PERCEPTIONS ON TEACHING THE MATHEMATICALLY GIFTED

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The aim of this study is to describe and analyze the structure of the perceptions of elementary school teachers concerning mathematically gifted students. The study was conducted among 377 elementary school teachers, using a questionnaire of 21 statements on a 5-point Likert type scale. The results of the study revealed that teachers' perceptions regarding gifted students in mathematics can be described across four dimensions based on the following factors; teachers' needs, teachers' self-efficacy beliefs, characteristics of the gifted and the different services delivered to meet the needs of the gifted. Implications for teachers, researchers and policy-makers are discussed.

Keywords: giftedness, teachers' perceptions, teacher training, self-efficacy beliefs, special education

INTRODUCTION

Gifted students differ from their classmates. Therefore, differentiated instruction is required, in order to maximize their talents. However, according to Archambault et al. (1993), as well as Westberg et al. (1993), very few instructional or curricular modifications are made in regular elementary classrooms in order to enhance gifted students' abilities.

The present study purports to examine the perceptions of elementary school teachers regarding gifted students, with reference to mathematics. In particular, in this paper we firstly aim to confirm that teachers' perceptions can be defined accross four dimensions which correspond to teachers' needs, teachers' self-efficacy beliefs, the characteristics of the gifted and the different services delivered to meet the needs of the gifted, as described in the model developed specifically for this study. Secondly, we intend to investigate the structure of teachers' perceptions about the ways to address the needs of gifted students, the characteristics of mathematically gifted students and the importance of the teacher in order to be able to provide the appropriate support and guidance to these students.

Investigating the views of teachers regarding gifted students is expected to provide valuable information on the aspects which are susceptible of improvements. In addition, this study could serve as a starting point for the development of inservice programs for teacher education concerning mathematical giftedness.

THEORETICAL FRAMEWORK

Characteristics of gifted students in mathematics

Mathematically gifted students are characterized by an expanded cognitive base and are more capable of exploiting knowledge in order to realize their objectives. A necessary trait of a teacher of the gifted should be the knowledge of their characteristics and needs, as stated by Kathnelson and Colley (1982). Several characteristics of mathematically gifted students have been discussed in previous studies. Maker (1982) pointed out three key areas in mathematics that gifted students differ from their peers; pace at which they learn, depth of their understanding and their interests.

Regarding the first area, gifted students are capable of providing answers with an unusual speed and precision (Heid, 1983), namely they are able to solve mahematical problems faster (Hettinger & Carr, 2003). Their ability in identifying relationships in subjects, concepts and ideas without previous related teaching (Heid, 1983), increases the pace at which they learn. The fact that gifted students are flexible in using different strategies and they are able to select the most suitable strategy for each situation in compination with the possession of complex metacognitive and self-regulative skills (Hettinger & Carr, 2003) proves the depth of their understanding. In addition, Johnson (2000) reported that mathematically gifted students give original explanations and have the ability to organize data, transfer knowledge and generalize ideas. It has also been observed that gifted students are often more interested and perform better in tasks that require mathematical reasoning than computational processes (Rotigel & Lupkowski-Shoplik, 1999). As far as their interests are concerned, gifted students prefer to discuss with adults and to be involved with professionals. They are more favorable to advanced issues than their classmates, e.g. mathematical proof, politics, space.

Nurturing gifted students

A number of methods have been proposed and developed to fulfill the needs of gifted students. Among them, enrichment activities, differentiation of teaching, flexible grouping, acceleration and increased use of technology are the most common ones. Research by Rotigel and Pello (2004) has shown that a combination of the aforementioned approaches is the best solution for the gifted.

Enrichment refers to the presentation of content in more depth, width, complexity or abstraction related to the curriculum delivered to all students (Florida Department of Education, Bureau of Exceptional Education and Student Services, 2003; Rotigel & Pello, 2004). According to Lewis (2002) and Renzulli (1976), new content is added to the curriculum, existing content is explored in more depth and the curriculum is expanded with additional tasks that require cognitive and research abilities.

