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Examining the Effects of Science Curriculum and Activities Developed for Gifted Students in Türkiye

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ABSTRACT

This study employed a mixed-methods design to investigate the impact of activities developed by the Ministry of National Education (MoNE) on the scientific creativity and scientist perceptions of gifted 5th-grade students. The research used a one-group pretest-posttest design with a sample of 22 students from a Science and Art Education Centre in a northwestern province of Türkiye. Quantitative data were collected using the "Scientific Creativity Test" and "Draw a Scientist Test", while qualitative data were gathered through an opinion form and a metaphor generation task. Results indicated that the activities significantly enhanced scientific creativity but did not alter scientist perceptions. Qualitative findings revealed that students developed more positive views of science and scientists, finding the activities both engaging and informative.

Keywords: gifted students, science and art education center, scientific creativity, scientist perception, special education

INTRODUCTION

The concept of giftedness and the identification of highly intelligent individuals have evolved significantly over time. Researchers have explored various indicators, including high IQ, academic achievement, and exceptional skills in fields such as art and music. McClain and Pfeiffer (2012) characterize gifted individuals as demonstrating exceptional intellectual abilities and outstanding performance.

Peterson (2019) broadens this definition, describing individuals with special talents as those possessing exceptional abilities, regardless of academic performance. Peterson (2015) proposes a framework for identifying such individuals, emphasizing both achievements and potential. However, the diversity within this group presents challenges (Peterson, 2019; Renzulli & Reis, 2021). The varied definitions and identification criteria complicate the classification of gifted students (Coleman & Cross, 2021; Kaufman & Sternberg, 2008; Sternberg, 2005). Typically, gifted students exhibit accelerated learning, excel in creativity, possess specialized academic skills, grasp abstract concepts readily, and display a penchant for independently pursuing their interests (Dixson, Olszewski-Kubilius, Subotnik & Worrell, 2020; MoNE, 2022a).

Despite numerous models in special education, a consensus on the definition of giftedness remains elusive (Coleman & Cross, 2021). This lack of agreement creates a significant research gap in developing effective programs tailored to the diverse needs and potentials of gifted individuals. While there is strong support for accelerated programs for intellectually gifted students, not all receive adequate support (Assouline, Mahatmya, Ihrig & Lane, 2021; Steenbergen-Hu, Olszewski-Kubilius & Calvert, 2020). Some argue that the primary goal of gifted education should be self-realization (Worrell, Subotnik, Olszewski-Kubilius & Dixson, 2019). Rinn and Bishop (2015) note that when identified in childhood through IQ testing, the "gifted" label often persists. However, some researchers suggest the criterion shifts from potential to actual achievement as individuals mature (Dai, 2019; Subotnik, Olszewski-Kubilius, Corwith, Calvert & Worrell, 2023). A functional definition of giftedness is crucial for developing programs that shape goals, curriculum, and student selection for gifted education.

Supportive structures-such as policies, teacher training standards, and robust instructional programs-play a vital role in revealing gifted students' talents (Brown, 2017). Traditional gifted programs typically focus on enrichment or acceleration, with the latter allowing for faster progression through studies. Research indicates that gifted students may not need 40-50% of conventional classroom content, yet they spend 80% of their time on the same material as their non-gifted peers, potentially missing valuable learning opportunities (Archambault, Westberg, Brown, Hallmark, Emmons and Zhang, 1993; Reis & Purcell, 1993; Yang & Siegle, 2006).

Effective teaching processes are crucial for students with special abilities, requiring instructional strategies that challenge and develop their unique talents. While frameworks for educating gifted students exist, ongoing research continues to evaluate their effectiveness (VanTassel-Baska & Brown, 2007). Recent studies have highlighted the importance of diverse activities, expert collaboration, and transdisciplinary projects in fostering creativity among gifted students. Lage-Gómez and Ros (2024) found that such approaches can effectively blur the boundaries between scientific, artistic, and humanistic domains, leading to a more holistic understanding of reality.

In Turkey, Science and Art Centers (SACs) play a pivotal role in gifted education. Paçacı (2024) examined these centers, highlighting their four-stage training process and practice-based education across various fields. However, the study also identified challenges, including the risk of these institutions losing their specialized focus. The author proposed an educational model to inform policymakers, emphasizing the need for a clear vision and purpose for SACs.

Research by Gorgulu and Unlu (2024) revealed that while gifted students generally presented perspectives aligned with the nature of science (NOS), some held views inconsistent with NOS principles. This finding underscores the need for targeted activities to enhance gifted students' understanding of the nature of science.

Zhou (2024) investigated the impact of science museums on gifted children's learning experiences in China. The study demonstrated that these museums offer valuable situational learning opportunities, contributing to children's knowledge expansion. However, it also identified challenges such as museum fatigue, suggesting strategies like selective exhibit coverage and providing rest areas to address this issue.

Piske, Collins, and de Cássia Nakano (2024) examined the effectiveness of teaching strategies for promoting creativity among gifted students. Their research emphasized the importance of student-centered learning approaches, incorporating various technologies, and maintaining a flexible curriculum. The study also highlighted the crucial role of teachers in creating a psychologically safe environment that encourages unusual questions and creative expressions.

Sönmez (2024) demonstrated the effectiveness of using metaphors in education to uncover and shape gifted students' understanding of scientific concepts, particularly in the context of upcycling. This approach helps students express complex ideas and structure new knowledge effectively.

Kaynar and Kurnaz (2024) found that an interdisciplinary approach in teaching, specifically the "Teaching Practices to Improve Thinking Skills Based on an Interdisciplinary Approach (PTSIA)," was effective in developing creative and critical thinking skills in gifted students. This approach helped students perceive relationships between concepts more clearly and establish deeper connections across various disciplines.

Maor, Paz-Baruch, Mevarech, Grinshpan, Levi, Milman, Shlomo and Zion (2024) examined teachers' attitudes towards integrating creativity in teaching and their use of creativity-based practices. While teachers generally held positive attitudes towards creativity, the study revealed a significant gap between theoretical understanding and actual classroom implementation. This research highlights the need for better support and training to help teachers effectively incorporate creative practices in their teaching.

In the 21st century, education systems strive to educate individuals effectively. The curriculum forms the foundation of education, acting as a bridge between individuals and their experiences. Thus, the quality of educational programs is vital in educating gifted students. Demonstrating the effectiveness of teaching activities for gifted students faces several challenges:

- Creating effective outcome measures for applied education programs (Hunsaker, Nielsen & Bartlett, 2010),
- Complexity in implementing instructional activities in practice,
- Obtaining measurable results due to the dynamic nature of gifted students (Sánchez, Beltrán Llera, Barberá & Cuesta, 2007).
- Lack of data on the accuracy of educational program applications (O'Donnell, 2008).

Concerns about the lack of challenging programs for talented students have led to the development of guiding principles for their education (Purcell, Burns, Tomlinson, Imbeau & Martin, 2002). The importance of educating gifted students is increasingly emphasized (Reis & Purcell, 1993; Renzulli & Reis, 2021). Models tailored to gifted students’ skills and learning pace reflect ongoing changes in educational practices (Tomlinson, 2001; Renzulli & Reis, 2021).

Türkiye has established regulations for gifted students, ensuring education aligns with their needs, as highlighted by the UN Declaration of Human Rights and the Convention on the Rights of the Child. Various laws and regulations provide for special education. The State Planning Organization and Ministry of National Education (MoNE) make key policy decisions, with additional studies by the Turkish Grand National Assembly shaping gifted education.

Gifted students in Türkiye attend Science and Art Centers outside of regular school to fully recognize and utilize their talents. These centers implement five educational programs, considering gifted students’ creative thinking and problem-solving skills. The programs are differentiated and enriched based on interests, abilities, and potential, ensuring high-level intellectual and personal development (MoNE, 2022b). Programs include:

- Orientation Program,
- Support Education Program,
- Individual Talent Identification Program,
- Special Talent Development Program,

The Orientation program introduces students to their environment. Support programs provide enriched education for those with general intellectual abilities. The Individual Talent Identification Program helps students identify their talents. The Special Talent Development Program focuses on skill enhancement. Finally, project programs allow students to explore interests under advisor guidance. Programs follow a hierarchy, starting with orientation, support, talent identification, and talent development (MoNE, 2022b).

The Individual Talent Identification Program underpins support and development programs. Published in 2020, the Science and Art Center Science Teaching Program includes this program, focusing on achievements in physics, chemistry, and biology. Structured spirally, it aligns with the special talents program, consisting of nine modules in flexible order. Modules cover World and Universe, Living Things and Life, and Physical Events with Matter and Nature. The two-year program comprises Individual Talent Identification Program-1 and 2, covering all areas (MoNE, 2022b).

Scientific creativity involves producing original products or ideas using given information (Hu & Adey, 2002). It encompasses field knowledge, divergent and convergent thinking, and science process skills (Rasul, Zahriman, Halim, Rauf & Amnah, 2018; Yang, Lin, Hong & Lin, 2016). Education aims to introduce science and scientists, developing students' science images in line with scientific nature (Doğan, 2015). Studies reveal individuals often hold stereotypical images of science (Brown, Grimbeek, Parkinson & Swindell, 2004; Emvalotis & Koutsianou, 2018; Farland-Smith, Finson & Arquette, 2017; Koren & Bar, 2009).

