency, flexibility, originality, imagination experience, creation and reproduction. In this group, there is no significant relationship between Score IG and Score DV and any sub-dimension of scientific imagination. A positive and significant relationship was found between Score IV and emotional understanding subscale scores.

In the all group, there is a positive and significant relationship between scores DG and IV and all sub-dimensions of scientific imagination. A positive and significant relationship was found between score IG and fluency, flexibility, originality, imagination experience, scientific reality and creation. There is no significant relationship between score DV and any sub-dimension of scientific imagination.

Second and Third Sub-question of the Research

Table 4. Independent sample t-test statistics between EPoC and scientific imagination subdimension scores between groups

Score	Group	N	Mean	sd	$t_{(58)}$	p	Eta-square
DG	Gifted	30	119,73	13,84	7,77	,000*	0,51
	Typical	30	95,43	10,10			
IG	Gifted	30	100,40	18,60	3,886	,000*	0,21
	Typical	30	84,43	12,67			
DV	Gifted	30	86,83	5,57	-0,784	0,436	
	Typical	30	88,80	12,57			
IV	Gifted	30	87,63	9,95	3,378	0,001*	0,16
	Typical	30	80,37	6,31			
Fluency	Gifted	30	19,50	3,81	11,059	,000*	0,68
	Typical	30	9,63	3,06			
Flexibility	Gifted	30	5,37	1,59	3,091	0,003*	0,14
	Typical	30	4,17	1,42			
Originality	Gifted	30	2,63	1,40	3,11	0,003*	0,14
	Typical	30	1,63	1,07			
Emotional Understanding	Gifted	30	2,03	1,00	1,499	0,139	
	Typical	30	1,63	1,07			
Imagination Experience	Gifted	30	2,87	1,20	7,604	,000*	0,50
	Typical	30	0,80	0,89			
Scientific Reality	Gifted	30	2,30	1,12	5,563	,000*	0,35
	Typical	30	0,83	0,91			
Creation	Gifted	30	0,77	0,90	2,142	0,036*	0,07
	Typical	30	0,37	0,49			
Reproduction	Gifted	30	0,43	0,63	1,184	0,241	
	Typical	30	0,27	0,45			

*p<.05

There was a significant difference between the scores of gifted and typically developing children in the sub-dimensions of the EPoC in terms of their scores in DG, IG and DV (p<.05). Gifted children have higher mean scores in DG, IG and DV than typically developing children. Effect sizes were analyzed with eta squared for significant differences in the groups. 0.51 for Score DG (large effect), 0.68 for Score IG (large effect) and 0.68 for Score DV (large effect).

There was a significant difference between the fluency, flexibility, originality, imagination experience, scientific reality and creation scores of gifted children and typically developing children from the sub-dimensions of the Scientific Imagination Inventory (p<.05). Similarly, the mean scores of gifted children in fluency, flexibility, originality, imagination experience, scientific reality and creation were higher than those of typically developing children. The effect sizes were 0.68 (large effect) for fluency, 0.14 (large effect) for flexibility, 0.14 (large effect) for originality, 0.50 (large effect) for imagination experience, 0.35 (large effect) for scientific reality and 0.07 (medium effect) for creation.

Fourth Sub-question of the Research

Table 5. Mann-Whitney U test between EPoC and scientific imagination subscale scores by gender in each group

	Gifted				Typical			
	Boy (N=15) Mean Rank	Girl (N=15) Mean Rank	Z	p	Boy (N=15) Mean Rank	Girl (N=15) Mean Rank	Z	p
DG	16,23	14,77	-0,46	0,646	16,07	14,93	-0,355	0,722
IG	17,53	13,47	-1,273	0,203	12,93	18,07	-1,608	0,108
DV	16	15	-0,326	0,745	15,67	15,33	-0,104	0,917
IV	14,9	16,1	-0,384	0,701	14,9	16,1	-0,379	0,705
Fluency	15,57	15,43	-0,042	0,967	16,53	14,47	-0,649	0,516
Flexibility	17,3	13,7	-1,142	0,254	14,2	16,8	-0,837	0,403
Originality	15,37	15,63	-0,085	0,932	15,53	15,47	-0,022	0,983
Emotional Und.	15,37	15,63	-0,087	0,931	15,5	15,5	0	1
Imagination Exp.	15,2	15,8	-0,193	0,847	13,83	17,17	-1,122	0,262
Scientific Reality	14,63	16,37	-0,561	0,574	16,7	14,3	-0,802	0,423
Creation	13,53	17,47	-1,328	0,184	16	15	-0,372	0,71
Reproduction	15,6	15,4	-0,073	0,942	16,5	14,5	-0,812	0,417