Acceleration is defined as the practice of presenting content sooner or in a faster pace. Brody and Benbow (1987) argued that acceleration can be obtained in a variety of ways. For example, acceleration can be achieved in one or many subjects or by skipping grades. In addition, university courses offered to secondary education gifted students or early graduation from secondary education and early enrolment in a

higher institution may be considered as acceleration options (Brody & Benbow, 1987). Acceleration provides the appropriate level of challenge in order to avoid boredom from repeated learning and to decrease the time required to graduate from an educational level (National Association for Gifted Children, 2004).

Useful suggestions about ways teachers can use in their classrooms in order to differentiate teaching to fulfill the needs of gifted students are provided by Johnson (2000). In particular, Johnson (2000) pointed that gifted students need inquiry-based learning approaches that emphasize open-ended problems with multiple solutions, as an opportunity to show their abilities. To this end, the teacher should pose a variety of higher-level questions during justification and discussion of problems. Moreover, technology can serve as a means for the gifted student to reach the appropriate depth and width of the curriculum (Johnson, 2000).

Teachers' needs

There is a prevailing myth that gifted students do not need special attention since it is easy for them to learn what they need to know (Johnson, 2000). On the contrary, their needs require a deeper, broader, and faster paced curriculum than the regular one. Due to the complexity of giftedness, it is of great importance that teachers have specialized preparation in gifted education, namely in identifying and nurturing the mathematically gifted (Johnson, 2000; VanTassel-Baska, 2007). Not only strong pedagogical knowledge is needed, but also a strong background in mathematical content. Providing a more general framework, Jenkins- Friedman and her colleagues (1984) argued that an effective teacher should have five kinds of skills; managerial-facilitative, pedagogical, social-consultative, directive and planning and interactive skills.

In this direction, Gear (1978) observed that teacher effectiveness can be improved with specific training. VanTassel-Baska (2007), commented that teachers of the gifted need to be able to address multiple objectives at the same time, recognize how students might manipulate different higher level skills in the same task demand, and easily align lower level tasks within those that require higher level skills and concepts.

Despite all recommendations and efforts in providing appropriate support to gifted students, previous studies have shown that the majority of teachers have neither the time, qualifications nor sources to develop and implement a differentiated curriculum (Tyler-Wood et al., 2000). In addition, low teacher efficacy beliefs in meeting the needs of gifted students, their lack of relevant teacher training which is partially originated by the lack of preparation for this task during their graduate studies (Lee & Bailey, 2003), reveals the intensity of this phenomenon.

Teachers' perceptions regarding gifted students

Teachers' perceptions about teaching and learning have a powerful influence on the ways teachers act in the classroom and interact with their students (Bain et al., 2007).

Despite their importance, little is known about the current perceptions of individuals in teacher-education programs regarding the educational practices for gifted children (Bain et al., 2007). Particularly in the case of gifted students, there is a disparison between teachers' perceptions; on the one hand teachers are overwelmed to work with gifted children and on the other hand they are negatively prejudiced towards them.

Regarding positive perceptions held by teachers about gifted students, Rothney and Sanborn (cited by Martinson, 1972) noted that teachers believe that the gifted will reveal themselves through academic grades and they need all existing content plus more. Therefore, teachers should add to the existing curriculum material requirements rather than delete anything. Studies conducted by Justment and colleagues (cited by Martinson, 1972) revealed that teachers experienced with special programs were generally enthusiastic to work with gifted students, since the experience with training programs produces more favorable attitudes toward gifted children (Martinson, 1972).

Nevertheless, teachers of the gifted often feel threatened by these students since they are sometimes confronted with students with more knowledge and abilities than themselves (Shore & Kaizer, 1989). In addition, the often stated misconception, as suggested by Bain and her colleagues (2007), namely that gifted children will find their way on their own, provides an alibi for educational system to continue neglecting their needs.

METHODOLOGY

Subjects

The sample consisted of 337 elementary school teachers. Table 1 presents demographical data of the study sample. The percentage of each category is presented in parenthesis.