Activities recognizing individual talents support creative thinking, particularly relevant in the Individual Talent Identification Program aimed at revealing gifted students' creativity and scientist image. The Science and Art Center Science Course Teaching Program incorporates this program. This study explores students' scientific creativity and scientist images, contributing to the existing literature.

The study addresses these research questions:

What impact do MoNE activities, aligned with the new curriculum, have on 5th-grade gifted students' scientific creativity at Science and Art Centers?

How do MoNE activities influence the scientific image of gifted students at Science and Art Centers during the Talent Identification Period?

What effect do MoNE activities have on gifted students' perceptions of scientists at Science and Art Centers?

What changes occur in gifted students' perspectives on scientists and science after lessons taught with MoNE activities at Science and Art Centers?

How do gifted students view science courses after lessons taught with MoNE activities at Science and Art Centers?

What creativity do gifted students exhibit in relating MoNE activities to daily life at Science and Art Centers?

This study underscores the need to address gifted individuals' needs through comprehensive education programs. Significant variability exists among individuals with extraordinary achievements or potential, necessitating a comprehensive education program. Literature reveals studies on scientific creativity levels and influencing factors in various courses (Aruan, Okere & Wachanga, 2016; Astutik & Prahani, 2018; Bermejo, Ruiz-Melero, Esparza, Ferrando & Pons, 2016; Siew, Chin & Sombuling, 2017; Yang et al., 2016). The study aims to contribute to the literature on gifted students' scientific creativity and scientist image, highlighting the importance of comprehensive education programs for individuals with special abilities.

RESEARCH METHOD

Design

The research employed a mixed-methods design, specifically an embedded experimental design, where qualitative data helps explain quantitative findings. This design uses the experimental model as the core of the study, integrating qualitative data into the experiment's structure (Creswell & Plano Clark, 2017). The study utilized a one-group pretest-posttest design, which is considered a weaker experimental design due to the lack of a control group. Quantitative data were collected and analyzed using the "Scientific Creativity Test" and "Draw a Scientist Test" to provide baseline and post-intervention measurements. Subsequently, qualitative data were gathered and analyzed using an opinion form and a metaphor generation task to gain deeper insights into the quantitative results.

Study Group

The study group consists of gifted fifth-grade middle school students. A typical case sampling method-one of the purposeful sampling methods-was used to determine the study group. In purposive sampling, researchers select a study group to obtain in-depth information relevant to the research's purpose. Typical case sampling is employed to select a large number of representative cases from the population related to this purpose (Büyüköztürk, Çokluk & Köklü, 2010). For this study, a Science and Art Education Centre in northwestern Türkiye was selected. The study group was comprised of 22 students-10 girls and 12 boys. In Turkish Science and Art Education Centers, student groups are typically limited to 15 people. Therefore, the activities were conducted in two groups of 9 and 13 students, respectively.

Data Collection Tools

Scientific Creativity Test (SCT)

The Scientific Creativity Test (SCT), developed by Hu and Adey (2002), demonstrated a Cronbach's α reliability coefficient of 0.89. Ayverdi, Asker, Aydin and Saritaş (2012) later translated the SCT into Turkish, yielding a Cronbach's α coefficient of 0.861. This test comprises seven open-ended questions designed to measure scientific creativity. The first four questions assess fluency, flexibility, and originality, while the last three focus on flexibility and originality. In the adaptation study, three different raters evaluated scientific creativity scores, resulting in inter-rater internal consistency coefficients ranging from 0.870 to 0.939. The Cronbach's α reliability coefficient calculated from the data collected in this study was 0.828. The time allotted to students for completing the test was 40 minutes.

Draw a Scientist Test (DAST) and Checklist for the Draw a Scientist Test (DAST-C)

The Draw-A-Scientist Test (DAST), developed by Chambers in 1983, assesses students' perceptions of scientists. Chambers analyzed students' drawings based on seven indicators of a typical scientist: lab coats, eyeglasses, facial hair, research symbols (e.g., laboratory equipment and scientific tools), information symbols (e.g., books and full cabinets), technology (scientific products), and relevant writings (e.g., formulas, taxonomic classifications, and "Eureka!" statements). DAST allows individuals to express their views about scientists through drawings on a blank sheet of paper. To enhance objectivity and inter-rater reliability in DAST evaluation, Finson, Beaver, and Cramond (1995) developed the Checklist for the Draw-A-Scientist Test (DAST-C). This checklist comprises 15 structured items and one open-ended item, incorporating stereotypical components identified by Chambers (1983) and previous studies, along with additional elements for a more comprehensive analysis. In this study, students were given 20 minutes to complete their drawings, which were then analyzed using the DAST-C.

Metaphors Related to Scientists

To gain insight into students' perceptions of scientists, they were asked to create metaphors. The prompt given was "A scientist is like..., because..." Students had ten minutes to complete their metaphors.

Opinion Form

An opinion form was used to gather feedback from gifted students on activities developed by the MoNE for the new Science and Art Education Centers curriculum. The form consisted of four open-ended questions, crafted by the study's researchers to elicit students' views on these activities. To ensure validity, three experts reviewed the questions. Their feedback was incorporated to refine and finalize the questionnaire. Students provided written responses to these questions, taking approximately 20 minutes to complete the form.

Implementation

Science and Art Education Centers implement the Individual Talent Identification Program (ITRP) in two formats: a one-year program (80 minutes weekly for 16 weeks, totaling 32 lesson hours) or a two-year program (40 minutes weekly for 32 weeks, also totaling 32 lesson hours). In the centers where this study was conducted, the program was implemented as 32 lesson hours during one academic term. The first two hours were dedicated to data collection using the Scientific Creativity Test and Draw a Scientist Test. The experimental process then unfolded over 28 hours, featuring activities developed by the Ministry in alignment with the framework program's outcomes for Science and Art Education Centers. Upon completion of the experimental process, the Scientific Creativity Test and Draw a Scientist Test were readministered. Additionally, students' opinions about the activities were gathered through open-ended questions in a feedback form.

The learning outcomes in the Science and Art Education Centers curriculum, as shown in Table 1, were taught using activities developed by the MoNE (2022b). The 32-lesson process, including the implementation of the scales, was completed.

Analyzing the Data

The quantitative data collected during the research (SCT and DAST) were analyzed using SPSS 22.0 software. SCT scores were determined based on criteria established by Hu and Adey (2002). For the first four questions, fluency, flexibility, and originality scores were calculated. Fluency was measured by the number of answers provided. Flexibility was based on the number of categories (approaches and fields) used. Originality was determined by answer frequency: less than 5% of students giving an answer earned 2 points, 5-10% earned 1 point, and more than 10% earned 0 points. Question 5 included flexibility and originality scores. Each method received 1 point for flexibility. Originality was scored as follows: 3 points if less than 5% of students gave the answer, 2 points for 5%-10%, and 1 point for more than 10%. Question 6 assessed flexibility and originality.

Flexibility was scored out of 9 points (3 each for tool, principle, and procedure). Originality scoring was: 4 points for answers given by less than 5% of students, 2 points for 5-10%, and 0 points for more than 10%. Question 7 evaluated flexibility and originality. Flexibility earned 3 points for each function of the apple-picking machine drawn. Originality scoring was: 5 points for answers given by less than 5% of students, 3 points for 5-10%, and 1 point for more than 10%.

Table 1: Individual Talent Recognition Program Modules, Activities, and Outcomes

Date	Module	Duration	Activity Name	Outcomes
Week 1	Science, Scientific Research and Science Process Skills	40" + 40"	Application of Scales (Scientific Creativity Test, Draw a Scientist Test and Metaphors Related to Scientist)	
Week 2		40" + 40"	Knowledge of Knowledge	1. Explains the differences between scientific knowledge from other types of knowledge. 2. Compares theories and laws. 3. Evaluates whether the information obtained as a result of their research is scientific knowledge or not.
Week 3		40" + 40"	Powerful Tools of Science: Methods	1. Explains the role of methods in the scientific research process. 2. Analyze the characteristics of different scientific research questions. 3. Uses scientific methods.
Week 4		40" + 40"	Can science be faked?	1. Explains the distinguishing features of pseudoscience. 2. Analyses the social effects of pseudoscience.

