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Research Article

An investigation on the mathematics teaching programs for gifted students based on teachers' opinions

Derya Zengin [1] and Menekşe Seden Tapan Broutin [2]

Bursa Halil İnalcık Science and Art Center, Bursa, Turkiye

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Abstract

This study reflects teachers' opinions about the mathematics teaching programs for gifted students. As a method, " a case study", which is qualitative research, was used to reveal the existing problems related to a problem or situation in detail and to offer solutions. During the academic year 2022-2023, a study was conducted in Türkiye with 57 mathematics teachers who work with gifted students in support education rooms and Science and Art Centers (SAC). Data were collected using a structured interview form prepared on Google Forms. The content analysis method was used to interpret and make sense of the data. Participants' opinions on the educational needs, teacher competencies, mental and physical characteristics of gifted students, software use and mathematical proof processes were analyzed and various results were obtained. In this study, to increase the effectiveness of the program, it was suggested that the program should be updated by taking teachers' opinions into consideration, differentiated and enriched activities should be prepared by integrating technology, workshops should be equipped, and in-service training should be provided in various fields. It was also suggested that it would be beneficial to use a common program accepted all over the world in the education process of these children. Recommendations also include a common pathway for students, directing them to universities in line with their abilities and creating specific employment opportunities after graduation.

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Introduction

For centuries, the definition of intelligence has been one of the most interesting and discussed topics. In general, intelligence consists of the abilities that individuals have to adapt to the changing world through culture, environment and experiences, which stem from their hereditary characteristics (Çevik, 2006). Binet (1916) emphasizes complex mental functions when expressing intelligence. According to Binet, complex functions involving high-level mental skills are required for the development of intelligence rather than simple functions. Binet is also a scientist who conducted various studies and developed scales to measure intelligence." The Binet-Simon test" was developed as a pen-and-paper test to measure intelligence and was soon accepted as proof of intellectual abilities (Binet & Simon, 1916). Gardner (2006) refers to intelligence; as the ability to shape a product, as well as the ability to overcome problems. Piaget (1971) considers intelligence as a mental activity that provides a balance between the individual and the environment. Piaget examines the development of basic concepts in two ways: adaptation and assimilation. While assimilation is expressed

[1] Corresponding Author: Doctorant, Teacher, Bursa Halil İnalcık Science and Art Center, Bursa, Turkiye. E-mail: derya_bilir@windowslive.com. ORCID: 0000-0001-9854-9664
[2] Assoc.Prof., Bursa Uludağ University, Faculty of Education, Math Education Department, Bursa, Turkiye. E-mail: tapan@uludag.edu.tr. ORCID: 0000-0002-1860-852X

as the placement of new situations encountered by the individual into the existing schema, adaptation is the change or expansion of existing schemas as a result of new situations encountered by the individual.

The term "giftedness" includes many different characteristics along with intelligence. According to Renzulli (2005), gifted individuals have three distinct intertwined characteristics. These characteristics are superior talent, creativity, and motivation. According to Brody and Stanley (2005), giftedness means individuals with high reasoning power and advanced development compared to their peers in areas such as verbal logic, mathematics, and visual and mechanical abilities. Since there are different characteristics of especially talented individuals, their educational needs also vary. Therefore, a special program for teaching these children is needed (Levent, 2014).

Differentiating teaching programs due to the high-level skills possessed by gifted students is very beneficial for the teaching process (Akkaş & Tortop, 2015). Differentiated instruction is a learning experience in which learning environments are organized in line with the readiness, attitudes, and needs of individuals, different learning strategies are used in the teaching process, students are allowed to learn by doing and experiencing, and students can make choices to show and display what they have learned (Şaldırak, 2012). Therefore, teaching program differentiation for gifted students should be at the forefront by using enrichment and acceleration strategies (Sak, 2012; Tomlinson & Strickland, 2005). In this teaching process, the personal and professional competencies of teachers who teach gifted children must be at a high level. Therefore, these teachers should have intellectual interest, high sensitivity, self-renewal, adaptability, a sense of duty and high technological equipment (Lindsay, 1980).

Although the field of mathematics and mathematics teaching is intertwined with daily life, it is universally difficult to learn and poses various obstacles in the teaching process. Although learning mathematics is a discipline based on logic, it is also a science that encourages mental development and creates a consistent and systematic thinking environment (İnam & Ünsal, 2017). Interdisciplinary connections play a very important role in creating a thinking environment for gifted students in mathematics teaching. Mathematics programs, which are prepared by taking into account the characteristics of gifted students in the teaching process, are based on making differences in content, process, and product according to student's readiness, interests, and learning styles. At the same time, Integrating technology into the learning process makes it more engaging and helps gifted students develop a concrete and experimental approach. This approach allows the learner to progress gradually toward more complex and abstract concepts through certain steps (Flores, 2006). This statement emphasizes the importance of considering the dynamic changes in mathematical relationships, conceptual understanding, and procedural knowledge to develop mathematical process skills and can facilitate students' progress in this area (Trigo & Perez, 2002). It has been observed that the use of technology-supported instruction in mathematics education can facilitate individualized learning and result in a more effective education process (Baki, Yalçınkaya, Özpınar, & Uzun, 2009). However, it is equally as important for gifted students to mentally construct the knowledge they learn in the process of studying mathematics. Mental development comes into play when students begin to grasp mathematical concepts with concrete materials at an early age. Students who build a strong foundation of understanding using these materials can easily understand abstract concepts as they progress. At the same time, structuring in the mind is realized by the student himself/herself, but it is also seen that external factors such as teacher guidance, equipped learning environment, variety of materials, technological equipment, and social interaction are important in the structuring process (Ding & Li, 2014).