Years of service	Men	Women	Total
1-10	39 (11.57)	174 (51.63)	213 (63.20)
>10	26 (7.72)	98 (29.08)	124 (36.80)
Total	65 (19.29)	272 (80.71)	337 (100.0)

Table 1: Sample demographic data

Data Collection

In order to collect data for this study, a questionnaire was administered to 337 elementary school teachers in Cyprus. The questionnaire consisted of 21 statements in a 5-point Likert scale with number 1 referring to the complete disagreement of the teacher and number 5 represented complete agreement with the statement. Participants indicated the degree that better expressed their opinion. In addition, empty space was provided to optionally add any remarks.

Data analysis

Data collected were analyzed in an effort to explore the perceptions of elementary school teachers regarding mathematically gifted students. In particular, the statements focused on four aspects; teachers' role, teachers' self-efficacy beliefs, ways to meet the needs of gifted and their characteristics. Given that on the theoretical part of the study several issues regarding mathematical giftedness have been highlighted, an effort was made to assess whether a theoretically driven model would fit to the data. To achieve this, confirmatory factor analysis was performed.

The statistical modeling program MPLUS (Muthen & Muthen, 2007) was used to test for model fitting in the present study. Three fit indices were calculated, before evaluating model fit: The ratio of chi-square to its degree of freedom (x^2/df), the comparative fit index (CFI), and the root mean-square error of approximation (RMSEA). According to Marcoulides & Schumacker (1996), in order to support model fit, the abovementioned indices required to be verified. In particular, the observed values for x^2/df should be less than 2, the values for CFI should be higher than 0.90, and the RMSEA values should be close to or lower than 0.08.

RESULTS

In this study, we hypothesized an a-priori structure of teachers' perceptions regarding the mathematically gifted and then tested the ability of a solution based on this structure to fit the data. The proposed model consists of four first-order factors: teachers'needs (F1; statements 15, 17, 18 and 21), teachers'self-efficacy beliefs toward teaching the mathematically gifted (F2; Statements 5 and 13), ways to meet the needs of these students (F3; Statements 9 and 20) and characteristics of gifted students in mathematics (F4; statements1, 2 and 3) that form the second-order factor of teachers' perceptions concerning the mathematically gifted.

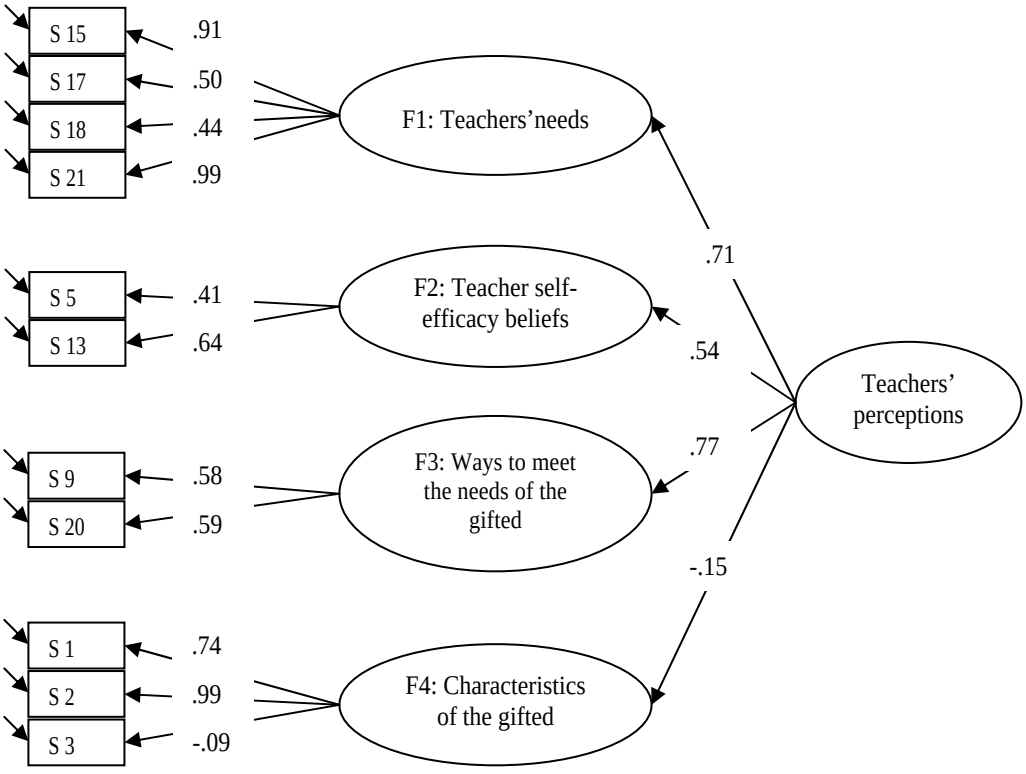

Figure 1: The structure of teacher perceptions about gifted students in mathematics.