				3. Puts forward an idea to refute one of the selected pseudoscience claims.
Week 5	Life Systems and Diversity	40" + 40"	Let's Explore Cell Theory	1. Explains the structure and functions of the cell. 2. Explains the cell theory. 3. Analyses the function of the cell in biological organization. 4. Evaluates the importance of different cell types in an organism for the organism.
Week 6		40" + 40"		
Week 7		40" + 40"		
Week 8		40" + 40"	Let's Explore Genetics	1. Explains the concept of heredity. 2. Summarizes the functions of inheritance material. 3. Analyzes the genetic kinship relationship through inheritance material.
Week 9		40" + 40"		
Week 10	Matter and Energy	40" + 40"	Theorist Resumes	1. Prepares a report comparing different atomic models.
Week 11		40" + 40"	Chemical Phenomena	1. Explains the concepts of element, compound, mixture, and chemical bond. 2. Gives examples of different chemical events. 3. Analyzes the reactions used to explain chemical change. 4. Tests the effect of chemical change on substances.
Week 12		40" + 40"		

Week 13	Earth and Space	40" + 40"	Renewable Energy	1. Give examples of renewable energy types. 2. Analyze the contribution of renewable energy to our daily lives. 3. Produce a solution to a problem using renewable energy.
Week 14		40" + 40"		
Week 15		40" + 40"	Future in Space	1. Prepares a report explaining current space research. 2. Compares the celestial bodies in the solar system in terms of their suitability for life. 3. Makes predictions about the future effects of space research. 4. Generates ideas to make the use of space technologies more effective.
Week 16		40" + 40"	Application of Scales (Scientific Creativity Test and Draw a Scientist Test, Metaphors Related to Scientist, Opinion Form)	

The Draw A Scientist Checklist (DAST-C), developed by Finson, Beaver, and Cramond (1995), was used to score the DAST. It comprises 15 items describing traditional scientist characteristics. Each traditional feature (e.g., lab coat, glasses, facial hair) present in a student's drawing is scored as 1, and its absence as 0. Students can score between 0 and 15 points, with scores approaching 15 indicating a more traditional scientist image.

After calculating SCT and DAST scores, the data were analyzed in SPSS 22.0. Normal distribution was confirmed by examining skewness and kurtosis coefficients, which ranged from -.747 to 1.053. As these coefficients fell between +2 and -2, the data were considered normally distributed (Tabachnick & Fidell, 2012). Consequently, parametric tests were employed. A dependent sample t-test compared pre-test and post-test results, and effect sizes were calculated. According to Cohen (2013), effect sizes are interpreted as: d=.20 (small), d=.50 (medium), and d=.80 (large).

Metaphors were analyzed using an inductive content analysis approach, which derives understanding directly from the data (Elo & Kyngäs, 2008).

Participants' metaphors, collected through specific questions, underwent a five-stage analysis: coding the data, creating categories, organizing data based on codes and categories, ensuring reliability and validity, and interpreting results.

The initial coding phase involved compiling an alphabetical list of all metaphors, determining their clarity, and systematically coding them for each participant. A sample list was developed to validate the analysis process and classify metaphors into categories. The second stage focused on category formation, examining relationships between metaphors based on common characteristics. In the third stage, data were structured according to comprehensive coding and category identification. The fourth stage ensured reliability and validity, with study authors categorizing metaphors and seeking expert opinion for comparison.

The reliability of categorization was quantified using Huberman and Miles's (2002) formula: Reliability = [Consensus / (Consensus + Disagreement) × 100]. This calculation revealed 95% agreement. An inter-coder agreement above 70% indicates sufficient reliability. In the fifth stage, metaphor categories were organized into tables, displaying frequency (f) and percentage (%) of usage for each category and metaphor. Data interpretation followed these findings.

Students' opinions from the opinion form underwent content analysis. Two independent researchers coded the data, and inter-rater agreement was calculated using the same reliability formula: [Agreement / (Agreement + Disagreement) x 100]. The resulting inter-rater agreement of .91 indicated sufficient reliability.

Table 2: t-test Results for Scientific Creativity Test

	Test	N	Mean	Standard Deviation	df	t	*p*
Fluency	Pre-test	22	9.36	4.865	21	-6.142	.000
	Post-test	22	16.05	4.923			
Flexibility	Pre-test	22	27.41	7.570	21	-9.860	.000
	Post-test	22	42.68	7.810			
Originality	Pre-test	22	23.00	11.191	21	-13.189	.000
	Post-test	22	59.55	12.902			
Scientific Creativity	Pre-test	22	59.77	21.454	21	-12.882	.000
	Post-test	22	118.27	22.102			

RESULTS

The first sub-problem of this research aims to determine how activities developed by MoNE-in line with the new curriculum for Science and Art Education Centers-affect the scientific creativity of gifted students during the Individual Talents Identification Period (5th-grade). Students' scientific creativity scores were evaluated based on three sub-dimensions: fluency, flexibility, and originality. From these, a total scientific creativity score was calculated. Table 2 presents the findings from this analysis.

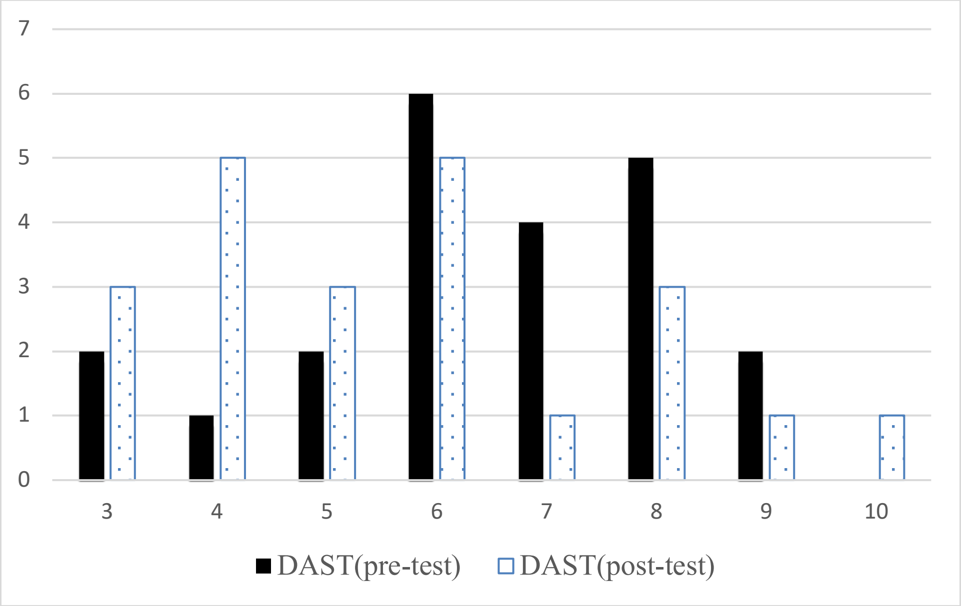
The mean differences between pre-test and post-test results were statistically significant for fluency ($t = -6.142$, $p < .05$), flexibility ($t = -9.860$, $p < .05$), originality ($t = -13.189$, $p < .05$), and total scores of scientific creativity ($t = -12.882$, $p < .05$). Effect sizes were high for fluency ($d=1.365$), flexibility ($d=1.985$), originality ($d=3.015$), and total scores of scientific creativity ($d=2.685$). After implementing the activities, students demonstrated improved ability to generate numerous ideas (fluency), across various categories (flexibility), and with unusual characteristics (originality). These results suggest that the activities developed by MoNE, in line with the new curriculum of Science and Art Education Centers, significantly enhance the scientific creativity of gifted fifth-grade students during the Individual Talents Identification Period.

The study's second sub-problem aims to determine how these MoNE-developed activities affect gifted students' perceptions of scientists during the same period. The findings are presented in Table 3, Table 4, and Figure 1.

Table 3: Frequencies of Students' DAST Scores in Pre-test and Post-test

Score	DAST Pre-test (f)	DAST Post-test (f)
3	2	3
4	1	5
5	2	3
6	6	5
7	4	1
8	5	3
9	2	1
10	0	1
Total	22	22

Figure 1: Frequency Distribution of Students' DAST Scores in Pre-test and Post-test



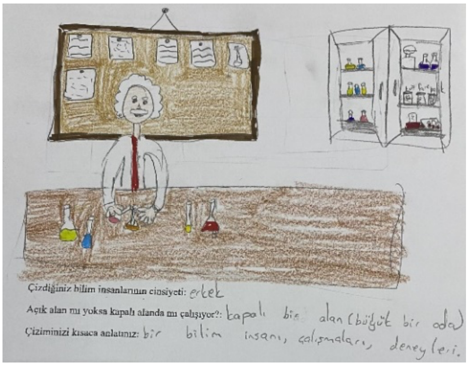
Examination of Table 3 and Figure 1 reveals that students' images of scientists are more traditional in the pre-test. To determine if the difference between the pre-test and post-test was significant, an independent sample t-test was conducted. The results are presented in Table 4.

Table 4: t-test Findings for The Draw A Scientist Test

	Test	N	Mean	Standard Deviation	df	t	*p*
Scientist Images	Pre-test	22	6.45	1.711	21	1.368	.186
	Post-test	22	5.64	6.013			

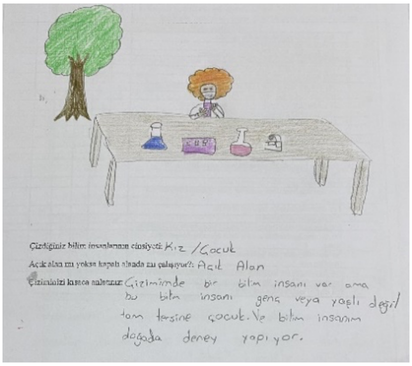
In Table 4, the mean differences between the pre-test and post-test results for the "Draw a Scientist" test scores were not statistically significant (t = 1.368, p > .05). The effect size for scientist images was small (d = 0.438). Analysis of the arithmetic averages showed that students' mean scores decreased after the implementation. This suggests that the students' post-test drawings deviated slightly from the traditional scientist image. Figures 2 and 3 illustrate this shift, showing the pre-test and post-test drawings of S7 (female).

