MODESTUM EURASIA Journal of Mathematics, Science and Technology Education, 2024, 20(12), em2554
ISSN:1305-8223 (online)
OPEN ACCESS Research Paper https://doi.org/10.29333/ejmste/15710

# The cognitive beliefs of mathematics teachers about gifted students and its relation to their cognitive beliefs to learn and teach mathematics

Nasser Helmy Youssef [1], Mansour Saleh Alabdulaziz [1*]

[1] Department of Curriculum and Instruction, College of Education, Imam Abdulrahman Bin Faisal University, P.O. Box 2375, Dammam 31451, SAUDI ARABIA

Received 05 September 2024 ▪ Accepted 21 November 2024

**Abstract**

The aim of this research was to identify mathematics teachers' cognitive beliefs about gifted students (MTCBGS), mathematics teachers' cognitive beliefs about learning and teaching mathematics (MTCBLTM), and the relationship between these beliefs. To achieve this, a scale of cognitive beliefs about gifted students among teachers was developed along with a scale of cognitive beliefs for learning and teaching mathematics. The tools were administered to 131 male and female mathematics teachers at different levels in the Eastern Province of the Kingdom of Saudi Arabia during the academic year 2024. The results revealed that levels of both MTCBGS and MTCBLTM were high. In addition, there was a statistically significant relationship between MTCBGS and MTCBLTM, as well as a statistically significant difference in MTCBGS between teachers with high MTCBLTM and teachers with low MTCBLTM. In view of the results, the researchers recommend building training programs for mathematics teachers according to MTCBGS and MTCBLTM and measuring their effectiveness, as well as spreading awareness about gifted students and teaching mathematics according to constructivist theory.

**Keywords:** cognitive beliefs, mathematics teachers, gifted students, learning, teaching

## INTRODUCTION

Due to the range of different learning needs present in motor, communicative, psychosocial and cognitive domains, teachers are now confronted with increased complexity in their efforts to improve student outcomes (Coleman & Gallagher, 2015). An issue that is particularly challenging is ensuring that the same educational opportunities are available to all learners, which is categorized under the term 'inclusive education' (Navarro et al., 2016). Educators globally are now attempting to determine the optimal method of preparing teachers to address the needs of more diverse classrooms, particularly as teachers are now being required to increase their workload with fewer resources (Lucas & Norbury, 2014a). Teachers must therefore be suitably equipped to effectively manage the diverse range of learners in their classrooms (Lucas & Norbury, 2014a).

Inclusive educational practices have become increasingly prevalent recently, which has resulted in a higher proportion of learners with varied learning requirements in general education classes, ranging from talented students to those with learning difficulties (Byrnes, 2008; Schwab, 2021). Resultantly, it is important that teachers possess the required abilities to support learners with diverse needs in the classroom environment (Navarro et al., 2016). When these types of learners are included, instruction must be differentiated, modified or adjusted by the teacher to ensure that each student has the opportunity to engage fully at a level that corresponds to their ability (Sharma & Nuttal, 2016). Considering the advantages of inclusion, supported by studies showing that teachers develop more positive attitudes, self-perceptions and self-efficacy as a result of enhanced teacher training, Sharma and Nuttal (2016) contended that inclusive education training should become an obligatory component of higher education teacher training programs. In fact, a significant body of literature has focused on the attitudes or perceptions of teachers towards students with diverse learning needs, including talented and twice-exceptional students (Bain et al., 2007; Carroll et al., 2003; Cooper, 2012; Foley-


✉ nyoussef@iau.edu.sa ✉ malabdulaziz@iau.edu.sa **(*Correspondence)**

**Contribution to the literature**

- This research can contribute to developing mathematics teaching practices for gifted students.
- It can help developers of teacher preparation programs, training programs, and professional development programs for mathematics teachers in developing and adapting programs to teach mathematics for gifted students.
- It can greatly help future researchers in developing mathematics teaching for gifted students.

Nicpon et al., 2010; Kronborg & Plunkett, 2012; Lucas, 2011; Lucas & Norbury, 2014b; Noble & Childers, 2009; Sharma & Nuttal, 2016).