Figure 1 presents the structural equation model with the latent variables of teacher perceptions regarding mathematically gifted students and their indicators. The descriptive-fit measures indicated support for the hypothesized model (CFI=0.97, χ^2=66.07, *df*=40, χ^2/df=1.65, *p*<0.05, RMSEA=0.04). The parameter estimates were reasonable in that almost all factor loadings were statistically significant and most of them were rather large (see Figure 1). Several statements were excluded from the model due to their low factor loadings compared to the remaining statements. The 11 statements included in the model are shown in Appendix 1.

In particular, the analysis showed that each of the statements employed in the present study loaded adequately only on one of the four factors (see the first order factors in Figure 1), indicating that the four factors can represent four distinct aspects of teachers' perceptions concerning gifted students in mathematics.

Teachers' comments that were written in the empty space provided are presented below to enhance the proposed model, after being categorized in the four factors formed by the abovementioned model.

Factor	Teachers' comments
1. Teachers' needs	- It is necessary for the teachers to receive training in teaching gifted students. Having a counselor in each school will be very helpful for the teachers. - The ideal is to have special teachers for gifted students in each school.
2. Teacher self-efficacy beliefs	- Gifted students might ask difficult questions that I will not be able to answer. I prefer not to have one in my classroom. - I am not aware of the criteria to identify a truly gifted child.
3. Ways to meet the needs of the gifted	- The Ministry of Education should send material for the gifted in order to differentiate their work. - The school should support gifted students, not only students who experience difficulties. They should be given opportunities to take advantage of their talents and experiences according to their interests. Challenging activities should be provided in order to avoid boredom. - It is difficult for them to follow a mechanical learning path. Thus, the learning process should conform to their personality and allow for creative activities. - Gifted students do not always prefer to have differentiated work. Sometimes they prefer to work like the others. Particularly in the first grades, they do not want to differ. - They should help low-ability students and facilitate teacher's work. - They can develop their talents out of school motivated and supported by their parents. - The fact that they have different potentials than those of their classmates, is enough. They do not need any other differentiation.

4.Characteristics of the gifted	- Being gifted does not mean being perfect in everything. Usually, you meet students gifted in one or more domains. - I think that nowadays it is difficult to talk about gifted students. Many children have special abilities-talents in specific domains. Intelligence is defined from various factors. A student may be gifted in mathematics, while another student may me gifted in art. I would say that there is no general giftedness. - In my opinion, the term "gifted" does not exist or it is used erroneously. - There are no objective criteria to define a student as gifted.

Table 2: Teachers' comments

DISCUSSION

Given the importance of the role of the teacher both in identifying and nurturing gifted students, the aim of this study was to examine the structure of the perceptions of elementary school teachers concerning gifted students in mathematics. The study reported in this paper provided evidence that teachers' conceptions about mathematically gifted students can be described across four dimensions based on the following factors. Specifically, the first factor is teachers' needs to appropriately cater this special group of students. The second factor refers to self-efficacy beliefs held by teachers, such as considering themselves able to provide adequate support to mathematically gifted students and help them realize full potential. The third factor is the different ways used during teaching to meet the needs of the gifted, i.e., providing them with more challenging activities than those of their peers. The fourth factor consists of the characteristics of the gifted; for instance, that gifted students prefer to reason than proceed to computational processes. The abovementioned structure suggests that teachers need to work not only on their knowledge regarding the characteristics of gifted students and the different approaches that proved to be useful in providing appropriate services, but also knowledge and skills required for the teachers to possess, as well as their self-efficacy beliefs. Based on this assumption, we could speculate that programs aimed at educating teachers in the domain of gifted education and more specifically in the field of mathematics, should focus on these four aspects.