$^*p<.05$

In each of the groups, the difference between the creativity potential and scientific imagination sub-dimension scores according to gender was compared with the Mann-Whitney U analysis method. The number of boys and girls in each group was not sufficient (N<30). There is no significant difference between the sub-dimensions of the EPoC and scientific imagination inventory sub-dimension scores according to the gender of the children in the gifted group. Similarly, there is no significant difference between the sub-dimensions of the EPoC and the sub-dimension scores of the scientific imagination inventory according to the gender of children in the typical development group.

Fifth Sub-question of the Research

Table 6. Logistic regression statistics

Models	Variables	B	SH	Wald	p	Odds Value
Model 1	DG	0,152	0,041	13,947	,000*	1,164
	IG	0,06	0,034	3,19	0,074	1,062
	DV	-0,128	0,066	3,715	0,054	0,88
	IV	-0,018	0,069	0,07	0,791	0,982
	R^2=0,545(Cox & Snell)	$\chi^2_{(4)}$=47.266				
	R^2=0,727 (Nagelkare	p<.001				
Model 2	Scientific Creativity	0,498	0,137	13,212	,000*	1,645
	Scientific Sensitivity	0,073	0,373	0,038	0,845	1,076
	Scientific Productivity	-0,307	0,418	0,539	0,463	0,736
	R^2=0,568(Cox & Snell)	$\chi^2_{(3)}$=50.411				
	R^2=0,758 (Nagelkare)	p<.001				
Model 3	DG Scores	0,03	0,063	0,22	0,639	1,03
	IG Scores	0,02	0,04	0,26	0,61	1,021
	DV Scores	-0,127	0,083	2,379	0,123	0,88

	Score IV	0,057	0,095	0,362	0,548	1,059
	Scientific Creativity	0,468	0,193	5,859	**0,015***	1,596
	Scientific Sensitivity	0,074	0,45	0,027	0,87	1,076
	Scientific Productivity	-0,369	0,421	0,768	0,381	0,691
	R^2=0,604(Cox & Snell)	$\chi^2_{(7)}$=55.542				
	R^2=0,805 (Nagelkare	p<.001				

**p<.05*

The effect of the instrument sub-dimensions on children's likelihood of being gifted was examined by logistic regression analysis. In this method, the dependent variable (group) is coded as 1 and 0 and is considered as the reference group (0=typical development).

According to Model 1, the logistic regression model for the sub-dimensions of the EPoC in relation to children's giftedness is significant ($\chi^2_{(4)}$=47.266, p<.001). The Cox & Snall R-squared and Nagelkerke R-squared values show the smallest and largest proportions explaining the probabilities of being the dependent variable. Between 54.5% and 72.7% of the variability related to children's giftedness is explained by the sub-dimensions of the EPoC. Score DG (B=0.152, Wald=13.947, p<.05) was found to be a significant predictor of children's likelihood of being gifted, and since the coefficient B was positive, the effect of Score DG was positive. A one-unit increase in the score on the DG scores increased the likelihood of being gifted by 1.164 times compared to children in the typical development group.

According to Model 2, the logistic regression model of the sub-dimensions of the Scientific Imagination Inventory in relation to children's giftedness is significant ($\chi^2_{(3)}$=50.411, p<.001). Between 56.8% and 75.8% of the variability related to children's giftedness is explained by the scientific imagination sub-dimensions. Scientific creativity (B=0.498, Wald=13.212, p<.05) was found to be a significant predictor of children's likelihood of being gifted, and since the coefficient B was positive, the effect of the scientific creativity variable was positive. A 1-unit increase in scientific creativity measures increased the likelihood of being gifted by 1.645 times compared to children in the typical development group.

According to Model 3, the logistic regression model of the sub-dimensions of the EPoC and the Scientific Imagination Inventory on children's giftedness is significant ($\chi^2_{(7)}$=55.542, p<.001). Between 60.4% and 80.5% of the variability in children's giftedness is explained by the sub-dimensions of the EPoC and the Scientific Imagination Inventory. Among both instruments, only scientific creativity (B=0.468, Wald=5.859, p<.05) was found to be a significant predictor of children's likelihood of being gifted, and since the coefficient B was positive, the effect of the scientific creativity variable was positive. A 1-unit increase in scientific creativity measures increased the likelihood of being gifted by 1.596 times compared to children in the typical development group.

