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Differentiating Mathematics for Gifted Children: A Professional Development Project for In-Service Teachers

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Gifted children should receive education that is appropriate to their potential, but the question is whether this is possible without a great deal of teacher competence. This project aims to increase the professional competence of mathematics teachers who were provided with training on the appropriate strategies for gifted students. In this study the knowledge and views of the teachers about the giftedness and the information used in gifted education is investigated. In the training process, seminars were provided regarding the teaching strategies used in gifted education, challenging mathematical tasks to be used to reveal and develop potential, and the differentiation of teaching with the help of technology. The participants of the study were 25 middle/high school in-service mathematics teachers from 17 provinces throughout the country. The teachers learned the teaching strategies for the gifted, and they provided enrichment using challenging mathematical tasks and technological tools.

Keywords: Mathematics, gifted children, teacher education

INTRODUCTION

In Turkey, there are a total of 17 million preschool, elementary school, middle school, and high school students (Ministry of National Education [MoNE], 2020), and approximately 64 thousand of them are gifted children (MoNE, 2019). It is controversial whether the education of these children is at adequate level. For instance, the gifted children in the United States do not receive education that is appropriate to their capacities and challenging enough to improve their performances (Callahan et al., 2015; Robinson & Moon, 2003) as well as in Turkey (Sak et al., 2015).

Development and implementation of curricula, and the use of teaching strategies to provide rich & productive learning opportunities are critical for gifted children to realize their potential. Some researchers (Maker, 2001; Öznacar & Bildiren, 2016; Tomlinson, 2001; VanTassel-Baska & Brown, 2007) developed various models (differentiation, acceleration, and grouping, etc.) to support education of gifted students. Thus, it is important to understand whether the teachers of gifted children have a rich and in-depth understanding of these models in their practices. Although having deep understanding of these models and relevant strategies such as acceleration, enrichment, or skill groups is evident, schools do not support these strategies or teacher's professional development in understanding these models (Missett et al., 2014). Hence, teachers do not have adequate information about how they can use these strategies (Gagné, 2011; Missett et al., 2014). Eventhough teachers' understanding of these models plays an important role in gifted education, their attitudes toward education of these children are important as well. McCoach and Siegle (2007) state that experienced teachers who were trained in the field of gifted education have more positive attitude towards the education of gifted children, compared to non-trained and inexperienced teachers.

Approaches for the Education of Gifted Children

Various educational models have been developed for gifted children including differentiation (Tomlinson, 2014), acceleration (Colangelo, Assouline & Gross, 2004; Gross, 2006; Wardman, 2017), and grouping (Steenbergen-Hu, Makel & Olszewski-Kubilius, 2016). Differentiation provides the necessary attention, appropriate strategies, and environment by meeting the individual needs of gifted students (VanTassel-Baska, 2003a). According to Tomlinson (2000), the number of students at the standard level is quite rare. Therefore, the preference of standard based curriculum structures makes it difficult to implement educational practices and ensure academic diversity by taking individual differences into consideration. However, there is no contradiction between standards-based teaching and differentiation. The curriculum tells us what to teach and differentiation tells us how to do it. Hence, if we choose to teach a standards-based curriculum, differentiation simply suggests the ways we can best enact that curriculum to meet the needs of the diverse student profiles. In other words, differentiation shows how we will teach the same standard to a number of students using various teaching and learning modes. Differentiation also indicates that it is critical for teachers to offer more than one way to achieve setting goals so that every student can make the furthest progress. Because differentiation approach argued that if the right conditions can be provided to each student, each student can learn and be successful (Tomlinson, 2005).

Differentiation-oriented teacher orchestrate classroom practices include selecting and sequencing topics, choosing appropriate teaching methods, focusing on students' thinking and creating a learning environment that is responsive to students' needs. Also, teachers can proactively differentiate the process of learning,

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implementing and thinking the content of the curriculum (Tomlinson, 2014, 2017). As such, in differentiation, it is important to support gifted students on the basis of their performance in the classroom. Many studies in the related literature have shown that this model positively affects the success of gifted children and equips them with high-level thinking skills (Beecher & Sweeney, 2008; Casa, Firmender, Gavin & Carroll, 2017; Dreeszen, 2010; Little, McCoach & Reis, 2014; Geisler et al., 2009; McCoach, Gubbins, Foreman, Rubenstein & Rambo-Hernandez, 2014; Rasmussen, 2006; Shaunessy-Dedrick, Evans, Ferron & Lindo, 2015).

Through curriculum differentiation, one could focus on student diversity by considering different learner profiles that the function of human brain research documented (Tomlinson 2004). With curriculum differentiation, the teacher-as an expert and guide in the classroom- can assist students in realizing their learning potential by using appropriate methods and techniques. It also provides an opportunity for each student to demonstrate their valued strengths through differentiated assessment techniques (Tomlinson & Jarvis, 2009).