Figure 2: S7's Pre-Test Drawing



Çizdiğiniz bilim insanlarının cinsiyeti: erkek
Açık alan mı yoksa kapalı alanda mı çalışıyor?: kapalı bir alan (büğük bir oda)
Çiziminizi kısaca anlatınız: bir bilim insanı, çalışmaları, deneyleri.

Figure 3: S7's Post-Test Drawing



Çizdiğiniz bilim insanlarının cinsiyeti: Kız / Çocuk
Açık alan mı yoksa kapalı alanda mı çalışıyor?: Açık Alan
Çiziminizi kısaca anlatınız: Çizimimde bir bilim insanı var ama bu bilim insanı genç veya yaşlı değil tam tersine çocuk. Ve bilim insanım doğada deney yapıyor.

Table 5 presents the results of analyzing the pre-test and post-test scientist drawings of S7 in Figure 2 and Figure 3, according to the criteria in DAST-C.

Table 5: Analyzing S7's Scientist Drawings According to DAST-C

Criteria	Pre-test drawings of S7	Post-test drawings of S7
Lab coat	Yes	Yes
Glasses	No	No
Facial hair	Yes	No
Research symbols (scientific instruments, laboratory equipment)	Yes	Yes
Information symbols (books, filing cabinets, pen holders, pens in pockets, etc.)	No	No
Technology (TV, telephone, missiles, computer, etc.)	No	No
Related headings (formulas, taxonomic classifications, "Eureka!" moment)	Yes	No
Gender	Male	Female

Ethnicity	Caucasian	Caucasian
Danger signs	No	No
Thought bubble	No	No
Recognizable scientist (stereotypical or famous)	Einstein	Not recognizable
Secrecy indicators ("Private", "No Entry", "Top Secret", etc.)	No	No
Working environment (inside or outside)	Inside	Outside
Age	Old	Young

Table 6: Students' Metaphors About Scientists

Category	Pre-test Metaphors	Pre-test Total f	Post-test Metaphors	Post-test Total f
Profession	Doctor (2) Inventor (1) Actor (1) Soldier (1) Teacher (1)	6	Science teacher (1) Inventor (1) Astronaut (2)	4
Mind-related	Brainbox (3) Brain (3)	6	Brainbox (3) Brain (1)	4
Adjectives	Different (1) Persevering (1) Hardworking (1) Hero (1) Creative (2) World-advancing (1)	7	Persevering (1) Savior (1) Confused (1) Visionary (1) Assistant (1) Miracle (1) Non-human (1)	7
Celestial bodies	Star (1)	1	Star (1) Sun (1)	2
Others	Robot (1) Future (1)	3	Bee (1) Development (1) Daytime (1) Future (1) Hope (1)	5

Analysis of Table 5 reveals that S7's pre-test scientist image aligned more closely with the traditional stereotype. This image depicted a familiar scientist like Einstein-an older male with facial hair working in a closed environment. However, S7's post-test image significantly diverged from this stereotype, portraying a young female working in an open area who wasn't a familiar figure. During scoring, statements matching the traditional scientist image were coded as 1, while those didn't were coded as 0.

The third sub-problem of the research examines how activities developed by MoNE, in line with the new Science and Art Education Centers curriculum, affect gifted 5th-grade students' perceptions of scientists during the Individual Talents Identification Period. To address this, students' metaphors about scientists were analyzed. Table 6 presents the findings from this analysis.

Students' metaphors about scientists were categorized into five groups: profession, mind-related, adjectives, celestial bodies, and others. Pre-test metaphors in the profession category included "doctors", "inventors", "actors", "soldiers", and "teachers", while post-test metaphors focused on "science teachers", "inventors", and "astronauts". The "inventor" metaphor was consistent across both tests. New metaphors like "science teacher" and "astronaut" emerged after the treatment, suggesting a shift in students' perceptions of scientific professions. Examples of profession-related metaphors include:

> "A scientist is like a soldier because they do everything for science." (S17, male, pre-test)
>
> "A scientist is like a teacher because they teach scientific innovations to the whole world." (S20, female, pre-test)
>
> "A scientist is like an inventor because they work to benefit humanity." (S4, male, post-test)
>
> "A scientist is like an astronaut because they do good things for humanity." (S12, female, post-test)

In the mind-related category, students consistently used "brainbox" and "brain" metaphors in both tests. Examples include:

> "A scientist is like a brain because they are very intelligent." (S5, female, pre-test)
>
> "A scientist is like a brainbox because they're complex yet intelligent and logical." (S3, female, post-test)

Students produced metaphors in the adjective category for both the pre-test and post-test. The concept of "persevering" appeared as a metaphor in both instances. In the pre-test, students used metaphors such as "different", "hardworking", "hero", "creative", and "world-advancing". For the post-test, they employed metaphors like "savior", "confused", "visionary", "assistant", "miracle", and "non-human". This category reveals a significant shift in the metaphors used by students before and after the treatment. Examples of adjective-related metaphors from both tests are provided below:

> "Scientists are like creators because we've achieved many things with them." (S14, male, pre-test)

> "A scientist is like a savior because every discovery contributes to humanity and solves problems." (S13, male, post-test)

For celestial bodies, students used the “star” metaphor in the pre-test, adding “sun” in the post-test:

> "A scientist is like a star because they try to advance our country." (S9, female, pre-test)
>
> "A scientist is like the sun because they illuminate the world." (S8, female, post-test)

The "others" category expanded from “robot” and “future” in the pre-test to include “bee”, “development”, “daytime”, and “hope” in the post-test:

> "A scientist is like a robot because they conduct research." (S1, male, pre-test)
>
> "Scientists are like bees because they are hardworking." (S1, male, post-test)

The significant differences in metaphors between pre-test and post-test-except in the mind-related category-suggest a potential change in students’ perceptions of scientists.

Table 7: Changes in Gifted Students' Perspectives towards Science and Scientists

Category	Code	f	%
Changed	Science and scientists are accessible to everyone, not just a select few	5	23
	Scientists work hard and use their intelligence	4	18
	Scientists solve problems through projects and inventions	3	14
	Age is not a barrier to becoming a scientist	3	14
	Gained more knowledge about science and scientists	2	9
Not changed	Maintained same perspectives	4	18
	Continued interest in science	1	4
Total		22	100

The study’s fourth sub-problem examines whether teaching gifted students’ activities developed by the MoNE for Science and Art Education Centers’ new curriculum affects their perspectives on scientists and scientific concepts. Table 7 presents findings on changes in gifted students’ perspectives towards science and scientists.

Analysis of Table 7 reveals that while 22% of students' views on science and scientists remain unchanged, 78% experienced a shift in perspective. The students' responses highlighted several key changes:

23% developed the view that science and scientific careers are accessible to everyone, not just a select few. As one student put it:

> "I realized anyone could be a scientist and I understood science better." (S11, male)
>
> 18% recognized that scientists work diligently and apply their intelligence. For example:
>
> "I gained a better understanding of scientists' work and how they use their intelligence." (S6, male)
>
> 14% came to see that science and scientists solve problems through projects and inventions. One student noted:
>
> "I used to think science was just about experiments, but I learned that science and scientists solve problems by making discoveries in various fields." (S1, male)

Another 14% realized that age is not a barrier to becoming a scientist. As one student expressed:

> "I discovered that young people can be scientists too." (S9, female)
>
> 9% reported gaining more knowledge about scientists overall:
>
> "My thoughts were different before. The lessons taught me more about science and scientists, changing my perspective." (S2, male)

The 22% who reported no change in their views expressed opinions such as:

> "There wasn't much change. I'm still interested in science, but my perspective remains the same." (S21, male)
>
> "My view of scientists didn't change as I already had broad ideas, but my scientific perspective evolved. We covered various topics, which I connected to science." (S3, female)

Those reporting no change generally maintained their pre-existing positive view of science.

The study's fifth sub-problem aims to determine gifted students' opinions about the science course after experiencing activities developed by the MoNE for the new Science and Art Education Centers curriculum. Table 8 presents these findings.

Gifted students' opinions about the science course, which uses activities developed by the MoNE for the new Science and Art Education Centers curriculum, were categorized under "Opinions about the Science Course." Some students expressed multiple viewpoints. Here are examples:

> "The information we learn at the Science and Art Education Center is useful in my life. We conduct various experiments there. With the small group size, we can ask questions immediately and communicate

effectively." (S3, female) (Life application, experimentation, effective communication)

"Science lessons at the Science and Art Education Center are both fun and informative," said S11, a male participant. (Informative and enjoyable)

"In science lessons at the Science and Art Education Center, we learn through experiments. We work in groups and communicate." (S20, female) (Experimentation, group work, communication)

The final research sub-problem aims to assess how creatively gifted students connect the MoNE-developed activities, aligned with the new Science and Art Education Centers curriculum, to daily life. Table 9 presents the students' responses.