Piaget (1986) stated that mental development is fundamentally related to heredity and divided this process into four parts. These parts are “the sensorimotor stage (0-2 years old), preoperational stage (2-7 years old), concrete operational stage (7-11 years old,) and formal operational stage (11 years old through adulthood)” (Huitt & Hummel, 2003). Accordingly, Piaget shaped the development of "spatial and geometric thinking" skills according to these stages. Studies have shown that gifted students go through the same cognitive development stages but enter the abstract processing stage earlier. It has been stated that geometric thinking skills develop earlier with abstract processes because these students enter the abstract thinking process earlier (Mason, 1997). Hence, it has been observed that these students, whose various abilities come to the forefront, can make logical inferences about proof during the abstract operations period and make connections between concepts in line with these inferences, so they are ready for a proof-based geometric program (Öztürk, 2017). Accordingly, gifted students need to experience different possible forms of shapes in appropriate learning environments using a proof-based geometry program. In the transition to the complex and abstract field of mathematics, students should be supported with different course materials such as appropriate learning environments, concrete materials and dynamic software (Olkun & Toluk, 2007).

In Türkiye, gifted students attend the Science and Art Center (SAC) along with formal education institutions affiliated with the Ministry of National Education. SAC is an independent educational institution that allows gifted students to realize their abilities, reveal their special abilities and produce projects by developing their high-level skills (Science and Art Centers Directive, 2015). In this educational institution, gifted students are educated in groups of 5-6 students with their friends and field teachers from different schools in line with their interests and abilities and according to their learning speed . The education process in SAC progresses in five stages: starting with the adaptation process for beginners, these studies continue with the support process, students become aware of their abilities, develop their special abilities and end with project studies (Ministry of National Education, 2019). At the same time, gifted students receive training in support education rooms in line with the enriched education programs of formal education institutions.

After conducting a thorough literature review, different studies on the evaluation of mathematics teaching programs were found. Some of these studies include the opinions of mathematics teachers regarding these programs (Aközbek,2008; Altındağ & Korkmaz, 2019; Anderson, 2013; Avcu, 2009; Berkant & İncecik, 2018; Bütün & Gültepe, 2 016; Çelen, 2011; Demir, 2021; Eroğlu, 2019; Karakoç, 2019; Keskin & Yazar, 2019; Sargın, 2016; Şen & Peker-Ünal, 2021; Uludağ, 2012). Some studies also include teachers' views on whether these programs are appropriate for gifted students or not (Yetim-Karaca & Türk,2020). However, there are few studies on the views of mathematics teachers or gifted students on the gifted education program (GEP) (Howley, Pendarvis & Gholson, 2005; Ilik, 2019; Jarrah & Almarashdi, 2019). Therefore, the need to evaluate the effectiveness of the Gifted Education Program (GEP), which is also used in science and art centers, has emerged. Considering these literature reviews, it is thought that a study that includes detailed information about the mathematics teaching program, has a large sample size and takes into account the views of mathematics teachers who teach gifted students, will be an example for future studies and will be a useful study for the literature.

Purpose of the Research

The research aims to examine the mathematics teaching programs for gifted students based on teachers' views. In line with this purpose, the problem statement was determined as "What are the opinions of teachers about the mathematics teaching program for gifted students?".

Method

Research Model

A qualitative research method was used in this study. This method allows us to establish connections between different disciplines and to study the events or phenomena encountered in the natural environment and social realities (Merriam & Grenier, 2019; Morgan, 1996). As the study aims to examine the education programs prepared for gifted students based on teachers' opinions, the case study design was considered to be appropriate. Case studies are used to conduct comprehensive analyses by collecting information about the functioning of a limited system (Chmiliar, 2010).

Participants

There were 57 mathematics teachers involved in the study, all of whom taught gifted students in SaAC and support education rooms throughout Türkiye. The study utilized the typical sampling method, which falls under criterion sampling, to select participating teachers. When selecting participants for a study, it is common to use various criteria for selection. According to Yıldırım and Şimşek (2016), the typical sampling method involves careful consideration of factors such as experience working with gifted students and being a mathematics teacher. These criteria are important to ensure that the study results are meaningful and applicable to the target population. In addition, participants were selected voluntarily. The universities from which the participants graduated are Gazi University (7 people), Atatürk University (5 people), Selçuk University (4 people), Cumhuriyet University (4 people), Balıkesir University (4 people), Yalova University (4 people), On Dokuz Mayıs University (4 people), Dokuz Eylül University (4 people), Anadolu University (3 people), Ankara University (3 persons), Uludağ University (3 persons), Hacettepe University (3 persons), Amasya University (2 persons), Fırat University (2 persons), Kahramanmaraş Sütçü İmam University (2 persons), Mehmet Akif Ersoy University (1 person), Erciyes University (1 person), Karadeniz Technical University (1 person). The study found that the 57 mathematics teachers who participated in the research graduated from various universities located in different cities across Türkiye. At the same time, coding in the form of P1, P2, P3... P57 was used to identify the participating mathematics teachers. Demographic information about the identified participants is shown in Table 1.

Table 1. Demographic information of participants

Variables		f
Working field	Secondary Mathematics	37
	High School Mathematics	20
Gender	Female	32
	Male	25
Years of Teaching Experience	0-5 years	4
	6-10 years	14
	11-15 years	13
	16 + years	26
Yearly Working Experiences at SAC	0-3 years	24
	4-6 years	15
	7-9 years	11
	10 + years	7
Yearly Working Experiences in the Support Education Room or Classroom with Gifted Students	0-3 years	23
	4-6 years	15
	7-9 years	10
	10 + years	9
Dynamic Software Usage in the Teaching Process	Yes	32
	No	25
	Total Participants	57

Based on the data presented in Table 1, there were 37 of the participants were secondary school mathematics teachers and 20 participants were high school mathematics teachers among the participants. The gender distribution among the participants is quite balanced, with almost equal numbers of men and women. Additionally, 26 teachers have 16 or more years of experience working. The participants mostly have 0-3 years of SaAC experience, and similarly, the participants working with gifted students in support education rooms have been working between 0-3 years at most. 32 teachers used dynamic geometry software in the Teaching Process.