Discussion

In this section of the study, the discussions on the five sub-questions of the research are given separately in order.

First Sub-question of the Study

Within the scope of this study, a significant positive correlation was found between the sub-dimensions of the EPoC and the sub-dimensions of the Scientific Imagination Inventory in gifted children. In each of the sub-dimensions of the EPoC test, a positive and significant relationship was obtained with at least one of the sub-dimensions of the Scientific Imagination Inventory. Therefore, there is a significant positive relationship between creativity potential and scientific imagination in gifted children. In preschool children with typical development, 2 of the 4 sub-dimensions of EPoC had a positive and significant relationship with the sub-dimensions of the Scientific Imagination Inventory, whereas no relationship was found in 2 of them. Therefore, we can speak of an existing relationship between creativity potential and scientific imagination in typically developing children. When we look at the scores of the all group, it was concluded that the scores of the DG and IV sub-dimensions of EPoC had a positive and significant relationship with all of the sub-dimensions of the Scientific Imagination Inventory. In the all group, there was a positive and significant relationship between the IG sub-dimension of EPoC and the 6 sub-dimensions of the Scientific Imagination Inventory. In the all group, no significant relationship was found between the DV sub-dimension of EPoC and any sub-dimension of the Scientific Imagination Inventory. As can be understood from the comparison of all group scores, it can be stated that there is a positive and significant relationship between children's creativity potential and scientific imagination. It is thought that the reason why there is no relationship between the DV sub-dimension of EPoC and scientific imagination may be due to the fact that the DV sub-dimension is closely related to verbal skills. In this sub-dimension, there are situations that are closely related to children's vocabulary and expression skills (Lubart et al., 2011). In the scientific imagination inventory, it can be said that drawing and painting skills are predominant (Kaynar, 2018).

When the literature is examined, it is understood that there are very limited studies examining the relationship between scientific imagination and creativity. Therefore, this may indicate the originality of the study. On the other hand, imagination and creativity were mostly emphasized in the studies and their related fields were examined. In their study, Jankowska & Karwowski (2015) suggested that the concepts of creativity and imagination intersect with each other at many points and emphasized the concept of creative imagination. In the study conducted by Çankaya et al. (2012), it was revealed that imagination had a high level effect in predicting creative thinking skills. Kandemir (2006) argued that imagination exercises have positive effects on creative thinking. Aljarrah (2017) theoretically examined the relationship between play-imagination-creativity and consequently emphasized the interrelationship between play, imagination and creativity. However, he emphasized the importance of realizing this reciprocal relationship in early childhood education. In addition, Torrence's (1974) criteria for scoring the Creative Thinking Test include the determination of the richness and colorfulness of imagination. This may emphasize the relationship between creativity and imagination.

Yolcu (2019) examined the relationship between imagination and creativity in preschool children in the context of the literature. As a result of the research, it was determined that in order to develop children's creativity, activities that will develop their imagination should be included more. Caiman & Lundegard (2018) also found that as the use of imagination increases in preschool children, children produce different and original solutions to problems. In the study conducted by Aydın (2022), it was emphasized that when children's imagination development is supported, their problem solving skills are also improved. Yorgun (2021) also found a significant relationship between problem solving and imagery ability. Er Bıyıklı & Gülen (2018) theoretically examined the effect of the concepts of imagination and creativity on the design process and stated that imagination is an important dynamic that provides motivation in situations that require extraordinary creativity such as artistic activities and design creation processes.

In studies conducted in the field of education, the relationship between imagination and other variables such as creative thinking, decision-making, and problem solving skills were examined (Ağraş & Şeyba, 2017; Çankaya et al., 2012; Er Bıyıklı & Gülen, 2018; Yolcu, 2019). As can be seen from the research, creativity and imagination education are inseparable parts of each other. Those who want to develop creativity need to engage children's imagination. As a result of this research, scientific imagination can be accepted as a functional tool for the development of creativity. Based on this result, it can be interpreted that when children's scientific imagination development is supported in the educational environment, their multidimensional development, especially their creativity, will be supported. As Vygotsky (2004) states, supporting children's multidimensional development enables them to be more productive and innovative in adulthood.