Differentiated teaching may include a learner-centered approach, planned assignments, measurement-based lesson planning, flexible grouping, materials, resources, and supervision (Tomlinson & Hockett, 2008). Differentiation is based on the need to prepare targeted educational practices. For this reason, differentiation enables the planning, development and implementation of appropriate learning experiences for individuals with diverse learning needs (Bildiren, 2018b). When differentiation is to be implemented for gifted students, teachers should apply the acceleration, comparison, depth, coercion, creativity and abstraction features of differentiation (VanTassel-Baska, 2003).

Tomlinson (1995) and Koshy and Casey (2005) suggest that it is not appropriate for mathematically gifted students to be faced with extra math problems from textbooks or additional homework. Enrichment in mathematics means expanding the knowledge base and the learning process, giving the gifted students the opportunity of rich mathematics learning, and thus the opportunity to go beyond the acquisition of skills (Koshy, 2001). Sheffield (1999) and Koshy and Casey (2005) argued that gifted children should be part of a carefully designed plan for enrichment in mathematics. To obtain enrichment, substantial teaching materials or more challenging teaching strategies are provided to develop the core content (Horne & Shaughnessy 2013). Enrichment is recommended as an alternative strategy for both differentiation and acceleration for mathematically gifted children (Koshy, 2001; Koshy & Casey, 2005). When a successful enrichment program motivates them to work with more complex problems, research shows there is an acceleration, as gifted students gain new and extensive knowledge faster than they would with regular activities (Koshy & Casey, 2005). Studies (Kim, 2016; Manuel & Freiman, 2017; McCoach et al., 2014) show that enrichment in the field of mathematics gives positive outcome for gifted children.

Another model is the acceleration approach, in which the gifted children are placed in a more advanced classroom for their age or they are allowed to progress at their own speed in their subject area (Colangelo, Assouline & Gross, 2004; Maker, & Schiever, 2005). The third educational model is the grouping approach, in which all gifted students are either placed in a special full-time classroom or in a special group within a mixed-ability classroom (Callahan et al., 2003; Feldhusen, 2003; Gagne & Gagnier, 2004).

There are many instructional models (Kaplan, 2005; Maker, 2001; Renzulli & Reis, 1997; Tomlinson, 2001) and experimental studies (Aljughaiman & Ayoub, 2012; VanTassel-Baska & Brown, 2007) on gifted education. It is difficult to identify which model is more effective due to the difficulty in measuring program results, the complexity of observable and measurable results in experimental studies, and the lack of data on implementation accuracy (Hunsaker et al., 2010; O'Donnell, 2008). In fact, it is most likely that no single model is the most effective one in all situations. However, it is important to note that the curriculum and depth of the educational topics should be appropriate for the characteristics of the gifted children in their education (Castle et al., 2005; Maker & Nielson, 1995).

Gifted Education in Turkey

The MoNE in Turkey is responsible for the education of the gifted. The responsibility mainly belongs to the Directorate General of Special Education and Guidance Services within organizational structure of the Ministry. Today, the formal education of gifted students is carried out in the form of supportive special education services using the inclusive education model. Identified students receive supportive education in the supportive education room in their schools or in the Science and Arts Centers (BILSEM) (Bildiren, 2018a).

BILSEM is a special education institution that provides education to gifted students from K-12 to assess their individual talents as well as providing opportunities for them to use their talents at the highest level (MoNE, 2018a). As of today, 2137 teachers provide special education to 42832 students in 138 BILSEMs (MoNE, 2018b). BILSEM aims to develop differentiation and enrichment programs based on the interests, talents, abilities and potential of gifted children. These programs support them to acquire the higher cognitive, social, personal, and academic skills that they need (Bildiren, 2018a). However, the studies conducted with BILSEM teachers revealed that the teachers do not have sufficient information regarding gifted education (Altun & Vural, 2012; Aslan & Doğan, 2017; Kurnaz, 2014). These results suggest that gifted students do not receive the quality education that is responsive to their needs.

Mathematics Education for Gifted Children

The related studies indicate that the mathematics education of gifted children is a highly complex field (Leikin, 2011). The main challenge in teaching and learning mathematics is seen as a necessity for revealing gifted students' mathematical potentials (Leikin, 2011). In addressing this challenge, students should engage in inquiry-based tasks that require complex thinking and create products requiring them to demonstrate and use what they have learned (Tomlinson et al., 2008). In addition to inquiry based-tasks, model building activities are used in various areas including problem solving (Yıldırım et al., 2010), identifying gifted students, developing superior talents (Coxbill et al., 2013), and determining mathematical creativity levels (Gilat & Amit, 2013).