Data Collection Tools

In the research, a Google form, which was prepared as a structured interview form, was used to reveal the perspectives of the participants about the Gifted Education Program (GEP). This form consists of a first section containing general details about the participants and a second section containing 13 questions about the mathematics teaching program for gifted students. While preparing this interview form, literature research was conducted on students with special abilities, problems were identified, arrangements were made by expert opinions, and a pilot application was realized with a SaAC mathematics teacher before the main application. Furthermore, the opinions of a faculty member who is an expert in her field were consulted while analyzing the participants' views after the implementation.

Data Analysis

Voluntary participation was taken into consideration while collecting research data through interview forms. This form was sent to the participants via Google form and their answers were recorded on the computer. The data was analyzed using content analysis to identify different categories and codes based on the participants' perspectives. Because in this analysis method, the data obtained are examined in depth and unnoticed concepts are revealed. Thus, the data obtained with this method are conceptualized and placed in a logical framework (Şimşek & Yıldırım, 2016). The data obtained through the forms were analyzed by dividing them into word, sentence and paragraph analysis units and various codes were obtained. The codes were deciphered, brought together and divided into subcategories under basic categories (themes). These categories and codes were arranged and tabulated. For example, when the teachers' views about gifted students were analyzed, codes such as creative thinking, extreme curiosity, broad perspective, analytical thinking, social communication difficulty, and high anxiety were obtained; these codes were organized into sub-categories "supportive characteristics" and "compulsive characteristics"; and finally the category "different characteristics" englobing these sub-categories was created. In addition, direct excerpts from the teachers' answers were also included to exemplify the categorization process.

Validity and Reliability

For validity and reliability in qualitative research, it is very important to present the data obtained in the research process in detail and to take various measures to ensure the accuracy of the information (Yıldırım & Şimşek, 2013). In qualitative research, using categories such as reliability instead of internal reliability, confirmability instead of external reliability, credibility instead of internal validity, and transferability instead of external validity is more functional in terms of detailing the process (Lincoln & Guba, 1985). The measures taken within the scope of validity and reliability in the research are as follows:

Reliability; The first measure taken to ensure reliability was to collect the data through structured interview forms voluntarily. The forms were sent to the teachers via Google form and their answers were recorded on the computer. The data obtained through the forms were analyzed by dividing them into word, sentence, and paragraph analysis units. In addition, direct quotations from the participants' answers were included in the findings section. Another measure taken to increase the reliability of the research is that the data obtained as a result of the content analysis is examined by two different experts. The data examined by the experts were divided into subcategories under the name of the main category (theme) and the categories and codes were organized in an interrelated manner and tabulated.

Verifiability; To ensure verifiability, the researchers reported the research process as a whole clearly and concisely, leaving no room for any questions. At the same time, expert opinion was consulted throughout the process to ensure the consistency of the relationships between the findings obtained as a result of the research and the interpretations made. At this stage, approximately 85% agreement was achieved between the researcher and the expert opinion. Thus, it is thought that when an expert evaluates or supervises the research process, its clarity, accuracy, and consistency can be accepted.

Credibility; In this study, the interview method was used to collect data. In the interviews, participants working in different provinces of Türkiye were selected for the research group, thus ensuring a diversity of data sources. At the same time, during the research process, the opinions of a faculty member who is an expert in the field were consulted during the preparation of the interview questions and the analysis of the data. After finalizing the form, a pilot study was conducted with a SaAC teacher with a Ph.D. in mathematics education about the comprehensibility of the questions in the structured interview form. In addition, while creating various categories and codes in the process of analyzing the data obtained in the research, the researcher consulted expert opinion. Another measure taken to increase the credibility of the research was to check and analyze the data immediately after the interview, thus confirming whether the views expressed were correctly understood by the researcher.

Transferability; To ensure transferability, the criterion sampling method, one of the purposeful sampling methods, was used to determine the participants in the research group. The criteria in the study were determined as follows: Having worked with gifted students and the participants being mathematics teachers. With these criteria, it is thought that it will contribute to collecting the most appropriate data for the qualitative research design and providing the most comprehensive information to the researchers. In addition, all participants of the research group were informed about the purpose and process of the research by observing the principle of voluntariness during the research group selection phase. Another measure to ensure transferability is to increase the chance of transferability of the research to other environments by explaining the research processes, selection of the research group, research method, data collection tools, data analysis methods, codes, and themes obtained from the analyzed data in detail. In addition, all participants of the research group were informed about the purpose and process of the research by observing the principle of voluntariness during the research group selection phase.

Results

In this section, findings related to the problem of the study and interpretations based on these findings are presented. At the same time, the findings are organized according to various categories and codes. The findings are interpreted and presented under six different categories. These categories are: “teachers’ opinions on different characteristics of gifted students”, “teachers’ opinions on the educational needs of gifted students”, “teachers' opinions on supporting activities in the classroom during the geometry teaching process”, “teachers' opinions about the use of dynamic geometry software”, “teachers' opinions on supporting activities in the classroom during the geometry teaching process” and “teachers' opinions about the mathematical proof process”.

Different characteristics of gifted students

The findings regarding the different characteristics of the students are presented under various codes and categories in Table 2.

Table 2. Teachers' opinions on different characteristics of gifted students

Category	Subcategory	Codes	Stating teachers	*f*
Different Features	Supporting Features	Quick learning	P1, P6, P12, P13, P25, P26, P28, P32, P38, P40, P41, P49, P51, P53	14
		Extreme curiosity	P1, P2, P18, P20, P24, P50, P51, P54, P55	9
		Wide perspective	P4, P5, P13, P28, P32, P48, P50, P52, P53	9
		Abstract thinking	P22, P41, P51	3
		Problem-solving ability	P5, P21, P35	3
		Reasoning power	P1, P5, P7, P8, P17, P23, P56, P57	8
		Motivation	P2, P7, P16, P31, P44, P52	6
		Attention	P3, P5, P6, P9, P55	5
		Analytical thinking	P3, P20, P29, P47, P55, P56	6
		Leadership	P7, P28, P51, P54	4
		Original idea	P15, P35, P36, P42, P51	5
		Sensitivity	P8, P14, P16, P20, P47, P55	6
		Fast action	P7, P19, P23, P31, P33, P40, P48	7
	Challenging Features	Perfectionism	P1, P17	2
		Social communication difficulty	P7, P11, P34, P37, P45, P49, P50	7
		Supersensitive	P14, P15, P28	3
		High anxiety	P17, P20, P46, P56	4
		Distractibility	P17, P25, P54	3