Second Sub-question of the Research

In this study, the EPoC subscale scores of gifted children and the EPoC subscale scores of their typically developing peers were examined. It was concluded that the mean scores of gifted children were higher than their typically developing peers in the DG, IG and DV sub-dimensions of EPoC, which has 4 sub-dimensions in total. When the effect sizes of this significant difference were examined, it was seen that a large effect level could be mentioned.

Kersher & Ledger (1985) found that gifted students were more successful in generating original ideas than their typically developing peers. Therefore, it is seen that it has results that support the findings of this research. Similarly, Preuss and Dubow (2004) found that gifted children have better problem solving skills than typical children. In addition, the study also reported that gifted students were successful in memory, analytical, speed of perception, production and stress tolerance. Kanevsky (2011) found that students who were identified as gifted preferred learning complex information, making connections between ideas, and choosing their own product formats more than undiagnosed students. When the findings obtained within the scope of the studies are examined in general, the finding of a positive and significant relationship between intelligence and creativity is supported.

The relationship between intelligence and creativity has been the subject of much research for many years (Chamorro-Premuzic, 2009; Dağlıoğlu, 2014). There are also studies that emphasize different results with this research finding. Findings from some studies have revealed that there is no relationship between high scores obtained from creativity tests and high scores obtained from intelligence tests (Kim et al., 2013). It has been emphasized that while a high IQ score can say something about intelligence, it is insufficient to express high creative ability (Barbot et al., 2016). This is because the answers to the intelligence test require the recall of certain information, convergent or non-convergent thinking. This is because the answers to the intelligence test require the recall of certain information, convergent or non-creative thinking. Therefore, a child who scores high on an intelligence test may be less creative than other children of average intelligence (Chamorro-Premuzic, 2009; Neihart, 2007). According to Torrance (1963), if we identify gifted children based solely on intelligence tests, we ignore 70% of children with high levels of creativity (Chamorro-Premuzic, 2009; Fox & Schirrmacher, 2012). In summary, it is also seen that there are studies indicating that there is no direct relationship between creativity and intelligence. In other words, it is said that an intelligent individual may not have the same degree of high creativity (Barbot et al., 2016; Dağlıoğlu, 2014; Kim et al., 2013). Creativity may require a certain level of intelligence. However, it is stated that a high IQ level does not necessarily mean high creativity. Similarly, average intelligence does not necessarily imply average creativity. Intelligence is seen as only one of the factors affecting creativity. It is stated that children with high levels of intelligence and children with high levels of creativity do not have the same profiles. Similarly, it is stated that the profiles of children with low intelligence and children with low creativity levels may not be similar (Fox & Schirrmacher, 2012).

Third Sub-question of the Research

In this study, the scores of gifted children on the sub-dimensions of the Scientific Imagination Inventory and the scores of their typically developing peers on the sub-dimensions of the Scientific Imagination Inventory were examined. It was concluded that the mean scores of gifted children in 6 sub-dimensions of the Scientific Imagination Inventory, which has 8 sub-dimensions, fluency, flexibility, originality, imagination experience, scientific reality and creation were higher than their typically developing peers. When the effect sizes of this significant difference were examined, it was seen that there was a large effect in 5 sub-dimensions and a medium effect in 1 sub-dimension.

Kaynar (2018) found results that support the findings of this study. In his study, all sub-dimensions of the main dimension of "Scientific Imagination"; scientific creativity (fluency, flexibility, originality), scientific sensitivity (emotional understanding, imagination experience) and scientific productivity (scientific reality, creation, reproduction) were examined. It was concluded that gifted students were more successful in all sub-dimensions of the main dimension of "Scientific Imagination" than students who were not diagnosed as gifted. Miller (2000) found that gifted students scored unexpectedly low on tests related to spatial ability, which may be related to scientific imagination, and scored lower on novel analysis tests that involve relationships such as perception and inference. These results have findings that differ from the results of this study. However, the same study also found that gifted students performed well on logical tests that require good memory.

Piechowski & Miller (1995) evaluated the developmental potential of gifted children and found that children aged 12-14 scored higher on emotional, intellectual and imaginative measures than children aged 9-11. Both the results of this study and the findings of other studies indicate that the levels of scientific imagination of gifted children differ more positively than their undiagnosed peers. Therefore, these areas of gifted children need to be supported from early childhood. As a result of this support, both an opportunity for the development of existing potential can be created and a need of the gifted can be met.