The use of inquiry-based tasks was found to be one of the most effective forms of working with gifted students from a constructivist perspective (Yevdokimov, 2007). When higher cognitive demand tasks are implemented, teachers should create a learning environment that is appropriate for their students' needs and levels. They should *mentor* students in the learning process (Yevdokimov, 2007). Also, they should motivate their students to learn mathematics by providing an exploratory approach that encourages students to explore concepts, focus on solving complex and open-ended problems, to work on mathematical proofs and providing opportunities for interdisciplinary connections. (Leikin, 2007; Manuel and Freiman, 2017, Sheffield, 2009). As such, the curriculum used by teachers should support this process and it should include high depth and complex content (Johnson, 1993).

Gifted children in Turkey receive mathematics instruction at BILSEM. Although BILSEM teachers participate in various pre-service and in-service professional development, they do not receive any specific support on how to teach mathematics to gifted students. Several research identified the areas of improvement needed for BİLSEM teachers and reported how these teachers feel inadequate in their qualities for teaching gifted students (Altun & Vural, 2012; Barış, 2019: Çalışkan, 2017; Çetin & Doğan, 2018; Eker, 2019; İlik, 2019; Kontaş & Yağcı, 2009; Semerci & Kaya, 2007). A project was implemented with the aim of creating a model that will support mathematics teachers' understanding and knowledge in working with gifted students through introducing and applying appropriate methods, techniques, and strategies for gifted students. This particular study aimed to examine the opinions of the teachers who participated in the "Differentiating Mathematics for Gifted Children" (FCFM) professional development (PD) program in gifted education field and to what extent they became familiar with and they would use of strategies in gifted education after they participated the PD. Thus, this study sought answers to the following research questions:

1. What are the knowledge and opinions of in-service mathematics teachers regarding to the giftedness and gifted education?
2. To what extent FCFM Professional development program influence to their knowledge about mathematics education for gifted students?

METHOD

In this section, the research design, the participants, model development, the data collection and the analysis process are given.

Research Design

Design experiment, also called design-based research (Brown, 1992; Cobb et al., 2003; Collins, 1992), was used to develop and implement the FCFM professional development program. In design studies revisions and refinements made on the model based on the ongoing analysis of iterative cycles of the research. These iterative cycles have multiple steps such as testing a design (implementation), evaluation, and revision (Gravemeijer & Cobb 2013; Van den Akker et al., 2006). This cyclic process focuses on providing continuous improvement in design and producing better models (Cobb et al., 2003). This particular study will report on

the data from first cycle of the research implementation of FCFM project. The findings from the examination of the differences in the knowledge and opinions of the teachers before and after the professional development were discussed.

Participants

In the recruitment process of the participants, the project was initially announced in the host university's website and then in official social media accounts of the project and in some of the educational agency accounts that teacher followed in general in Turkey. In addition, project flyers were sent to BILSEM. Nearly 400 in-service teachers from across Turkey applied online to voluntarily participate in the project. To make selection among the teachers who applied to the project, a purposeful sampling method, also called criterion sampling, was used. The selection criteria were determined by the researchers. Based on the selection criteria to the project, the teachers who are affiliated with an academic project or research on the education of gifted children, working in BILSEM, and taking graduate level education specialized for gifted education was selected. To increase interaction between PD facilitators and selected teachers, and encourage the active participation throughout the sessions, the number of the participants was limited to 25 teachers. Thus, 25 in-service mathematics teachers working with gifted students in 17 different provinces throughout the country were selected as participants. Appendix 1 shows the summary of teachers' academic background, professional experience in years and the assigned school of the participating teachers.

Model Development

In the design process of FCFM professional development, the needs of mathematically gifted individuals, teachers' lack of pedagogical content knowledge and instructional practices used worldwide to teach mathematics to gifted individuals were taken into consideration. In the FCFM program, the teaching strategies for gifted individuals in the literature were transferred through theoretical and practical training specialized in mathematics education. In addition, in this program, mathematically challenging high cognitive demand tasks including model building activities were used. The teachers had the opportunity to engage with these tasks and saw examples of how to use these activities in the education of gifted individuals in mathematics. Also, the teachers participated interactive workshops on mathematical task design for gifted children. Within all these processes, the examples of technological applications that can be used in the education of gifted individuals were provided. The structure of FCFM professional development program is presented in Figure 1.