As seen in Table 2, the main category of "Different characteristics of gifted students" was formed by two sub-categories: "Support characteristics" and "Compulsive characteristics". When participants' opinions were analyzed, among the supportive characteristics; were quick learning (14 participants), extreme curiosity (9 participants), wide perspective (9 participants), analytical thinking (6 participants), fast action (7 participants), and reasoning power (8 participants) came to the fore. Among the compelling characteristics, the prominent characteristics were social communication difficulties (7 participants) and high anxiety (4 participants). For example, P57 from participants expressed his opinion: “I've seen the students with the highest talent focus for a long time, they're very curious, they question everything and they're very careful. I also saw that nature's love is high, emotional, and sensitive...”. When the answer of Participant P57 was evaluated, it was concluded that they were extremely curious according to the section "Gifted students focus on the subjects they are interested in for a long time, they are curious about everything and question everything". P57 continued to express his opinion as follows "I found that they were careful and detail-oriented." the code of analytical thinking was determined through the sentence. The participant P45 expressed that "Students are introverted, bored easily and have difficulty in social communication." These and similar expressions were analyzed and the social communication difficulty code was determined.

Educational needs of gifted students

The subcategories and codes of the main category created under the name of educational needs by analyzing teacher opinions are shown in Table 3.

Table 3. Teachers' opinions about the educational needs of gifted students

Category	Subcategory	Codes	Stating teachers	*f*
Educational Needs	Educational Needs in the General Field	Update the education program	P7, P8, P20, P23, P24, P36, P52, P47, P50, P51, P55, P57	12
		Homogeneous groups	P2, P6, P8, P17, P53	5
		Lack of resources, materials and equipment	P4, P15, P21, P24, P25, P28, P29, P33, P34, P35, P39, P41, P48, P49, P50, P51, P36, P52, P53	19
		Enriched and differentiated activities	P3, P5, P6, P8, P11, P17, P18, P23, P24, P34, P35, P42, P46, P50, P51, P52, P56	17
		Teacher education	P21, P37, P48	3
		Increasing motivation	P12, P16, P25, P28, P33, P35, P40, P55, P56, P57	10
		Desire to be understood	P1, P10, P30, P35, P45, P54, P56, P57	8
		Desire to be successful	P1, P33, P55	3
		Measuing tools	P13, P25, P33, P57	4
	Educational Needs in Mathematics	Updating programs	P3, P5, P6, P16, P44	5
		Homogeneous math groups	P7, P9, P11, P23	4
		Equipped workshops	P1, P15, P25, P36, P49, P53	6
		Use of dynamic software	P8, P12, P25, P26, P49, P55	6
		Enriched and differentiated math activities	P9, P14, P15, P35, P38, P41, P44, P50	8
		Mathematical proof teaching	P8, P20, P22, P28, P29, P45, P51	7
		Include real-life problems	P8, P12, P22, P28, P45, P51, P56	7
		Increasing their interest in mathematics	P3, P5, P7, P14, P17, P21, P24, P27, P32, P36, P38, P48, P54, P56, P57	15

As seen in Table 3, the main category of "educational needs of gifted students" was formed by two sub-categories: "Educational Needs in General Field" and "Educational Needs in the Field of Mathematics". When the data on general educational needs were examined, the prominent codes were: the need to update the education program (12 participants), the need for enriched and differentiated activities (17 participants), the need to eliminate the equipment needs in the workshops (19 participants), the need to increase students' motivation (10 participants) and the need to satisfy students' desire to be understood (8 participants). For example, the expression of participant P8 can be given as an example of a response: "Since gifted students learn faster, it is necessary to design different activities, these activities should be more complex and up-to-date. In general, it is necessary to arrange activities that employ higher-order thinking skills. This is a process that takes time and competence". When these and similar expressions are analyzed, it is concluded that it is necessary to prepare enriched and differentiated activities. P56, one of the participants, expressed, "Students should be given feedback frequently because they are quickly bored. Motivation must also be increased. They have a lot of instability, so students need to understand." From these and similar expressions like this last one, codes "need to increase motivation and students' need for understanding" were obtained.

When teachers' opinions on the needs of mathematics education are analyzed, the prominent codes are as follows: increasing their interest in mathematics (15 participants), designing enriched and differentiated mathematics activities (8 participants), teaching proof (7 participants), creating well-equipped mathematics workshops (6 participants) and using dynamic software (6 participants). Participant P27's expression is given as an example: "They can adapt to the subject earlier. Unfortunately, they are easily distracted. When they can't, their cravings dwindle. For this reason, it is necessary to keep their interest in mathematics alive." According to these and similar expressions, the code of increasing their interest in mathematics was reached. One of the participants, P8, states; "In mathematics, it is necessary to present complex and real-life problems to students. In addition, dynamic software environments are very important for mathematics lessons. Likewise, the environment is critical for them to learn how to prove." The codes for teaching proof and the use of dynamic software were obtained from these and similar expressions.

Supportive activities in the geometry teaching process

The codes and categories obtained when the teachers' views on the supportive activities carried out in the lesson during the geometry teaching process were analyzed are shown in Table 4.