Identifying the gifted and then determining and meeting their needs has become one of the basic educational goals, the achievement of which requires teaching practices that differ from those applied to regular students (Delisle, 2006; Purcell & Eckert, 2006).Thus, to teach in classes that include gifted students, educators must prepare special activities that are differentiated to match the abilities of each student (Ayebo, 2011).

Abu Zaid and Mustafa (2015), however, reported a general lack of awareness among teachers about the characteristics, traits, and qualities of gifted students. There are also evident misconceptions among teachers about talent and gifted students (Jarwan, 2021; Soliman, 2016).

Sah and Shah (2020) emphasized the importance of beliefs in guiding teaching practices, and Tatto (1998) stressed the need to identify teachers' beliefs regarding their teaching, as verifying such beliefs and how they influence teachers' practices and roles is a necessary requirement for developing and enhancing their pedagogical behavior. It assists teachers in effectively designing their actions and practices in the classroom and identifying strengths and weaknesses in teaching, thus improving their performance as teachers (Aksoy, 2015; Kutálková, 2017; Sah & Shah, 2020).

Teachers' interactions with gifted students and their corresponding teaching practices are thought to be linked to their perceptions and cognitive beliefs about gifted students (Daugherty, 2010). For instance, mathematics teachers' practices are linked to their cognitive beliefs about learning and teaching mathematics, which may then influence their beliefs about gifted students. Cognitive beliefs refer to individuals' perceptions and awareness of the nature of knowledge and learning (Chrysostomou & Philippou, 2010). Such beliefs guide individuals' behavior in daily life and affect their performance and responses to different situations. Learners' beliefs about their abilities and learning tasks have a significant impact on their subsequent performance (Hassan, 2010). For instance, Ryan (2011) identified a significant and positive relationship between the degree to which mathematics teachers practice constructivist teaching and their beliefs about their teaching effectiveness. Thus, teachers' cognitive beliefs are extremely important because they not only shape their own behavior, but also students' beliefs and learning (Schommer-Aikins et al., 2005).

Ryan (2011) defines mathematics learning and teaching beliefs as an interconnected system of feelings and perceptions that student teachers hold towards learning and teaching mathematics. Such views then affect their teaching behavior. For instance, teachers who view mathematics as a set of fixed procedures and believe that teaching it means teaching students how to apply these procedures will give their students a vast number of problems and exercises to solve. They will then direct them in using specific methods for solving such problems, rather than directing them to search for new and diverse solutions (Abu Zeina, 2003). Conversely, teachers who see mathematics as a complex structure and believe that the goal of teaching is to develop thinking in students are likely to be convinced that students learn mathematics best through participation in activities that allow them to apply what they have learnt, as well as to discuss their ideas with each other and with the teacher. In this case, the teacher strives to develop creativity in students during their study of mathematics (Asr, 2001).

Numerous studies have investigated the relationship between teachers' beliefs about teaching and learning and their teaching performance or beliefs about their teaching effectiveness. For instance, Shuhua (2002) revealed that beliefs about learning and teaching significantly impact teachers' acquisition of pedagogical knowledge (knowledge of teaching content). Barkatsas and Malone (2005) reported that teachers' beliefs about learning and teaching mathematics are consistent with the contemporary vision of teaching and learning mathematics which places the student at the center of the educational process. Their research revealed that teachers' cognitive beliefs affect their classroom behavior, that such beliefs in general are formed at the early stages of education, and that beliefs about learning and teaching mathematics are formed at university level. Anderson et al. (2005) found that teachers' beliefs about solving, learning and teaching mathematical problems overlapped between very traditional, traditional, contemporary, and very contemporary beliefs. Moreover, out of a total of 162 mathematics teachers in the primary stage, the percentages of teachers whose beliefs were classified according to the previous patterns were 4%, 11%, 5%, and 8%, respectively, whilst 72% of teachers had overlapping beliefs and carried more than one pattern. Al-Adwi (2008) concluded that teachers need to reconsider their beliefs and educational practice, as their beliefs about learning and teaching mathematics tend to align with the constructivist theory without being in full agreement with it. Ryan's (2011) study demonstrated that student teachers' beliefs about learning and teaching mathematics are largely consistent with modern trends in teaching mathematics that place the learner at the center of the educational process. Furthermore, there were statistically significant differences in beliefs about learning and teaching mathematics among student teachers in favor of student teachers specializing in mathematics. However, there were no statistically significant differences in beliefs about learning and teaching mathematics in terms of gender or academic year.