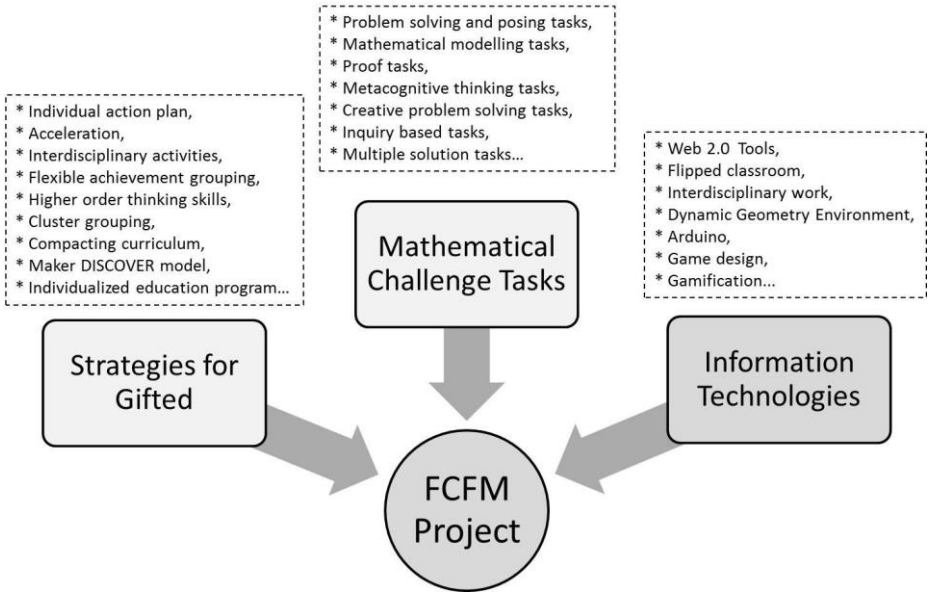

Figure 1: FCFM Program

The professional development provided with the scope of the project was held as face-to-face sessions and lasted one week. Generally, each day had six sessions such as two sessions in the morning, two sessions in the afternoon and two sessions in the evening. Each session lasted approximately 90 minutes.

The first days of the professional development focused on the concept of giftedness, fundamental characteristics of gifted children, and the concept of mathematical giftedness. In parallel, training in mathematical problem solving and posing, computational thinking, and Web 2.0 were provided. In the forthcoming days, specific mathematics teaching strategies for gifted children were discussed, and the teachers

were asked to prepare their own lesson plans by using the teaching strategies used in the PD along with the theoretical knowledge. This strategy-based training was supported with tasks such as mathematical modelling, inquiry-based tasks, creative problem solving, multi-solution problems, and mathematical proof used in the preparation process for the mathematical challenge. All the sessions were facilitated by the project team members and they all have Ph.D. in the field of mathematics education or gifted/special education as well as the field experience in their area of interests.

Data Collection and Analysis

In the study, semi-structured interviews and document analysis (case reports and participant journals) were used to examine the teachers' opinions on the change of their knowledge and perspectives about gifted education in particular for mathematics teaching and learning. Therefore, interview forms and the case studies which were developed by Öznacar and Bildiren, (2016) were used as data collection instruments before and after the professional development. In both pre-interview and post-interview, some questions focused on gifted education in general and some of them were particularly for mathematics teaching and learning of gifted children/students. Some example interview questions are as follows:

- Could you briefly tell us your teaching approach for gifted students in mathematics?
- What should be taken into consideration in teaching mathematics to gifted students?
- What kinds of tasks or problems should be presented to gifted students in mathematics?
- What should be the characteristics of the problems to be asked to gifted students in mathematics?
- How does the problem-solving process work in gifted students?
- What strategies do gifted students use in problem solving?
- To what extent and how can interdisciplinary approach be used in problem solving with gifted students in mathematics?

All interviews were conducted face to face and audio recorded. Pre-interview lasted for 15-20 minutes, and each post-interview lasted 30-45 minutes. The case studies were presented to the teachers as a written task before and after the professional development and took approximately 15-25 minutes in the beginning and 60-90 minutes in the end.

In addition to interview data, teachers' reflective journals were used as a data source. All teachers were asked to write a reflective journal at the end of each day. In order to ensure anonymity, the teachers were encouraged to choose their own pseudonyms before the data collection process.

Content analysis, which is one of the qualitative data analysis methods, was used to analyze journal data and the interview transcripts. To ensure the validity of the study; triangulation, detailed descriptions, and direct quotations were used and the confirmations of the participants were obtained. To ensure reliability, cross-checks were performed by comparing the codes obtained in the independent analyses conducted by two researchers in the light of the components of the FCFM program (Figure 1). The researchers are mathematics education and gifted education experts who took qualitative analysis courses at graduate level as well as their qualitative research experience in their field of expertise. Based on the codes obtained as a result of the analysis, the matching and non-matching codes were determined and the percentage of compatibility was calculated (Miles & Huberman, 1994). As a result of the analysis, inter-coder reliability was calculated as .92. Then, the researchers discussed the instances of disagreements and reached an agreement.

FINDINGS

In this section, we will firstly report on general findings regarding the gifted education, then specific findings regarding mathematics education for gifted will be discussed.