Table 4. Teachers' opinions on supporting activities in the classroom during the geometry teaching process

Category	Codes	Stating teachers	*f*
Supporting Activities in the Classroom	Basic geometry knowledge	P10, P29, P44, P46	4
	Real-Life problems	P3, P34, P35, P51	4
	Dynamic software activities	P2, P8, P9, P11, P12, P13, P21, P24, P26, P27, P30, P31, P32, P33, P39, P48, P53	17
	Application workshops	P7, P14, P36, P37, P41, P43, P51, P55	8
	Tangible materials	P5, P8, P9, P12, P24, P25, P32, P33, P45, P49, P52, P55	12
	Making proof	P16, P18, P23, P34, P40, P45, P46, P48, P53, P54, P55, P56	12

As seen in Table 4, various codes were obtained when the teachers' views on the supportive activities carried out in the lesson during the geometry teaching process were analyzed. It is seen that teachers have common views on the codes of designing activities suitable for dynamic geometry software (17 participants), using concrete materials (12 participants) and making proof (12 participants) among these codes. About these common views, P9 from the participants; "Because geometry is an abstract subject, it can be difficult to focus students on the process, so more tangible materials or software can be used." These and similar expressions mentioned the importance of tangible materials and dynamic geometry software. P53; "The course teacher should give extra activities suitable for dynamic software that will require research, use technology, make inferences to questions, etc." In his statement, he stated that activities suitable for dynamic software should be designed and students' proof skills should be developed by questioning.

Use of Dynamic Geometry Software:

The codes generated by analyzing the data obtained in line with the teacher's opinions on the use of dynamic geometry software and the categories they belong to are shown in Table 5.

Table 5. Teachers' opinions on the use of dynamic geometry software

Category	Subcategory	Codes	Stating teachers	*f*
Using Dynami Geometry Software Thoughts on	The Convenienc Provided by the Use of Dynamic Geometry Software	Convenient interfaces	P8, P12, P15, P17, P18, P19, P21, P22, P25, P27, P28, P29, P30, P32, P33, P35, P38, P54	18
		Enriched events	P4, P15, P24, P26, P31, P35, P36	7
		Concretization	P4, P5, P8, P12, P13, P16, P21, P24, P25, P26, P27, P28, P29, P30, P31, P32, P33, P36, P37, P38, P39, P40, P41, P44	24
		Reasoning process facilitation	P19, P20, P22, P24, P25, P26, P31, P44, P46	9
		Making the lesson fun	P3, P6, P7, P14, P15, P18, P33, P34, P38, P40, P49	11
		Saving time	P1, P10, P14, P20, P22, P25, P34	7
		Getting the answer quickly	P1, P4, P10, P12, P22, P25	6
		Focus on the process	P1, P4, P6, P20, P22, P25, P40	7
		Keeping motivation high	P14, P15, P16, P17, P19, P20, P21, P22, P23, P25, P31, P34, P55	13
		Content creation	P4, P14, P18, P21, P23	5
		Ultimate skill development	P11, P18, P22, P23, P33	5
		Active participation	P10, P32, P33, P41	4
		Ease of detection	P11, P13, P15, P17, P19, P22, P25, P27, P31, P33, P37, P39, P40, P41, P42, P44, P45	17
	Challenges Usin Dynamic Geome Software	Scarcity of equipped workshops	P2, P5, P6, P8, P13, P18, P20, P25, P53	9
		Student education	P3, P4, P5, P12, P14, P15, P24, P25, P28, P31, P38	11
		Teacher Education	P7, P8, P12, P13, P14, P16, P17, P18, P20, P38, P47, P50	12
		Difficulty in content creation	P1, P4, P5, P7, P9, P10, P11, P14, P15, P17, P21, P23, P25, P27, P32, P46	16
		Waste of time explaining the software	P1, P12, P30	3

The main category of "Thoughts on the use of dynamic geometry software" was analyzed by dividing it into two sub-categories "Ease of using dynamic geometry software" and "Difficulties in using dynamic geometry software". When the codes that stand out for the convenience provided by dynamic geometry software are examined; 18 participants stated that the software had useful interfaces, 24 participants stated that they embodied geometry, which is an abstract lesson, 13 participants stated that they increased the motivation of the students and 17 participants stated that they facilitated perception. For example, in P34; "specially gifted children are accustomed to combining their lessons with technology or other courses. It helps them to be more satisfied with what they had learned and increases their motivation." When these and similar expressions were analyzed, dynamic software was determined to increase students' motivation. From P8's statement; "With the drag movement, the process is kept alive and the chance to see the useful conceptual background is obtained. It is also very effective for proof processes and helps students understand what and why." When these and similar expressions were analyzed, codes were obtained that the software has useful functional interfaces, facilitates perception, and embodies geometry.

Regarding the difficulties teachers experienced in using dynamic geometry software (such as Geogebra, Cabri), 9 participants talked about the scarcity of equipped workshops, 16 participants talked about difficulties in preparing content and 13 participants talked about the necessity of student and teacher education. For example, P2; "The most challenging part is that every student cannot provide an equipped environment to access." and P18; "Computer and tablet are required, it can be difficult to find." When these and similar expressions were analyzed, the code of scarcity of equipping workshops was reached. P32; "The content preparation part about geometry education for students is very difficult for us." It was determined from these and similar expressions that teachers had difficulties in preparing content

When examining the difficulties that teachers encounter when using dynamic geometry software, it's important to consider the learning curve associated with the technology. While these tools can be incredibly powerful, they can also be complex and challenging to navigate at first. Additionally, some teachers may struggle to integrate the software into their lesson plans and teaching styles. However, with the right training and support, many educators can successfully incorporate dynamic geometry software into their classrooms and enhance their students' learning experiences.

Competencies for effective use of dynamic geometry technologies

According to the analysis of teachers' views, Table 6 shows the codes and categories corresponding to the competencies required to effectively use dynamic geometry technologies.