Tablo 8: Opinions of Gifted Students towards Science Course

Category	Code	f	%
Opinions about the science course	Learning by doing/experimenting	15	46
	Detailed information	10	30
	Interactive communication	3	9
	Enjoyable experience	3	9
	Real-life applications	1	3
	Collaborative work	1	3
Total		33	100

Tablo 9: Students' Association of Science Lessons with Daily Life

Category	Code	f	%
Powerful Tools of Science: Methods	Using a magnet to collect iron, nickel, and cobalt objects (e.g., needles, spoons)	4	18
	Floating a ship in water, sinking a stone	1	4.5
	Making tea from herbs without a teapot	1	4.5
Cell theory	Examining microorganisms in samples from contaminated areas	1	4.5
Chemical phenomena	Brushing teeth	2	9
	Cleaning pollution with acidic substances	2	9
	Understanding chemical events in digestion	1	4.5
	Diabetes	2	9

Let's Explore Genetics	Blood cell diseases	1	4.5
Renewable Energy	Environmental awareness	3	14
	Energy production from waste	2	9
	Self-cleaning headphones	1	4.5
Future in Space	Self-cleaning bottle for use in space	1	4.5
Total		22	100

Analysis of Table 9 reveals six categories in students' responses: powerful tools of science: methods, cell theory, chemical phenomena, let's explore genetics, renewable energy, and future in space. The analysis yielded thirteen distinct ideas, indicating a group fluency score of 13. These six categories demonstrate the group’s flexibility in generating ideas across different domains.

Regarding originality, Hu and Adey’s (2002) evaluation criteria consider ideas given by less than 5% of the group as highly original, those between 5% and 10% as moderately original, and those given by more than 10% as not original. Based on these criteria, seven of the 13 ideas were highly original, four had medium originality, and two were not original. Examples of students' answers include:

> "When a pin falls on the floor at home, I can easily pick it up with a magnet. I learned this through scientific methods in my science class." (S12, female)
>
> "People around me think brushing teeth is unnecessary. I explain that the food they eat is acidic, while toothpaste is basic. When we brush our teeth, a neutralization reaction occurs, ensuring our teeth stay healthy." (S1, male)
>
> "For example, a ship floats on water, but a stone sinks." (S16, female)

DISCUSSION

This study evaluated the effectiveness of MoNE's Science and Art Education Centers (SACs) curriculum gifted students’ scientific creativity. Results revealed that activities implemented during the Individual Talents Identification Period significantly enhanced students' creativity, as evidenced by their ability to generate numerous ideas across different categories with high originality. This finding aligns with previous research highlighting the importance of incorporating creative activities into educational curricula to foster student creativity. Studies have shown that integrating creative thinking exercises and activities in education can boost students' creative thinking abilities, including fluency, flexibility, and originality (Kim, 2011; Runco, 2004). Moreover, research indicates that gifted students often require specialized programs and activities to fully develop their creativity (Starko, 2021), with activities designed for gifted students and aligned with the curriculum being particularly effective (Callahan, Moon, Oh, Azano & Hailey, 2015; VanTassel-Baska, Bass, Ries, Poland & Avery, 1998). Santanen, Briggs and Vreede (2004) found that creative interventions, such as brainstorming activities, positively affected students’ creative potential. Similarly, Sun, Wang and Wegerif (2020) discovered that a creativity training program emphasizing problem-solving skills and divergent thinking significantly improved high school students’ creativity. These findings corroborate the results of the MoNE study, suggesting that incorporating creative activities into educational curricula can indeed enhance students' creativity.

In the post-test, students' drawings deviated slightly from the traditional image of a scientist. Research has shown that exposure to science education programs can positively impact students' perceptions of science and scientists. For instance, Leblebicioglu, Metin, Yardimci and Cetin (2011) found that students who participated in a science education program were more likely to draw scientists as diverse individuals with various characteristics, rather than as the stereotypical "mad scientist" or "white male in a lab coat". Similarly, Huang, Ko, Lin, Dai and Chen (2021) discovered that after implementing a creative science education program, students in the experimental group showed significant improvement in their creativity compared to the control group. Additionally, students’ perception of scientists as "mad" or "eccentric" shifted to a more positive and diverse image. These results suggest that incorporating creative activities in science education can positively impact students' creativity and their perception of scientists. Ruiz-Mallén, Gallois and Heras (2018) found that after participating in a creativity training program, students' drawings of scientists became less stereotypical and more varied, indicating that creative interventions can lead to changes in students' perceptions and stereotypes about science and scientists. Painter, Jones, Tretter and Kubasko (2006) discovered that involving researchers in science learning activities and incorporating artistic techniques can increase students' interest in science and related careers, though they suggested that additional time and integration of the artistic dimension may be necessary for greater impact. Shimwell, DeWitt, Davenport, Padwick, Sanderson and Strachan (2023) found that incorporating creative activities into science education curricula led to increased scientific creativity among students and challenged traditional stereotypes of scientists. Their study showed that students who participated in a science and art integrated program had a higher level of scientific creativity and drew more diverse representations of scientists compared to the control group. These findings support the idea that creative activities can enhance scientific creativity and promote a more diverse and inclusive image of scientists among students.

This study examined the categories of metaphors that students created about scientists, classified into professions, mental attributes, adjectives, and other categories. The pre-test revealed that students associated scientists with metaphors related to doctors, inventors, actors, soldiers, and teachers. However, after an intervention, the post-test showed that students used metaphors related to science teachers, inventors, and astronauts. This suggests that interventions can impact students' perceptions of scientists and their understanding of what science is and who can do it. Research has consistently shown that students' perceptions of scientists are often stereotypical and limited, with scientists being seen as white, male, and lacking social skills (Piatek-Jimenez, Cribbs & Gill, 2018). These stereotypes can negatively impact students' interest in science and their willingness to pursue science careers (Finson, 2002). Studies investigating the use of metaphors to explore students' perceptions of scientists have found that students often associate scientists with traditional scientific professions such as doctors, engineers, and lab technicians (Scherz & Oren, 2006). However, interventions aimed at broadening students' understanding of what science is and who can do it have been successful in changing students' perceptions of scientists (Shin, Parker, Adedokun, Mennonno, Wackerly & San Miguel, 2015). Similarly, Şaşmaz Ören, Karapinar, Sari and Demirer (2023) found that a science program positively affected middle school students' perceptions of scientists, particularly in terms of physical appearance and symbols of knowledge and research. For example, Hong and Lin-Siegler (2012) highlighted that the diverse backgrounds and experiences of scientists led to a more complex and diverse understanding of what it means to be a scientist among students. These findings that an intervention can change students' perceptions of scientists are consistent with previous research. Interventions that aim to broaden students' understanding of what science is and who can do it may be effective in promoting more diverse and inclusive representations of scientists.

This study examines the use of metaphors by students in both pre-test and post-test settings. The results show that students used metaphors related to the “brainbox” and “brain” in the mind category, as well as adjectives. The most commonly used metaphor was “persevering”. In the pre-test, students used different metaphors, including “hardworking”, “hero”, “creative”, and “world-advancing”, while in the post-test, they used metaphors such as “savior”, “confused”, “visionary”, “assistant”, “miracle”, and non-human metaphors. These findings suggest that students' use of metaphors can change over time and that different metaphors may be used when thinking about the same concept. Several studies have examined the use of metaphors in various contexts. In education, research has shown that metaphors can enhance learning and understanding of complex concepts (Cameron, 2003). Similarly, studies have found that metaphors can help students make connections between different topics and ideas (Wormeli, 2009). Regarding students’ use of metaphors, one study found that students tend to use metaphors that reflect their personal experiences and cultural backgrounds (Demir, 2007). Another study examined the use of metaphors by students in a pre-test and post-test setting and found that students' use of metaphors can change over time (Menia, Mudzakir & Rochintaniawati, 2017). The findings of the current study are consistent with previous research. The results suggest that students' use of metaphors can shift over time and that different metaphors may be used when thinking about the same concept. This highlights the importance of understanding the context and cultural background of the students when analyzing their use of metaphors.

The study examined students' use of metaphors about celestial bodies. In the pre-test, students produced the "star" metaphor and others that included "robots" and the "future". However, in the post-test, students produced both the "star" and "sun" metaphors, and others that included "bee", "development", "daytime", "future", and "hope". The results suggest that students' use of metaphors can evolve and change over time and that different metaphors can describe the same concept.

Understanding the use of metaphors in education can potentially aid in developing effective teaching strategies based on students' cognitive processes. Although some students' views on science and scientists remained unchanged, most experienced a shift in perspective. Additionally, some students developed the belief that science is not limited to a select few, and anyone can do science and become a scientist. They recognized that scientists are ordinary people. Metaphors are a powerful tool in education, as they can help students understand complex concepts by relating them to familiar concepts. Lawley and Tompkins (2000) found that students' use of metaphors can evolve and change over time, and different metaphors can describe the same concept. This suggests that educators need to be aware of the metaphors that students use to better understand their thought processes and develop effective teaching strategies. Additionally, Cameron (2003) found that the use of metaphors in education can help students remember and recall information more effectively. Moreover, the study highlights the potential of metaphors to facilitate changes in students' perspectives and beliefs about science and scientists (Aubusson, Harrison & Ritchie, 2006). Therefore, understanding the use of metaphors in education can potentially aid in developing effective teaching strategies based on students' cognitive processes. Sönmez (2024) further emphasizes the effectiveness of using metaphors in education to uncover and shape students' understanding of scientific concepts, particularly in the context of gifted primary school students conceptualizing complex ideas like upcycling.