The high factor loadings of the statements regarding the existence of counselors of the gifted in schools (S15 and S21) to the corresponding factor might be explained by the fact that teachers receive no guidance or training regarding educating the gifted. This is also reported in the remarks provided by teachers after completing the questionnaire. In Cyprus, there is no provision for gifted students stated in the mathematics curriculum. Therefore, the need for gifted education programs inside or outside the school boundaries is apparent. The teachers' concerns about the absence of relevant support by the state is also evident by the factor loadings of F1 and F3 in the second-order factor which is the teachers' perceptions. The results verify similar findings by Tyler-Wood et al. (2000) as well as by Lee and Bailey (2003).

It is evident from teachers' remarks related to the ways of meeting the needs of gifted students, that although they are aware of various approaches, such as differentiation as suggested by Johnson (2000), enrichment discussed by Lewis (2002) and Renzulli

(1976), they also hold various misconceptions. In particular, a remark that was noted by a teacher is that gifted students should help low-ability students and facilitate teacher's work. Another view held by a teacher is that the fact that gifted students have different potentials than their classmates is already enough and they do not need any other differentiated teaching. The aforementioned perceptions contribute to the prevailing myth that gifted students do not need special attention since it is easy for them to learn what they need to know (Johnson, 2000). Another teacher pointed out that students can advance their talents out of school motivated and supported by their parents. It is also important to note that no teacher mentioned anything about the use of technology as a way of supporting mathematically gifted students as proposed by Johnson (2000).

The results reveal that teachers are also concerned about their efficacy. In fact, a teacher acknowledged the fact that he is not able to identify a gifted student, while another teacher stated that gifted students might ask difficult questions, thus embarrassing the teacher and causing negative attitudes towards the gifted. This remark enhances the findings of Lee and Bailey (2003), according to which teachers have low efficacy beliefs in meeting the needs of the gifted.

At the same time, the characteristics that distinguish mathematically gifted students do not seem to be of great significance to the teachers. This could be owed to the fact that teachers are more interested in providing suitable experiences and activities for their students, without being aware of their distinctive characteristics. This implies that whether teachers have high ability or gifted students in their classrooms, they treatall students in the same way. In order to succesfully deliver the appropriate services to gifted students, teachers need first to identify them. Therefore, a solid understanding of characteristics observed in gifted children should be a requirement for teachers.

The present study extended the literature in a way that a model was validated examining the structure of teachers' perceptions concerning the mathematically gifted. The model proposed in this study offers teachers, researchers and policy makers a means to examine mathematical giftedness as it is experienced through the eyes of the teachers. From the perspective of teachers, the model may be used in order to aknowledge their lack of knowledge regarding behaviors that characterize gifted students and receive the appropriate support to feel confident to help mathematically gifted students realize their potentials. From the perspective of researchers and policy makers, it is likely that the model could serve as a starting point for the development of appropriately designed teacher training programs for the identification and nurture of the gifted. As a consequence, the change observed to teacher beliefs towards the gifted could be examined by researchers, as well as their shift in using various instructional approaches regarding mathematically gifted students. Finally, policy makers could exploit the results of this study by adding a special section in the curriculum for gifted students, acknowledging the fact that they have special needs that should be met.

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Appendix 1: The 11 statements included in the model.

S1	Mathematically gifted students solve problems faster.
S2	A mathematically gifted student prefers to reason than compute.
S3	Gifted students might have attitude problems.
S5	I believe that I have the appropriate means to provide adequate support to gifted students.
S9	Gifted students should be provided with more challenging activities compared to their classmates.
S13	Having a gifted student in my classroom makes me feel very nervous.
S15	It is important to have at least one specially trained teacher for gifted students in each school.
S17	It is important to use identification procedures for gifted students.
S18	University programs should include teacher training regarding teaching gifted students.
S20	Acceleration of gifted students should be permitted through grade-skipping.
S21	I believe that there should be councelors/mentors for gifted students.