Evidently, these studies underline the significance of researching the attitudes of teachers towards talented students and determining how these attitudes are shaped by their perceptions of teaching and learning mathematics. Nevertheless, there is limited available literature on the cognitive beliefs of mathematics teachers regarding talented students and the correlation with their cognitive beliefs regarding teaching and learning mathematics. To resolve this deficiency, the present study was conducted with the aim of determining the cognitive beliefs of mathematics teachers regarding talented students and how they relate to their perceptions of teaching and learning mathematics.

## THEORETICAL BACKGROUND

### Definitions of Mathematical Giftedness

Mathematical talent is difficult to describe, as children manifest it in several different ways (Gavin et al., 2013). One of the earliest scholars to study mathematically gifted students was Krutetsky (1988). On the basis of his study conducted over an eleven-year period (1955-1966), he proposed that students identified as being mathematically gifted could be grouped into three categories: students who can engage in abstract reasoning with an algebraic mindset, students with robust spatial proficiencies with a geometric mindset, and students to whom both applied. According to Krutetsky (1988), being gifted in mathematics involves generalized, compact and flexible thinking with regard to mathematical relations, mathematical mentality, and numerical and sign symbolism. This characteristic of mathematical thinking enables them to process mathematical information at a faster rate (which is related to the substitution of a significant amount of data with a lesser volume, as it is generalized and contracted); resultantly, this allows neuro-psychic forces to be saved. His perception of students who had a gift for mathematics was that their brains had innate functional characteristics, contending that this allowed them to differentiate stimuli such as numerical and spatial relations from their environment, and that they are capable of adequately perceiving and operating with them (Krutetsky, 1988).

Moreover, Kholodnaya (1997) stated that students identified as being mathematically gifted are differentiated by higher indicators when forming conceptual experience. This is particularly the case in the question formulation process when establishing a connection between three distinct concepts and that the semantic context they create has increased complexity. They also have the ability to generate more complex problems and connections with a specific object by analyzing their properties in greater depth. The definition of mathematical giftedness recently proposed by Kontoyianni et al. (2013) is that it is the convergence of mathematical competency (spatial, qualitative, quantitative, causal, inductive, and, deductive reasoning) and mathematical creativity (being original, flexible, and fluent).

### Characteristics of Students Gifted in Mathematics

Regardless of the nature of the given mathematical problem, be it one that requires deductive reasoning, inferential thinking abilities, problem-solving approaches or computation skills, the speed and precision with which mathematically gifted students are capable of solving such problems is atypical. They are capable of perceiving relationships connecting ideas, concepts, and topics with no need to be educated on the given topic through a formal teaching program (Heid, 1983). Their ability to intuitively understand mathematical processes and functions means that when solving a problem, they could skip certain stages, and thus not be able to give a complete explanation regarding how they were able to produce the right answer to that problem (Greenes, 1981).

Students with a mathematical talent generally do not display the same level of mathematical understanding and development in all aspects of the topic, as their ability to develop concepts may be stronger than their computational ability (Rotigel, 2000; Sheffield, 1994). The focus of such students is normally on the 'whys' and 'hows' of mathematical concepts rather than the actual process by which things are computed (Sheffield, 1994). As they have a general preference for developing a comprehensive understanding of a given mathematical concept prior to progressing to different ones, it is necessary to adopt a more expansive strategy for teaching mathematics according to the specific interests of the students, which can help prevent the frustration they may experience when the standard lesson plan requires them to start focusing on a different topic. Talented children benefit more from a linear mathematics learning style compared with the spiral approach that characterizes most textbooks adopted by teachers in their classrooms. For instance, when introducing the decimals topic, mathematically talented students should be given the opportunity to explore the topic in greater depth, learning how to apply decimals in practical situations, and how decimals connect with different mathematical domains (Rotigel & Fello, 2004).