Table 6. Teachers' views on competencies for effective use of dynamic geometry technologies

Category	Subcategory	Codes	Stating teachers	*f*
Competences/Knowledge for Effective Use of Dynamic Geometry Technologies	Teacher Competencies	Software usage	P1, P2, P3, P4, P5, P6, P7, P8, P10, P11, P12, P13, P16, P19, P20, P22, P23, P24, P25, P26, P28, P29, P30, P31, P33, P34, P35, P36, P38, P39, P40, P41, P42, P44, P45, P48, P49, P50, P51, P52, P53	44
		Content creation	P1, P5, P6, P8, P11, P17, P19, P21, P22, P25, P27, P29, P3(P33, P36, P37, P39, P45, P47	20
		Area information	P1, P17, P25, P29, P30, P32, P35, P44, P55, P56	10
		Coding skill	P20, P31, P34, P35, P36, P54	6
		Effective use of time	P28, P29, P47, P49, P55, P56	6
		Pedagogical content knowledge	P9, P17, P25, P29, P38	5
		Being open to innovations	P2, P3, P4, P8, P10, P12, P14, P19, P21, P27, P29, P30, P39, P41, P43, P53	16
	Teaching Methods Used	Learning by living	P1, P2, P4, P10, P12, P20, P33, P36, P46, P49, P50, P56	12
		Show and make	P23, P24, P25, P27, P32, P34, P37, P39, P42, P43, P45, P51, P53	13
		Presentation method	P1, P8, P21, P39, P54	5
		Invention method	P3, P5, P8, P9, P12, P19, P22, P28, P41, P45, P50	11
		Problem-solving	P17, P25, P34, P52	4
		5E model	P6, P15, P29	3
		Question -answer	P1, P24, P32, P50, P55	5
	Preparation for the Teaching Process	Equipped workshops	P2, P8, P9, P11, P13, P19, P24, P29, P30, P36, P38, P39, P53, P54	14
		Software information	P2, P3, P4, P6, P7, P12, P33, P39, P40, P46, P47, P48, P49, P54	14
		Current programs	P4, P9, P11, P16, P17, P19, P21, P24, P27, P29, P31, P49, P50, P55	14
		Pilot application	P9, P14, P15, P20, P22, P24, P28, P29, P31, P34, P37, P40, P45, P49, P54, P55, P56	17
		Enriched and differentiated events	P5, P7, P9, P15, P19, P21, P22, P24, P26, P29, P31, P33, P31, P39, P44, P45, P47, P49, P51, P53, P54	21

The main category of "Qualifications for the effective use of dynamic geometry technologies" was examined into three sub-categories "Teacher competencies", "Teaching methods used" and "Preparation for the teaching process". When the data obtained from the interview forms were analyzed, various codes were determined in line with the subcategory of teacher competencies. Among these codes, 44 teachers talked about the importance of using software, 20 teachers talked about the importance of content production, 10 teachers talked about the importance of field knowledge and 16 teachers talked about the importance of being open to innovations. For example, P1's; "The teacher himself should know in the field at the level of being able to use the mentioned applications effectively and prepare activities." When these and similar expressions were analyzed, the codes for the teachers' opinions about the importance of using software, field knowledge, and content production were obtained.

Based on the research, it was found that different codes were determined according to the sub-category of teaching methods. Out of these codes, 12 teachers reported using the learning-by-doing method, 13 teachers preferred the demonstration method, and 11 teachers utilized the discovery method. Teachers' views on these findings were examined. For example, in P7; "When I teach with Geogebra, I use the show-and-make method. Then I allow the student to produce their content." When these and similar expressions were analyzed, it was determined that the teachers used the show-and-make method. P50's; "Learning by doing and taking an active role in the creation process using software will be a developer in terms of its ability to embody." His statement determined that they used the method of learning by living.

In the research, teachers stated that various preparations should be made before using dynamic geometry software. Among these preparations, 22 teachers stated that enriched and differentiated activities should be prepared before the lesson, 17 teachers stated that a pilot application could be made with the activities prepared before the lesson, and 14 teachers stated that the workshops should be equipped physically and technically. For example, the P45; "First of all, when technology is involved, a long preliminary preparation should be made for the subject to be explained in the lesson. Because the use of technology is not like plain subject expression. It is necessary to prepare activities. It is necessary to be constantly active and not to make mistakes." When these and similar expressions were examined, teachers mentioned the importance and contributions of enriched and differentiated activities in the teaching process. P40's; "Of course, it will have to adapt the technology to the activities and apply the teacher himself as a preliminary preparation, so he should practice the activity beforehand. I think the lessons are more interactive when technology is added." When his statement was analyzed, the teachers stated that a pilot application could be made beforehand.

Mathematical Proof Process:

Teachers' views on the mathematical proof process were analyzed, and the codes and the categories they belong to are shown in Table 7.

Table 7. Teachers' opinions about the mathematical proof process

Category	Subcategory	Codes	Stating teachers	*f*
Mathematical Proof process	The Meaning of Mathematical Proof	Derivative reasoning	P1, P2, P8, P17, P41, P46, P50, P51, P55	9
		Logical description	P1, P2, P6, P8, P11, P20, P21, P28, P32, P34, P39, P40, P41, P55	14
		Meaning of formulas	P3, P5, P7, P15, P18, P22, P29, P35, P37, P38, P42, P49, P52, P56	14
	The Importance of Mathematical Proof	Learning by doing	P2, P3, P9, P35	4
		Permanent learning	P1, P4, P5, P11, P24, P25, P26, P27, P28, P45, P52, P55, P56	14
		Reinforcing what you've learned	P8, P14, P18, P54	4
		Making sense of formulas	P3, P20, P21, P22, P23, P38, P41, P49	8
		To convince	P4, P29, P32	3
	Technology Integration into Mathematic Proof Process	Concretization	P2, P19, P21, P22, P24, P25, P44, P55	8
		Artificial intelligence	P9, P33, P56	3
		Coding	P36, P38	2
		Calculation and graphics tools	P15, P47, P54	3
		Using GeoGebra	P1, P3, P4, P7, P8, P10, P11, P15, P19, P21, P27, P34, P35, P47, P50, P54	17
		Using Cabri	P1, P2, P3, P4, P7, P17, P26, P44, P50, P54	10