The opinions of gifted students regarding the science course improved, particularly in terms of their preference for learning by doing/experimenting and receiving detailed information. Research has shown that gifted students tend to prefer hands-on learning experiences, such as learning by doing or experimenting, over traditional lecture-based methods (Gomez-Arizaga, Valdivia-Lefort, Castillo-Hermosilla, Hébert & Conejeros-Solar, 2020; Samardzija & Peterson, 2015).

Additionally, providing detailed and in-depth information can enhance the learning experience for gifted students, as they have a greater capacity for processing complex information (Aubry, Gonthier & Bourdin, 2021). Thus, it is not surprising that the opinions of gifted students regarding science courses improved when they were provided with opportunities for hands-on learning and detailed information. This aligns with Kaynar and Kurnaz's (2024) findings that an interdisciplinary teaching approach can boost students' cognitive abilities, helping them perceive relationships between concepts more clearly and forge deeper connections across disciplines.

The student's ability to relate scientific concepts to everyday life has improved in terms of fluency and flexibility. Specifically, they are now capable of generating a greater range of ideas across different categories. Furthermore, when evaluated using the criteria established by Hu and Adey (2002), the originality of their responses also improved. According to a study by Kim and Kim (2021), students' ability to relate scientific concepts to everyday life can be improved through explicit instruction and hands-on experiences. The study found that students who received this type of instruction demonstrated greater fluency and flexibility in generating ideas related to scientific concepts. Additionally, the study found that students who received this instruction showed increased originality in their responses when evaluated using established criteria. These findings support the observation that the students' ability to relate scientific concepts to everyday life has improved in terms of fluency, flexibility, and originality. According to Aikenhead (2006), teaching science with real-life examples improved students' ability to relate scientific concepts to everyday life. The students were able to generate more analogies, make more connections between scientific concepts and everyday life, and provide more examples related to everyday life. Similarly, in a study by Mayo (2001), students who were taught science concepts using real-life examples performed better in terms of generating analogies and providing examples. These studies suggest that teaching science using real-life examples can enhance students' fluency and flexibility in relating scientific concepts to everyday life. This aligns with the findings of Lage-Gómez and Ros (2024), who highlight the importance of diverse activities, outings, expert collaboration, and the creation of transdisciplinary final products in fostering interconnections between areas of creativity in STEAM education.

The study evaluated the effectiveness of incorporating creative activities into educational curricula to enhance scientific creativity and promote a more diverse and inclusive image of scientists among gifted students. The results showed that the activities implemented significantly enhanced the students' creativity, and their perception of scientists became less stereotypical and more diverse. The study also examined the use of metaphors by students about scientists and celestial bodies, which were found to evolve and change over time. The opinions of gifted students regarding science courses improved, particularly in terms of their preference for learning by doing/experimenting and receiving detailed information. Finally, the students’ ability to relate scientific concepts to everyday life improved in terms of fluency, flexibility, and originality. These findings are consistent with recent research by Gorgulu and Unlu (2024), which revealed that while gifted students generally presented perspectives aligned with the nature of science, some held views on the role of scientists in producing scientific knowledge and the basis of scientific knowledge that were not consistent with NOS principles. This highlights the need for targeted activities to enhance the NOS evaluations of gifted students.

To enhance students' scientific creativity and promote a more inclusive view of scientists, educators should incorporate creative activities, hands-on learning experiences, and detailed information into science curricula, especially for gifted students. Using metaphors as a teaching tool can help students grasp complex concepts and reveal their perceptions of science. Designing interventions that broaden students' understanding of science and scientists, integrating real-life examples, and providing opportunities for problem-solving and divergent thinking can improve creativity in scientific contexts. Regular assessment and adaptation of teaching strategies based on students' evolving perceptions and use of metaphors is crucial for maintaining an effective learning environment. This approach aligns with the findings of Piske, Collins and de Cássia Nakano (2024), who emphasize the importance of student-centered learning approaches, incorporating various technologies and activities, and creating a psychologically safe environment that encourages unusual questions, answers, and creations. Additionally, as highlighted by Zhou (2024), collaboration between educational institutions, museums, and policymakers can maximize the impact of informal learning experiences on children's cognitive development and scientific understanding. However, as noted by Maor et al. (2024), there is often a gap between teachers' positive attitudes towards creativity and its practical implementation in the classroom, suggesting a need for further support and training for educators in implementing creative teaching practices.

In the context of gifted education in Turkey, Paçacı (2024) highlights the substantial expectations placed on gifted students and the need for comprehensive content in gifted education, particularly in science. The study identifies several challenges in Science and Art Centers (SACs), including the risk of these institutions losing their specialized focus. To address these issues, it is crucial to develop a clear vision and purpose for SACs, ensuring their continued effectiveness in nurturing gifted students' talents. This aligns with the broader findings of our study, emphasizing the need for specialized, creative approaches in gifted education to foster scientific creativity and promote a more inclusive understanding of science and scientists.

CONCLUSION AND IMPLICATIONS

This study reveals that activities developed by MoNE for Science and Art Education Centers significantly boost gifted students' scientific creativity-especially in fluency, flexibility, and originality. Students' perceptions of scientists shifted slightly away from traditional stereotypes, while their metaphors about scientists evolved, indicating a broader understanding of scientific professions. Notably, 78% of students experienced a change in their views on science and scientists, realizing that science is accessible to all and that age doesn't limit one's potential to become a scientist. The science course was positively received, with students particularly valuing the hands-on learning approach and comprehensive information provided.

Based on the study's findings, here are some recommendations:

- Integrating creative activities into educational curricula to enhance scientific creativity and promote diverse scientist representation
- Implementing hands-on learning experiences and providing detailed information in science courses, especially for gifted students
- Using metaphors as a teaching tool to explain complex scientific concepts and gauge perceptions
- Designing interventions to broaden understanding of science and scientists, fostering inclusive representations
- Incorporating real-life examples and applications in scientific concept teaching to improve relevance to everyday life
- Offering problem-solving and divergent thinking opportunities to enhance scientific creativity
- Regularly assessing and adapting teaching strategies based on metaphor usage and evolving perceptions of science and scientists

The study has several limitations and suggests avenues for future research:

Limitations:

- Small sample size: The study included only 22 students, potentially limiting result generalizability.
- Lack of control group: The one-group pretest-posttest design is considered weaker due to the absence of a control group.
- Short duration: Conducted over one academic term, the study may not capture long-term curriculum effects.
- Limited geographical scope: The study took place in a single Science and Art Education Centre in northwestern Türkiye, possibly not representing the country's diverse gifted education landscape.

Future Research:

- Conduct larger-scale studies with a more diverse sample of gifted students from various regions of Türkiye to improve generalizability.

- Implement a randomized controlled trial to compare MoNE activities' effectiveness with traditional curricula or other interventions.
- Perform longitudinal studies to assess the curriculum's long-term impact on students' scientific creativity and perceptions of scientists.
- Investigate the curriculum's effectiveness across different age groups and grade levels within Science and Art Education Centers.
- Explore how teacher training and implementation of fidelity affect MoNE activities' effectiveness.
- Examine whether enhanced scientific creativity transfers to other academic domains and real-world problem-solving situations.
- Investigate potential differences in the curriculum's effectiveness based on gender, socioeconomic background, or other demographic factors.

Disclosure Statement

The authors declare no competing interest.

REFERENCES

Aikenhead, G. S. (2006). *Science education for everyday life: Evidence-based practice*. Teachers College Press.

Archambault, F. X., Westberg, K. L., Brown, S. W., Hallmark, B. W., Emmons, C. L., & Zhang, W. (1995). *Regular classroom practices with gifted students: Results of a national survey of classroom teachers* (Research Monograph 93102). The National Research Center on the Gifted and Talented, University of Connecticut.

Aruan, S. A., Okere, M. I., & Wachanga, S. (2016). Influence of culture and gender on secondary school students' scientific creativity in biology education in Turkana County, Kenya. *Journal of Education and Practice*, *7*(35), 25-35.

Assouline, S. G., Mahatmya, D., Ihrig, L., & Lane, E. (2021). High-achieving rural middle-school students' academic self-efficacy and attributions in relationship to gender. *High Ability Studies*, *32*(2), 143-169. https://doi.org/10.1080/13598139.2020.1740582

Astutik, S., & Prahani, B. K. (2018). The practicality and effectiveness of collaborative creativity learning (CCL) model by using PhET simulation to increase students' scientific creativity. *International Journal of Instruction*, *11*(4), 409-424.