Knowledge and Opinions about the Concept of Giftedness, Gifted Education, and Mathematics Teaching

Prior to study, teachers had a very limited knowledge about the concept of giftedness. In both interviews and their journals before the professional development, the teachers identified giftedness with improvised sentences and the features that were not specific to gifted children. Their definitions only focused on one characteristic such as "Gifted children are the children who are always successful.", "Gifted children are the children who answer the questions very quickly.", and "Gifted children are the children who have high IQ scores.". However, the post-interview data showed that teachers provided definitions of giftedness based on the theories of giftedness. They also concentrated on multiple characteristics of gifted children in their definitions. Some characteristics emphasized in teachers' definitions were as follows: above- average ability,

creativity and task commitment components, general ability, special aptitude, non-intellective requisites, environmental support and chance factors.

In the pre-interview, except for one teacher who mentions "differentiation and enrichment", the rest of the teachers could not name a particular method, technique, or strategy that they knew or used in the education of gifted children. However, the analysis of post-interview data showed that teachers shared their knowledge and examples about almost all strategies and methods that were emphasized in the professional development. Some of the strategies that teachers mentioned were the Maker's DISCOVER model (Maker, 2001), interdisciplinary study, individualized education program (IEP), acceleration, curriculum compacting, mentoring, and taxonomy.

The examination of the pre-interview data on the teachers' responses regarding their knowledge and experience in the use of the contemporary approaches while teaching mathematics to gifted students showed non-specific responses. They mainly indicated that they could use problem solving and concrete materials without referencing any specific approach in working with gifted students. Nevertheless, their responses showed that the teachers at least were aware of the importance of using a constructivist approach in their teaching. Further, the teachers provided examples which were not specific to the education of gifted individuals such as creative writing, associations with art, quizzes, preparation for Olympic tests, brain games, and origami. In the post-interview, teachers emphasized models or approaches that are used to differentiate/enrich mathematics education in the form of Geogebra, robotic applications, STEM, argumentation-inquiry, modelling, drama, project work, and proof and development of high achievement ability to be used in the education of gifted children.

Knowledge and Opinions on Methods, Techniques, Strategies, and Approaches Used in Mathematics Education for the Gifted

The most prominent approach among the teachers' suggestions for a solution to the problems in case studies is referring gifted students to the counselling teacher or the Counselling Research Center (CRC) instead of working with the gifted child on the basis of various methods, techniques, and strategies. In the cases evaluated before the professional development, nine teachers stated that it is appropriate to refer their gifted students to CRC, a counsellor, or an expert. This situation can be interpreted as an indicator for prior to the PD, teachers cannot assume the responsibility of education for their gifted students alone. Based on the case reports, the teachers did not refer the students to the CRC for psychological support, but for the decision to propose that the student should study in a different class because s/he would not be sufficient in his/her gifted education. There were no teachers who stated opinions in terms of guidance in the evaluations of teachers, then the PD case reports were found to be one of the most striking findings of the case studies. Another striking finding regarding the teachers' evaluation of the case studies after the professional development was that no teacher made any statement about referring a gifted child to a counsellor. After the teachers participated in the PD, they started to enhance their required knowledge (e.g., methods and approaches) and build their confidence in autonomously serving and supporting gifted students.

In the case studies that teachers examined before the professional development, eight teachers insisted that gifted students should be educated at their assigned grade level. This finding suggests that teachers did not individualize or differentiate education for their gifted students and ignored gifted students in their classrooms before their professional development. However, the fact that none of the teachers stated this opinion in their case studies after the professional development suggested that they could possibly provide differentiation and enrichment for the gifted children after their training.

In the pre-training implementation of case reports, teachers' knowledge of methods, techniques, and strategies for the education of gifted individuals was quite insufficient in parallel with the analysis of pre-interviews. In the preliminary implementations of case studies, only one teacher emphasized methods, techniques, and strategies, whereas only two teachers mentioned enrichment, the other two mentioned supportive education rooms, three teachers mentioned differentiation, and two other teachers mentioned IEPs. In addition, none of the teachers mentioned methods, techniques, or strategies such as acceleration, mentoring, curriculum compacting, Maker's model, or independent study. In fact, before the professional development, no teacher expressed any opinions about the necessity of determining the level of performance of gifted individuals. Only eight teachers referred to interdisciplinary work with expressions and examples, though not explicitly, by referring to the cross-domain association. After the PD, teachers could suggest solution strategies for the

presented cases by using the strategies that they learned during PD. For instance, 'Nehir' one of the teachers, suggested a solution to Case 2 on the strategies for gifted children after the professional development.

"The strategies of acceleration and curriculum compacting could be applied. Learning outcomes with high performance are not included. Outcomes should be determined and then a preliminary evaluation should be performed. A general definition should be created and comments should be added on the outcome. Repeating outcomes could be omitted. Enriched activities should be planned instead of the omitted outcomes. In addition, IEP should be prepared. Short-term and long-term objectives should be written down. Problem solving, problem posing, and modelling activities should be included.