Fourth Sub-question of the Research

Within the scope of this research, it was examined whether there was a difference in both creativity potential scores and scientific imagination scores according to gender. It was concluded that there was no significant difference between the sub-dimensions of creativity potential and scientific imagination inventory sub-dimension scores according to the gender of the children in the gifted group. Similarly, there is no significant difference between the sub-dimensions of creativity potential and scientific imagination sub-dimension scores of typically developing children according to their gender.

It is understood that there are very limited studies examining the difference of scientific imagination in the context of gender variable. In this context, there are studies that found that female students use imagination more than male students (Gündoğan, 2011). Pearson et al. (2001) investigated the relationship between having imaginary friends and gender in children aged 5-12 years. The study revealed that girls had more imaginary friends than boys. Forisha (1978) found a relationship between creative ability and keep alive image in women, whereas he found a relationship between creative ability and creative production in men.

Similar to this research finding, Baer & Kaufman (2008) emphasized that there is no evidence to support that there is a clear gender difference in creativity test results when the test results to measure creativity are evaluated in terms of gender differences. Similarly, Naderi et al. (2009), Wu (2010), Rudowicz et al. (1995) and Urban (2005) found that there is no gender difference in creativity. In some studies, there is no gender difference in creative product, in some studies girls outperform boys in some tasks, and in some studies boys outperform girls (Baer & Kaufman, 2008).

Stephens et al. (2001) reported that girls scored higher than boys in all subtests of the creativity test. Ai (1999) examined the effect of gender difference on the relationship between creativity and academic achievement and found that girls scored higher on fluency measures in natural sciences and mathematics than boys, which may be due to the gender role expectations of most societies for girls to imagine objects. DeMoss et al. (1993) state that women score higher than men in verbal creativity tests. Kershner & Ledger (1985) reported that both average and gifted girls scored higher in verbal and formal fluency than boys. Milgram et al. (1978), in their research on the quality and quantity of creative thinking in children and adolescents, state that older girls generate more ideas, but these ideas are not of high quality. When the findings of the studies are examined in general, it will not be sufficient to explain the effect of gender alone on creativity and scientific imagination. There can be many individual, societal and cultural influences on both creativity and scientific imagination. Therefore, within the framework of the findings obtained in this study, it is not possible for the gender variable to predict creativity and scientific imagination alone.

Fifth Sub-question of the Research

In this study, the effects of EPoC sub-dimensions and Scientific Imagination Inventory sub-dimensions on children's likelihood of being gifted were examined. It was concluded that the DG sub-dimension of EPoC was a significant predictor of children's likelihood of being gifted. It is understood that the Scientific Creativity (fluency+flexibility+originality) sub-dimension of the Scientific Imagination Inventory is a significant predictor of children's likelihood of being gifted.

Gifted people are defined as people who have been determined by experts to be superior to their peers in cognitive abilities (Ataman, 2004; Sak, 2014). In other words, individuals who have a high level of performance or potential compared to their peers in terms of their mental abilities or intelligence, have a strong creative side, and are highly motivated to finish what they start (Clark, 2013). Some of the characteristics of gifted children are flexible thinking (VanTassel-Baska, 1994; 2005), have a vivid imagination (Freeman, 2003), creativity (Renzulli, 2005), excellent problem solving skills (Sak & Maker, 2005). In the literature, the characteristics of gifted children, such as high-level creativity, high imagination, being a good observer, having very interesting ideas, being extremely curious, asking a lot of questions and being able to solve complex problems, are closely related to creativity and scientific imagination. The findings obtained within the scope of this study also support the characteristics of gifted students having creativity potential and scientific creativity. Therefore, it is thought that it may be important to support these skills in gifted children from an early stage.

Implications

Within the scope of this study, a positive and significant relationship between creativity potential and scientific imagination was determined. Therefore, designs (training program, activity, any content etc.) can be designed and implemented to develop and support these skills in children. In addition, variables that may affect creativity potential and scientific imagination can be examined. At the same time, the reasons for the differences in the creativity potential and scientific imagination of gifted children compared to their typically developing peers can be investigated. This study revealed that creativity potential and scientific creativity are characteristics of gifted children. Therefore, when identifying gifted individuals, multiple diagnoses can be made, such as tools that assess not only intelligence tests but also creativity potential and scientific creativity.

Limitations

One of the limitations of this study is that gifted children were diagnosed as gifted using only intelligence tests. Another limitation is that no intelligence test was applied to the group of undiagnosed peers of gifted children. Therefore, there may be children in this group who can be diagnosed as gifted. However, considering the prevalence of giftedness in the society, it is thought that the number of children who may be diagnosed may be quite low.

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