Aubry, A., Gonthier, C., & Bourdin, B. (2021). Explaining the high working memory capacity of gifted children: Contributions of processing skills and executive control. *Acta Psychologica, 218*, 103358. https://doi.org/10.1016/j.actpsy.2021.103358

Aubusson, P. J., Harrison, A. G., & Ritchie, S. M. (2006). Metaphor and analogy: Serious thought in science education. In P. J. Aubusson, A. G. Harrison,

& S. M. Ritchie (Eds.), *Metaphor and analogy in science education* (pp. 1-9). Springer. https://doi.org/10.1007/1-4020-3830-5_1

Ayverdi, L., Asker, E., Aydin, S. Ö., & Saritaş, T. (2012). Determination of the relationship between elementary students' scientific creativity and academic achievement in science and technology courses. *Elementary Education Online,* *11*(3), 646-659. https://dergipark.org.tr/en/pub/ilkonline/issue/8588/106717

Bermejo, M. R., Ruiz-Melero, M. J., Esparza, J., Ferrando, M., & Pons, R. (2016). A new measurement of scientific creativity: The study of its psychometric properties. *Anales de Psicología*, *32*(3), 652-661. http://dx.doi.org/10.6018/analesps.32.3.259411

Brown, B. (2017). *The predictive value of self-regulation to predict the underachievement of gifted preadolescent students* [Unpublished doctoral dissertation]. University of Alabama.

Brown, K., Grimbeek, P., Parkinson, P., & Swindell, R. (2004). Assessing the scientific literacy of younger students: Moving on from the stereotypes of the Draw-A-Scientist-Test. In *Educating: Weaving research into practice* (Vol. 1, pp. 144-152). Griffith University, School of Cognition, Language and Special Education.

Büyüköztürk, Ş., Çokluk, Ö., & Köklü, N. (2010). *Statistics for the social sciences* (6th ed.). Pegem Akademy.

Callahan, C. M., Moon, T. R., Oh, S., Azano, A. P., & Hailey, E. P. (2015). What works in gifted education: Documenting the effects of an integrated curricular/instructional model for gifted students. *American Educational Research Journal,* *52*(1), 137-167. https://doi.org/10.3102/0002831214549448

Cameron, L. (2003). *Metaphor in educational discourse.* Continuum.

Chambers, D. (1983). Stereotypic images of the scientist: The Draw-A-Scientist Test. *Science and Children, 67*(2), 255-265.

Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*. Routledge.

Coleman, L. J., & Cross, T. L. (2021). *Being gifted in school: An introduction to development, guidance, and teaching*. Routledge.

Creswell, J. W., & Plano Clark, V. L. (2017). *Designing and conducting mixed methods research*. Sage Publications.

Dai, D. Y. (2019). Toward a new era of gifted education: Principles, policies, and strategies. *Talent*, *9*(1), 2-15. https://theeducationjournals.com/index.php/talent/article/view/68

Demir, C. E. (2007). Metaphors as a reflection of middle school students' perceptions of school: A cross-cultural analysis. *Educational Research and Evaluation,* *13*(2), 89-107. https://doi.org/10.1080/13803610701204099

Dixson, D. D., Olszewski-Kubilius, P., Subotnik, R. F., & Worrell, F. C. (2020). Developing academic talent as a practicing school psychologist: From potential to expertise. *Psychology in the Schools*, *57*(10), 1582-1595. https://doi.org/10.1002/pits.22363

Doğan, H. (2015). *A study on 11 to 13 year old students' perception of science and scientist from different countries* [Unpublished master's thesis]. Akdeniz University.

Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, *62*(1), 107-115. https://doi.org/10.1111/j.1365-2648.2007.04569.x

Emvalotis, A., & Koutsianou, A. (2018). Greek primary school students' images of scientists and their work: Has anything changed?. *Research in Science & Technological Education*, *36*(1), 69-85. https://doi.org/10.1080/02635143.2017.1366899

Farland-Smith, D., Finson, K. D., & Arquette, C. M. (2017). How picture books on the national science teacher's association recommend list portray scientists. *School Science and Mathematics*, *117*(6), 250-258. https://doi.org/10.1111/ssm.12231

Finson, K. D. (2002). Drawing a scientist: What we do and do not know after fifty years of drawings. *School Science and Mathematics, 102*(7), 335-345. https://doi.org/10.1111/j.1949-8594.2002.tb18217.x

Finson, K. D., Beaver, J. B., & Cramond, B. L. (1995). Development and field test of a checklist for the Draw-A-Scientist Test. *School Science and Mathematics, 95*(4), 195-205. https://doi.org/10.1111/j.1949-8594.1995.tb157 62.x

Gomez-Arizaga, M. P., Valdivia-Lefort, M., Castillo-Hermosilla, H., Hébert, T. P., & Conejeros-Solar, M. L. (2020). Tales from within: Gifted students' lived experiences with teaching practices in regular classrooms. *Education Sciences, 10*(5), 137. https://doi.org/10.3390/educsci10050137

Gorgulu, D., & Unlu, S. (2024). Investigation of gifted secondary school students' assessment of the nature of science in turkey. *ESI Preprints, 30*, 129-150. https://doi.org/10.19044/esipreprint.6.2024.p129

Hong, H.-Y., & Lin-Siegler, X. (2012). How learning about scientists' struggles influences students' interest and learning in physics. *Journal of Educational Psychology, 104*(2), 469–484. https://doi.org/10.1037/a0026224

Hu, W., & Adey, P. (2002). A scientific creativity test for secondary school students. *International Journal of Science Education*, *24*(4), 389-403. https://doi.org/10.1080/09500690110098912

Huang, Y., Ko, J., Lin, H., Dai, H., & Chen, C. (2021). Creative thinking counseling teaching program can improve the creativity, creative tendency, and self-concept of grade 7 students: A quasi-experimental study. *The Journal of Creative Behavior*, *55*(3), 819-838. https://doi.org/10.1002/jocb.491

Huberman, M., & Miles, M. B. (2002). *The qualitative researcher's companion*. Sage.

Hunsaker, S. L., Nielsen, A., & Bartlett, B. (2010). Correlates of teacher practices influencing student outcomes in reading instruction for advanced readers. *Gifted Child Quarterly*, *54*(4), 273-282. https://doi.org/10.1177/0016986210374506

Kaufman, S. B., & Sternberg, R. J. (2008). Conceptions of giftedness. In S. I. Pfeiffer (Ed.), *Handbook of giftedness in children* (pp. 71–93). Springer.

Kaynar, H., & Kurnaz, A. (2024). The effect of interdisciplinary teaching approach on the creative and critical thinking skills of gifted pupils. *Thinking Skills and Creativity*, 101637. https://doi.org/10.1016/j.tsc.2024.101637

Kim, K. H. (2011). The creativity crisis: The decrease in creative thinking scores on the Torrance Tests of Creative Thinking. *Creativity Research Journal, 23*(4), 285-295. https://doi.org/10.1080/10400419.2011.627805

Kim, S. L., & Kim, D. (2021). English learners' science-literacy practice through explicit writing instruction in invention-based learning. *International Journal of Educational Research Open, 2*, 100029. https://doi.org/10.1016/j.ijedro.2020.100029

Koren, P., & Bar, V. (2009). Pupils' image of 'the scientist' among two communities in Israel: A comparative study. *International Journal of Science Education*, *31*(18), 2485-2509. https://doi.org/10.1080/09500690802449375

Lage-Gómez, C., & Ros, G. (2024). On the interrelationships between diverse creativities in primary education STEAM projects. *Thinking Skills and Creativity, 51*, 101456. https://doi.org/10.1016/j.tsc.2023.101456

Lawley, J., & Tompkins, P. (2000). *Metaphors in mind: Transformation through symbolic modelling*. Developing Company Press.

Leblebicioglu, G., Metin, D., Yardimci, E., & Cetin, P. S. (2011). The effect of informal and formal interaction between scientists and children at a science camp on their images of scientists. *Science Education International, 22*(3), 158-174.

Maor, R., Paz-Baruch, N., Mevarech, Z., Grinshpan, N., Levi, R., Milman, A., Shlomo, S., & Zion, M. (2024). Teaching creatively and teaching for creativity–theory, teachers' attitudes, and creativity-based practices. *Educational Studies*, 1-15. https://doi.org/10.1080/03055698.2024.2371091

Mayo, J. A. (2001). Using analogies to teach conceptual applications of developmental theories. *Journal of Constructivist Psychology, 14*(3), 187-213. https://doi.org/10.1080/10720530126292

McClain, M., & Pfeiffer, S. (2012). Identification of gifted students in the United States today: A look at state definitions, policies, and practices. *Journal of Applied School Psychology, 28*(1), 59-88. https://doi.org/10.1080/15377903.2012.643757

Menia, M., Mudzakir, A., & Rochintaniawati, D. (2017). The effect of conceptual metaphors through guided inquiry on student's conceptual change. In *AIP Conference Proceedings* (Vol. 1848, No. 1). AIP Publishing.