Beginner → Contents of the topics are divided into smaller parts.
Basic → Themed projects and studies are performed.
Intermediate → Real-life examples are presented.
Advanced → Subject theme is diversified. Interdisciplinary studies are conducted and the student makes a presentation." ('Nehir', After PD, Case 2)

The analysis of teachers' solution strategies to the presented cases included a wide range of strategies; acceleration (18), interdisciplinary work (18), determining performance level (15), mentoring (15), curriculum compacting (15), and IEPs (13). Some of the teachers stated that the Maker's curriculum differentiation model (9), enrichment (6), differentiation (4), taxonomy (4), and independent working strategy (2) could be used. For instance, teacher 'Mavi' suggested the following solutions for Case 1:

> "Since 'Ozan' does not have a formal diagnosis, I would start by performing an evaluation test. I would apply the strategies of curriculum compacting and acceleration according to the weak and missing spots. In this way, I could help him improve by learning quickly in the areas where he is good at or missing some points and by achieving extraordinary outcomes in the areas in which he is already very successful. I would also consider the meta-cognitive skills in the activities related to the outcomes… ('Mavi', Post-Training)

Considering the change in teachers' responses to the interview questions and their ability to generate solutions to the presented case, it is an indication for the effectiveness of the PD in raising teachers' awareness and knowledge for teaching mathematics to the gifted with using the methods, techniques, and strategies discussed in the PD. These changes in the suggestion of using the strategies can be interpreted as raising awareness about the issue.

When the explanations of the teachers regarding case studies were examined in the context of mathematics education, 11 teachers emphasized instructional activities in traditional mathematics lessons that are not specific to gifted individuals in parallel with the answers they gave in the pre-interviews. After the professional development, almost all teachers offered solutions based on the strategies and theories as an alternative to the practices used in traditional mathematics lessons. Such progress in teachers' ability to suggest solution strategies specific to mathematics teaching and learning for gifted students could perceive as evidence for the contribution of the professional development program to teachers' knowledge and awareness of mathematics education for the gifted.

Prior to the professional development, when teachers examined the presented cases, seven teachers expressed their opinions about the application of the advanced cognitive activities such as "modelling/model building", "reasoning", and "meta-cognitive activities" for the education of gifted students. At the end of the professional development, 13 teachers stated similar views. When referring to the use of technology, no teacher noted the ideas regarding the use of technology-based applications (STEM, dynamic geometry, robotics, and coding) in the education of gifted students during the case reports implemented before the professional development, but 11 teachers recommended using these applications after the professional development. For instance, teacher 'Fatma' commented as follows:

"Creative problem solving, argumentation-based learning, problem posing, project construction, STEM applications, modelling activities, robotic applications, coding, proof finding, meta-cognitive activities, dynamic mathematics/geometry software… Before all these strategies, a curriculum compacting and IEP plan should be created." ('Fatma', Post-Training Case 1)

In the case studies examined before the professional development, one teacher suggested inquiry-based teaching in mathematics education and another teacher suggested drama practices as a solution. After the professional development, seven teachers emphasized argumentation and inquiry-based teaching, whereas four teachers highlighted drama. This finding can be interpreted as that teacher will start to prefer inquiry-

and creativity-based practices in their lessons. Furthermore, four teachers expressed their opinions about using methods that are not specific to mathematics and its teaching in the context of gifted education. They suggested strategies and/or methods such as concretization (with manipulatives or materials), educational games (n = 3) and brain games (chess, abalone, pentagon etc.) (n = 2) prior to the professional development program. However, after participating in the professional development program, teachers could suggest mathematics specific strategies as well as suggesting more than one strategy to the presented case.

The following statement of teacher 'Ferah' was an example of the use of multiple strategies which are related to mathematics teaching and learning. She emphasized the contemporary approaches she learned in this professional development program in her proposed solution for the Case 1:

> "I can apply the strategies of creative problem solving, argumentation-based learning, problem posing, project making, STEM applications, modelling activities, robotic applications, coding, proof finding, meta-cognitive activities, dynamic mathematics/geometry software for 'Ozan'… and before all these activities, a curriculum compacting and IEP should be created (Ferah, Case 1, Post-Training)

DISCUSSION AND CONCLUSION

This study aimed to help teachers provide education to gifted children and learn education strategies to interact with the gifted. The results of the present study showed that teachers' knowledge of giftedness and gifted education as well as their opinions of how mathematics should be taught to gifted students improved with using mathematics specific strategies.