As seen in Table 7, the main category of "mathematical proof process" was examined into three sub-categories "meaning of mathematical proof", "the importance of mathematical proof" and " Technology Integration into Mathematical Proof Process ". First of all, the teachers were asked what mathematical proof means, and various codes were obtained by examining the answers received. The Meaning of Mathematical Proof; 14 teachers expressed logical explanation, 9 teachers as derivational reasoning, and 14 teachers expressed the meaning of formulas. For example, P21; "Mathematical proofs are logical explanations and justifications starting from axioms. It would be better to embody this verification." From these and similar statements, it was determined that the participants define mathematical proof as a logical explanation. P41; "Another argument that shows the conclusion that the assumptions derived for mathematical proof are logically correct." When his statement was analyzed, he stated the mathematical proof as derivational reasoning. As a result of the analysis of the data obtained under the heading of the importance of mathematical proof, it is seen that the codes of permanent learning (14 participants) and making sense of formulas (8 participants) come to the fore. P55 one of the participants;" By questioning with proof, we also reinforce intellectual skill and reasoning. Different mathematics and geometry software also help us in making these proofs, allowing students to embody the proofs and see the results with their eyes." He stated that the proofs can be made concrete with his opinion. P27; "I think that more permanent learning will be provided as students are involved in the process of creating the rule instead of memorizing the rule directly." He stated that children can realize permanent learning by making proof.

Teachers resort to different ways when integrating technology into the mathematical proof process. Teachers stated that they use dynamic software such as Geogebra (17 participants) and Cabri (10 participants), especially when doing mathematical proofs. For example, one of the participants, P7; "It should include studies to discover why and the reasons for a mathematical rule. Technology can be used here to validate the proof. For example, a circle's circumference/diameter ratio gives the pi number. With the Geogebra software, we can have the difference discovered through the calculation of the circles, and find that this constant ratio expresses the pi number." When these and similar statements were analyzed, it was found that they mostly used GeoGebra and Cabri programs.

Discussion and Conclusion

This study comprehensively evaluated mathematics teachers' views on various issues related to gifted students. The study focused on various topics under the headings of students' personality traits, educational needs, teacher competencies, geometry software and mathematical proof processes. As a result of the study, various conclusions were reached about how teachers perceive and approach these important issues in their work with gifted students.

Regarding the different characteristics of gifted students, teachers stated that they learn quickly, can easily solve complex problems, can focus for long periods, have higher-order thinking skills, have a strong memory, and have no difficulty generating original ideas. At the same time, teachers concluded that gifted students have supportive personal characteristics such as extreme curiosity, high motivation, leadership and sensitivity, as well as challenging personal characteristics such as perfectionism, difficulty in social communication, excessive emotionality, high anxiety, irresponsibility, boredom and distractibility. Various studies supporting these results were found when the literature was examined. These studies indicate that gifted students have various cognitive characteristics. These characteristics include high academic achievement (Akkanat, 2004; Davis & Rimm, 2004), use of problem-solving skills (Ataman, 2009; Doğan & Çetin, 2018; Sisk, 1987), ability to focus attention for a long time (Çağlar, 2004; Sriraman, 2004), learning easily (Calero, Belen, & Robles, 2011; Levent, 2013), higher-order thinking skills (Bonner 2000; Kettler, 2014) and generating original ideas (Çitil & Ataman, 2018; Janos, Fung, & Robinson, 1985; Özbay, 2013).

In addition, the findings obtained from the research are similar to the studies emphasizing the affective characteristics of gifted students such as hypersensitivity, high motivation (Renzulli, 1978), leadership (Bain & Bell, 2004), boredom, social communication difficulties (Bahtiyar & Şahin, 2017; Çetin & Doğan, 2018; Özbay, 2013) and perfectionism (Clark, 2002; Çitil & Ataman, 2018; Davis & Rimm, 2004; Saranlı & Metin, 2012). Talas, Talas and Sönmez (2013) found in their studies that, unlike our work, communication between gifted students and their friends who are like them is good, but they have problems with other peers and prefer to be alone. Examining the characteristics of the peers with whom gifted students communicate in studies conducted in this respect will be very useful to get a detailed idea about the characteristics of these children.

Various needs were identified in the fields of general education and mathematics education. Regarding general education needs, teachers stated that the identification process should be updated when selecting students for SACs and that it is important to create homogeneous student groups in SACs as a result of identification. Teachers emphasized that parent training should be given for parents to adapt to the SAC process. At the same time, teachers emphasized that their colleagues should be educated when necessary to keep up with the age and be aware of innovations. In addition, the teachers also stated that the updated education programs using enriched and differentiated activities would improve the quality of teaching. Regarding physical equipment, the teachers expressed that the materials and technical equipment deficiencies of the workshops should be eliminated. Teachers also stated that the emotional needs of students such as making them feel special, increasing their motivation, wanting to be understood, controlling anxiety, and wanting to be successful should not be ignored. These results align with the studies that contain similar results in the literature. These studies include needs such as; updating teaching programs in line with the educational needs of gifted children (Baykoç-Dönmez, 2009; Davaslıgil 2004; Heward & Orlansky, 1980), enriched and differentiated activities, workshops, out-of-school practices, etc. standards should be established (Ataman, 2009; Davis & Rimm,2004; Göktepe-Yıldız & Özdemir, 2018; Kanlı, 2011), eliminating the lack of resources, materials, and equipment (Şenol, 2011), training teachers (Levent, 2014; Manning,2006), making students feel special and increasing motivation (Gross, 2002; Kelly & Jordan, 1990; Levine & Tucker, 1986; Özsoy, Özyürek & Eripek, 1998). However, in our study, only teacher and student competencies were mentioned. According to Summak and Çelik-Şahin (2013), SaAC directors should possess strong instructional leadership skills to effectively meet educational needs. To truly understand the needs of these centers, it is important to conduct thorough studies that examine all aspects of SaACs and reveal general needs as a whole.