Ministry of National Education (MoNE) (2022a). *Science and art centers student identification and placement guide.* https://orgm.meb.gov.tr/meb_iys_dosyalar/2021_12/30144032_2021-2022_YILI_BILIM_VE_SANAT_MERKEZLERI_OGRENCI_TANILAMA_VE_YERLESTIRME_KILAVUZU.pdf

Ministry of National Education (MoNE) (2022b). *Special education area.* http://orgm.meb.gov.tr/www/ozel-egitim-alani/icerik/1951

O'Donnell, C. L. (2008). Defining, conceptualizing, and measuring fidelity of implementation and its relationship to outcomes in K–12 curriculum intervention research. *Review of Educational Research*, *78*(1), 33-84. https://doi.org/10.3102/0034654307313793

Paçacı, Ç. (2024). Gifted education in Turkiye from the perspectives on Science and Art Centers (SAC): Issues and suggestions. *Journal of Gifted Education and Creativity, 11*(1), 23-35. https://doi.org/10.5281/zenodo.

Painter, J., Jones, M. G., Tretter, T. R., & Kubasko, D. (2006). Pulling back the curtain: Uncovering and changing students' perceptions of scientists. *School Science and Mathematics, 106*(4), 181-190. https://doi.org/10.1111/j.1949-8594.2006.tb18074.x

Peterson, J. S. (2015). School counselors and gifted kids: Respecting both cognitive and affective. *Journal of Counseling & Development, 93*(2), 153-162. https://doi.org/10.1002/j.1556-6676.2015.00191.x

Peterson, J. S. (2019). Presenting a qualitative study: A reviewer's perspective. *Gifted Child Quarterly*, *63*(3), 147-158. https://doi.org/10.1177/0016986219844789

Piatek-Jimenez, K., Cribbs, J., & Gill, N. (2018). College students' perceptions of gender stereotypes: Making connections to the underrepresentation of women in STEM fields. *International Journal of Science Education, 40*(12), 1432-1454. https://doi.org/10.1080/09500693.2018.1482027

Piske, F. H. R., Collins, K. H., & de Cássia Nakano, T. (2024). Teaching strategies and the role of creativity in gifted education: Perceptions of students, families, and educational professionals. *International Journal for Talent Development and Creativity, 11*(1), 225-240. https://files.eric.ed.gov/fulltext/EJ1436970.pdf

Purcell, J. H., Burns, D. E., Tomlinson, C. A., Imbeau, M. B., & Martin, J. L. (2002). Bridging the gap: A tool and technique to analyze and evaluate gifted education curricular units. *Gifted Child Quarterly*, *46*(4), 306-321. https://doi.org/10.1177/001698620204600407

Rasul, M. S., Zahriman, N., Halim, L., Rauf, R. A., & Amnah, R. (2018). Impact of integrated STEM smart communities program on students scientific creativity. *Journal of Engineering Science and Technology*, *13*(11), 80-89.

Reis, S. M., & Purcell, J. H. (1993). An analysis of content elimination and strategies used by elementary classroom teachers in the curriculum compacting process. *Journal for the Education of the Gifted*, *16*(2), 147-170.

Renzulli, J. S., & Reis, S. M. (2021). The three ring conception of giftedness: A change in direction from being gifted to the development of gifted behaviors. In R. J. Sternberg & D. Ambrose (Eds.), *Conceptions of giftedness and talent* (pp. 327-343). Palgrave Macmillan. https://doi.org/10.1007/978-3-030-56869-6_19

Rinn, A. N., & Bishop, J. (2015). Gifted adults: A systematic review and analysis of the literature. *Gifted Child Quarterly, 59*(4), 213-235. https://doi.org/10.1177/0016986215600795

Ruiz-Mallén, I., Gallois, S., & Heras, M. (2018). From white lab coats and crazy hair to actual scientists: Exploring the impact of researcher interaction and performing arts on students' perceptions and motivation for science. *Science communication, 40*(6), 749-777. https://doi.org/10.1177/1075547018808025

Runco, M. A. (2004). Creativity. *Annual Review of Psychology, 55*(1), 657–687. https://doi.org/10.1146/annurev.psych.55.090902.141502

Samardzija, N., & Peterson, J. S. (2015). Learning and classroom preferences of gifted eighth graders: A qualitative study. *Journal for the Education of the Gifted, 38*(3), 233-256. https://doi.org/10.1177/0162353215592498

Sánchez, L. P., Beltrán Llera, J. A., Barberá, C. G., & Cuesta, J. A. (2007). Gender differences in intelligence and achievement in gifted Spanish children. *Gifted and Talented International*, *22*(2), 96-104. https://doi.org/10.1080/15332276.2007.11673500

Santanen, E. L., Briggs, R. O., & Vreede, G. J. D. (2004). Causal relationships in creative problem solving: Comparing facilitation interventions for ideation. *Journal of Management Information Systems, 20*(4), 167-198. https://doi.org/10.1080/07421222.2004.11045783

Şaşmaz Ören, F., Karapinar, A., Sari, K., & Demirer, T. (2023). The effect of scenario-based learning on 8th grade students' perceptions of scientists. *Journal of Educational Research and Practice, 13*(1), 9-122. https://doi.org/10.5590/JERAP.2023.13.1.09

Scherz, Z., & Oren, M. (2006). How to change students' images of science and technology. *Science Education, 90*(6), 965-985. https://doi.org/10.1002/sce.20159

Shimwell, J., DeWitt, J., Davenport, C., Padwick, A., Sanderson, J., & Strachan, R. (2023). Scientist of the week: Evaluating effects of a teacher-led STEM intervention to reduce stereotypical views of scientists in young children. *Research in Science & Technological Education, 41*(2), 423-443. https://doi.org/10.1080/02635143.2021.19418

Shin, S. Y., Parker, L. C., Adedokun, O., Mennonno, A., Wackerly, A., & San Miguel, S. (2015). Changes in elementary student perceptions of science, scientists, and science careers after participating in a curricular module on health and veterinary science. *School Science and Mathematics, 115*(6), 271-280. https://doi.org/10.1111/ssm.12129

Siew, N. M., Chin, M. K., & Sombuling, A. (2017). The effects of problem based learning with cooperative learning on preschoolers' scientific creativity. *Journal of Baltic Science Education*, *16*(1), 100-112.

Sönmez, D. (2024). Upcycling perceptions of gifted students. *Journal of Gifted Education and Creativity, 11*(3), 91-98. https://doi.org/10.5281/zenodo.13756761

Starko, A. J. (2021). *Creativity in the classroom: Schools of curious delight.* Routledge.

Steenbergen-Hu, S., Olszewski-Kubilius, P., & Calvert, E. (2020). The effectiveness of current interventions to reverse the underachievement of gifted students: Findings of a meta-analysis and systematic review. *Gifted Child Quarterly*, *64*(2), 132-165. https://doi.org/10.1177/0016986220908601

Sternberg, R. J. (2005). The WICS model of giftedness. In *R. J. Sternberg & J. E. Davidson (Eds.), Conceptions of giftedness* (2nd ed., pp. 327–343). Cambridge University Press.

Subotnik, R. F., Olszewski-Kubilius, P., Corwith, S., Calvert, E., & Worrell, F. C. (2023). Transforming gifted education in schools: Practical applications of a comprehensive framework for developing academic talent. *Education Sciences*, *13*(7), 707. https://doi.org/10.3390/educsci13070707

Sun, M., Wang, M., & Wegerif, R. (2020). Effects of divergent thinking training on students' scientific creativity: The impact of individual creative potential and domain knowledge. *Thinking Skills and Creativity, 37*, 100682. https://doi.org/10.1016/j.tsc.2020.100682

Tabachnick, B. G., & Fidell, L. S. (2012). *Using multivariate statistics*. Pearson.

Tomlinson, C. A. (2001). *How to differentiate instruction in mixed-ability classrooms*. ASCD.

VanTassel-Baska, J., & Brown, E. F. (2007). Toward best practice: An analysis of the efficacy of curriculum models in gifted education. *Gifted Child Quarterly*, *51*(4), 342-358. https://doi.org/10.1177/0016986207306323

VanTassel-Baska, J., Bass, G., Ries, R., Poland, D., & Avery, L. D. (1998). A national study of science curriculum effectiveness with high ability students. *Gifted Child Quarterly, 42*(4), 200–211. https://doi.org/10.1177/001698629804200404

Wormeli, R. (2009). *Metaphors & analogies: Power tools for teaching any subject.* Stenhouse Publishers.

Worrell, F. C., Subotnik, R. F., Olszewski-Kubilius, P., & Dixson, D. D. (2019). Gifted students. *Annual Review of Psychology*, *70*, 551-576. https://doi.org/10.1146/annurev-psych-010418-102846

Yang, K. K., Lin, S. F., Hong, Z. R., & Lin, H. S. (2016). Exploring the assessment of and relationship between elementary students' scientific creativity and science inquiry. *Creativity Research Journal*, *28*(1), 16-23. https://doi.org/10.1080/10400419.2016.1125270

Yang, W., & Siegle, D. (2006). Curriculum compacting: The best way to bridge the education of school-house giftedness and creative/productive giftedness in China. *Gifted Education International*, *22*(1), 101-107. https://doi.org/10.1177/026142940602200113

Zhou, L. (2024). Thematic analysis of studies on gifted students in the field of mathematics education. *Journal of Gifted Education and Creativity, 11*(1), 13-22. https://doi.org/10.5281/zenodo.

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