Teachers faced difficulty in explaining the concept of giftedness before participating in the FCFM professional development program. Although there is no consensus on the definition of giftedness (Ambrose et al., 2010; Dai & Chen, 2014; Stenberg, 2018; Subotnik et al., 2011), the teachers' ability to define giftedness in the conceptual framework can make it easier for them to plan gifted education. For teachers to direct their gifted students to special programs, it is necessary for them to have accurate, complete definitions of giftedness and to know the characteristics of these students (Schroth & Helfer, 2009; Speirs Neumeister et al., 2007). Speirs Neumeister et al. (2007) state that teachers generally have their own concepts of giftedness. In our study, after the individual definitions of the teachers were evaluated, theoretical approaches were expressed. In this study, the teachers needed to refer their students to the CRC for psychological support because they did not feel competent to provide the necessary instruction to gifted students. In the previous studies conducted in several branches in Turkey, the teachers suggested a CRC to allow gifted students to receive an education at a different school (Bildiren, 2018b; Bildiren, Gür, Sağkal, & Özdemir, 2020). In this study, teachers were also able to define the giftedness in the theoretical framework after participating in the professional development program. These definitions are believed to support the acquisition of educational strategies for gifted children.

The participant teachers expressed knowledge of limited, inadequate methods and techniques for these children before participating in the professional development program. After participating the professional development program, they designed activities according to Maker's DISCOVER model (Maker, 2001), utilized interdisciplinary learning approach in their activities, individualized professional development programs, acceleration, curriculum compacting, mentoring, and Bloom's taxonomy. Blumen-Pardo (2002) found that professional development programs for teachers providing education to gifted children are effective and such programs support children's academic achievement and creative thinking skills. Şahin and Kargın (2013) detected that teachers' levels of knowledge increased as a result of the professional development provided about gifted students. In similar studies (Gökdere, 2004; Reis & Westberg, 1994), teachers' competencies related to the education of gifted children increased. In this study, it can also be set forth that the gifted education competencies of the trained teachers increased.

Despite the recommendations and efforts to support gifted students, the research has shown that most teachers do not have the time, qualifications, and resources needed to develop and implement projects to enact a differentiated curriculum (Tyler-Wood et al., 2000). Differentiated teaching has become the most widely used way to provide teaching and learning opportunities for gifted students in the United States (National Association for Gifted Children and the Council for the Gifted, 2015). Similarly, differentiation in the education of gifted children was often highlighted in the Special Education Services Regulation by the MoNE (2018) in Turkey. In this project, the teachers planned well-thought and enriched activities for differentiation and emphasized the strategies for differentiation in the interviews. In Schroth's (2007) study, more than 97% of 411

principals and teachers considered the differentiation of teaching in the normal classroom environment as an important proposal, and most of them (71%) considered it to be a very important option. Yet teachers may resist differentiation due to the concerns about the lack of administrative support or the lack of sufficient time for planning (Hertberg-Davis & Brighton, 2006). Effective differentiation of education is a challenging task that requires expertise and flexibility (VanTassel-Baska & Stambaugh, 2005). However, providing professional development for teachers on this subject can reduce concerns. Considering that the teachers, who are supported professionally for implementation of differentiation strategies, can maintain a positive attitude toward this complex teaching strategy (Latz et al., 2009; Moon et al., 1999), it is anticipated that it will be possible to implement these strategies.

Before participating in the professional development program, the mathematics teachers who worked at BILSEM and the teachers who taught in heterogeneous classrooms held opinions that were not specific to gifted students but mostly related to teaching practices in traditional mathematics lessons. The review of literature shows that the teachers working with gifted students in mathematics often do not have the necessary knowledge and skills, do not understand the unique solutions of students, do not know how to encourage creativity, critical and independent thinking, feel lack of teaching materials to use in heterogeneous classrooms, and do not know how to use those when they have them (Applebaum et al., 2008). Also, the literature review suggests that teachers should make a professional preparation for identifying and supporting gifted individuals in mathematics (Johnson, 2000; VanTassel-Baska, 2007). Especially teachers can provide more challenging activities for their gifted students to meet their needs. In this context, there is a decrease in the opinions of the teachers who prepare and implement individual and collaborative plans under the supervision of field experts about using non-specific teaching practices on gifted students, and there is a significant increase in their awareness about mathematics teaching based on methods, techniques, and strategies. Moreover, the teachers did not have enough knowledge about the education of gifted children before the professional development. However, they demonstrated high motivation throughout the professional development to acquire a comprehensive knowledge about gifted education. It is anticipated that the teachers working in the education of gifted children will be more competent in gifted education than the teachers in heterogeneous classes. Cross and Frazier (2013) found that the teachers who serve gifted students in heterogeneous classes provide less support for gifted high school students than the teachers in a school specialized. In this study, it is thought that the high motivation of teachers stems from the aforementioned fact.

In our research, which is the first project in our country that combines mathematics education approaches and gifted education in the context of professional development program strategy, the reflections of teachers after the program are discussed. In our country, undergraduate students take only one compulsory Special Education Course and if offered, they take a few elective courses. However, the professional development of teachers who will work with gifted students starts at undergraduate level in Canada, Switzerland and Sweden. In other countries including Australia, Taiwan, the Netherlands, the United Kingdom, Russia, the United States, Canada, Australia, the Netherlands, and the United Kingdom, such professional developments start after the undergraduate education. In our country, the lack of competencies of teachers in the education of gifted children could originate from the lack of pre-service and in-service education specifically designed on gifted education.