As for the educational needs in the field of mathematics; teachers stated that it is important to update mathematics programs, prepare enriched mathematics activities that include real-life problems, and use dynamic software to make abstract geometry subjects concrete. In addition, teachers emphasized that teaching mathematical proof is very important for students to establish meaningful relationships between mathematical expressions. It is also among the important needs that mathematics workshops should be equipped with. In the literature, similar studies have been found for the educational needs in the field of mathematics; equipping mathematics workshops (Çakır, 2009; Kazu & Şenol, 2012; Sezginsoy, 2007; Tantay, 2010), creating enriched and differentiated mathematics activities (Even, Karsenty ve Friedlander, 2009; Kurtdede-Fidan, 2008), and creating environments that will increase students' interest in mathematics (Camcı-Erdoğan, 2014; Mesh, 2008; Orbeyi, 2007).

In line with the study, teachers stated that students should gain basic geometry knowledge and technical drawing skills regarding the supporting activities carried out in the course during the geometry teaching process. In addition, teachers mentioned the importance of developing complex activities involving real-life problems and three-dimensional objects for students' visual-spatial abilities. Teachers stated that while designing these activities, it is necessary to benefit from the opportunities provided by concrete materials and dynamic geometry software (GeoGebra, Cabri…). Teachers also mentioned the importance of supporting the teaching process with proof studies. Various studies supporting these results were found in the literature (Baydaş, 2010; Güven & Karataş, 2003).

One of the results obtained from the research is the advantages and disadvantages of dynamic geometry software. While talking about the advantages of the software, teachers said that it has a user interface, concretizes the teaching process, facilitates perception, supports the proof and reasoning process, saves time, makes the lesson fun and increases students' motivation. In addition, the teachers stated that the disadvantages caused by dynamic geometry software could disrupt the motivation of students and teachers and cause a loss of time. In parallel with these results, Genç (2010) stated that the Geogebra program which is dynamic geometry software has an easy interface, its language is Turkish, and it is free, creating positive thoughts in students. Cengiz (2017) also stated that with dynamic geometry software, students could move shapes quickly and learn formulas easily, making the learning process fun.

In the research, teachers said that various preparations should be made to effectively use dynamic geometry software. Regarding these preparations; teachers stated that the workshops should be equipped materially and technically, the programs should be updated, the teachers and students should be trained about the software, the technology should be integrated into the activities and if necessary, a pilot application should be made beforehand. Similarly, Kocasaraç (2003) stated that teachers do not have sufficient computer-assisted teaching skills and should receive an education. Bozkurt, Bindak, and Demir (2011) stated that activities should be prepared to use dynamic geometry software and teachers and students should also receive training to use the software. According to Kazu and Şenol (2012) and Tantay (2010), the workshops in SACs are facing numerous equipment-related deficiencies.

While expressing mathematical proof, teachers used expressions like validation of formulas, logical explanations and derivative reasoning. At the same time, teachers stated that mathematical proof is very important because it provides opportunities such as learning by doing, consolidating what has been learned, connecting disciplines, making sense of formulas, and persuading. Teachers also stated that dynamic software such as GeoGebra and Cabri used in the mathematical proof process are very useful in modelling shapes, giving dynamic structures to forms, and concretizing the process. Various studies in the literature have supported these results. It was determined by Harel and Sowder (1998) that dynamic visualization skills were improved by students' rotating and moving shapes by dragging, and it had positive effects on spatial reasoning. Similarly, Güven and Karataş (2003) found that dynamic software such as GeoGebra and Cabri changed students' perceptions of mathematical expressions and that they began to see mathematical expressions as a set of meaningful relationships rather than something to be memorized.

Recommendations

After analyzing the findings of the study in depth, various conclusions were reached. In line with these conclusions, various suggestions were made considering the characteristics of gifted students. Teachers stated that the teaching programs and activities used in SACs are insufficient. In this direction, it should be ensured that the curriculum applied in SACs is updated by considering the teachers' opinions. At the same time, differentiated and enriched activities prepared by integrating with technology should be presented to students. Teachers also stated that the workshops used in SACs are insufficient. Therefore, the workshops used in SACs should be ensured that they are physically and technically equipped. Teachers said that they should constantly update their knowledge through in-service training programs to improve the quality of education and to be informed about the latest developments in education. Thus, regular in-service training programs should be organized by the Ministry of National Education in various fields.

Today, private schools and universi:ties have been established in countries such as ABD, China, Russia, Sweden, Germany, and Finland using programs such as "International Baccalaureate IB (International Baccalaureate), Study of Mathematically Precocious Youth and Talent Search (SMPY), Study of Gifted Youth in Mathematics and Talent Pooling Project, Europe Private the Council for the Talented (ECHA) and Dalton school "has been established. In Türkiye, the gifted education program (GEP) is an education program that was founded in 2007 and started to be implemented in 2014. GEP can be accepted as Türkiye 's first and only training program in this field in terms of its content and scope. Türkiye has very little experience in gifted education. For this reason, it may be more beneficial to implement a common program accepted all over the world in Türkiye. At the same time, a common path should be followed for gifted students in Türkiye, they should be directed to universities in line with their abilities and special employment opportunities should be created after graduation.

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Biodata of Authors

Derya Zengin is a mathematics teacher at the Halil Inalcık Science and Art Center (SaAC) in the Ministry of National Education. She is also a Ph.D. student in the faculty of education at Uludag University. She studies in the field of Social Sciences and Humanities. **Affiliation**: Bursa Halil İnalcık Science and Art Center, Türkiye. **E-mail**: derya_bilir@windowslive.com **ORCID**: 0000-0001-9854-9664,

Menekşe Seden Tapan Broutin is an associate professor at Uludağ University, Faculty of Education. Her research interests include Social Sciences and Humanities. **Affiliation**: Bursa Uludağ University, Türkiye. **ORCID**: 0000-0002-1860-852X **E-mail**: tapan@uludag.edu.tr

Ethics Statements

Our study is part of a PhD thesis in preparation and ethics committee permission (Bursa Uludag University Rectorate, Student Affairs Department is notified with the letter dated 8.4.2022 and numbered 53989) was obtained from Uludağ University.

Conflict of Interest

I confirm that there is no personal or financial relationship or conflict of interest between the researchers and any other person or organization involved in the research

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