After the program implementation, 19 of 25 teachers met and shared what they learned in the professional development with their colleagues in their own schools. Also, the researchers asked them to implement a strategy-based lesson plans in their own mathematics courses. By this way, our project's beneficiaries and the widespread impact were planned to increase. As a follow up study of this project, teachers' implementations and plans for the instruction of gifted children are planned to be assessed in the forthcoming studies.

The limitation of this research is the limited number of the teachers participated in the professional development program. Yet there is a need for implementing and assessing the effectiveness of our professional development model in other contexts with mathematics teachers teaching gifted children. Also, the effects of our research on the development of gifted student should be examined. Similarly, the instructional practices for the non-gifted students of trained teachers can be compared with the instructional practices for gifted students. Likewise, comparisons can be made with in-service professional development in different disciplines such as science and social studies.

As a result of this project, it is recommended that teachers from various discipline areas, especially mathematics teachers, be provided with systematic ongoing professional development on gifted education.

Declarations

Conflict of Interest

No potential conflicts of interest were disclosed by the author(s) with respect to the research, authorship, or publication of this article.

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Research and Publication Ethics Statement

Hereby, we as the authors consciously assure that for the manuscript the following is fulfilled:

- This material is the authors' own original work, which has not been previously published elsewhere.
- The paper reflects the authors' own research and analysis in a truthful and complete manner.
- The results are appropriately placed in the context of prior and existing research.
- All sources used are properly disclosed.

Contribution Rates of Authors to the Article

The first author is the project coordinator. The authors provide equal contribution to this work.

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Appendix 1. The background and the experiences of the teachers

Name	Sex	Expertise	Graduate Education	Assigned School	Years of Experience
T1	female	Secondary Mathematics Teacher	Master's Degree in Mathematics	High School (Public) & BILSEM (temporary)	18
T2	female	Middle School Mathematics Teacher	Master's Degree in Educational Administration and Inspection	Middle School (Private)	11
T3	female	Middle School Mathematics Teacher	Ph.D. Student in Mathematics Education	Middle School (Public)	6
T4	female	Middle School Mathematics Teacher	Master's Degree in Elementary Mathematics Education	Middle School (Public)	11
T5	female	Middle School Mathematics Teacher	Ph.D. Student in Elementary Education	BILSEM (1 year)	13
T6	female	Middle School Mathematics Teacher	Ph.D. Student in Elementary Mathematics Education	Middle School (Public)	10
T7	female	Middle School Mathematics Teacher	N/A	BILSEM (3 years)	11
T8	female	Middle School Mathematics Teacher	Master's Student in Elementary Mathematics Education	Middle School (Public)	8
T9	female	Middle School Mathematics Teacher	Ph.D. Student in Elementary Mathematics Education	Middle School (Public)	5
T10	female	Middle School Mathematics Teacher	Master's Student in Elementary Mathematics Education	Middle School (Public)	3
T11	female	Middle School Mathematics Teacher	Master's Degree in Educational Administration and Inspection	BILSEM (3 years)	6
T12	female	Middle School Mathematics Teacher	Master's Student in Mathematics Education	Middle School (Public)	3
T13	female	Middle School Mathematics Teacher	Master's Degree in Mathematics	BILSEM (7 years)	14
T14	female	Secondary Mathematics Teacher	Master's Student in Mathematics Education	High School (Public) & BILSEM (temporary)	9
T15	male	Middle School Mathematics Teacher	Master's Degree in Elementary Education	BILSEM (3 years)	18
T16	male	Middle School Mathematics Teacher	Master's Student in Mathematics Education	Middle School (Public)	2
T17	male	Middle School Mathematics Teacher	N/A	BILSEM (1 year)	9
T18	male	Secondary Mathematics Teacher	Master's Degree in Educational Curriculum and Instruction	BILSEM (2 years)	10
T19	male	Middle School Mathematics Teacher	Master's Degree in STEM Education	BILSEM (3 years)	6
T20	male	Middle School Mathematics Teacher	Master's Degree in Elementary Mathematics Education	BILSEM (3 years)	16
T21	male	Middle School Mathematics Teacher	Ph.D. Student in Mathematics Education & Master's Degree in Assessment and Evaluation	Middle School (Public)	5
T22	male	Middle School Mathematics Teacher	Master's Degree in Mathematics Education	Middle School (Public)	10
T23	male	Middle School Mathematics Teacher	N/A	Middle School (Public)	5
T24	male	Middle School Mathematics Teacher	Master's Degree in Computer and Instructional Technologies	Middle School (Public)	13
T25	male	Middle School Mathematics Teacher	Master's Degree in Local Administration and Politics	BILSEM (1 year)	5