In a notable teaching experiment, Hekimoglu (2004) found that his participant (a mathematically gifted student) was confident and exhibited the capacity to use mathematical knowledge flexibly and creatively, think abstractly, and transfer concepts to unfamiliar situations. Ayebo (2011) elicited the views of 98 teachers on mathematically gifted students through an online survey. The survey included both open-ended questions and items on a 5-point Likert scale. The results revealed that teachers thought gifted students were eager to solve challenging mathematical problems, understood new mathematical concepts more easily than other students, and attained exceptionally high test scores. Güçyeter (2015) conducted a similar study using surveys sent to 161 teacher participants. The teachers reported that gifted students were good at memorizing and thinking creatively, and also generated new methods for solving problems.

In summary, multiple definitions of mathematical giftedness exist in literature. Thus, there is no unique way to identify mathematically gifted students, but they usually exhibit some of the characteristics listed above.

### The Beliefs of Mathematics Teachers About Mathematics and Gifted Students

Abu et al. (2017) conducted research with the aim of investigating the opinions of classroom teachers regarding how gifted students should be educated in standard classrooms. The study sample consisted of ten teachers providing primary school education in the City of Amasya, whose classes included gifted students. They adopted a phenomenological research design when formulating the study. Semi-structured interviews were collected as part of the data collection process, and then qualitative research software N-Vivo was used for descriptive analysis of the collected data. According to the study findings, the teachers believed that it was not necessary for the curriculum to be differentiated for gifted students as it was adequate in its current format. Based on the results, it is evident that teacher training is required on the necessity for gifted students to be afforded differentiated education and strategies, as well as the methods by which gifted students should be educated. An investigation on the beliefs of teachers regarding gifted students in standard classrooms should be performed because if teachers are not sufficiently supportive of differentiating gifted children in this way, it may have a general impact on their attitudes towards such children.

In the current study, the researchers defined mathematics teachers' beliefs about gifted students as their perceptions and awareness of a gifted student's traits (mental, emotional, and social) and their problems in relation to their family, the school, and themselves as students. These were measured using a scale of teachers' cognitive beliefs about gifted students prepared by the researchers.

### Teachers' Beliefs About Learning and Teaching Mathematics

Beliefs about learning and teaching mathematics refer to the perceptions, awareness, and assumptions of mathematics teachers regarding mathematics teaching, mathematics curricula, mathematical knowledge, and the mathematics teaching environment (Levin & Wadmany, 2006). Ryan (2011) defined these topics as an interconnected system of feelings and perceptions that student teachers hold towards the processes of learning and teaching mathematics.

The researchers in the current study defined such beliefs as the perceptions and awareness of mathematics teachers about learning and teaching mathematics. They were measured using the mathematics learning and teaching beliefs scale for teachers, prepared by the researchers.

Buchanan et al. (1998) demonstrated that these beliefs are formed intuitively and are influenced by the teacher's experience and professional development. The pedagogical and professional knowledge that student teachers acquire during preparation programs shape their cognitive beliefs (Turnuklu & Yesildere, 2007). Esterly (2003) showed that student teachers' beliefs regarding their competence in teaching mathematics increase during the preparation period, and that these beliefs are directly related to their cognitive beliefs. Chrysostomou and Philippou (2010) reached the same conclusion and found that pre-service and in-service teachers' beliefs about their competence in teaching can be predicted from their cognitive beliefs. Beliefs about teaching and learning affect a teacher's actions during teaching, their understanding and perception of the teaching and learning process, as well as their evaluation of students and their abilities (Barkatsas & Malone, 2005). These beliefs affect teachers' knowledge of how to teach the content in a way that makes the scientific material understandable to their students (Hashweh, 2005). Abbasi (2011) highlighted the importance of knowing how to teach the content so as to respond to the characteristics of students, as well as those of mathematics and mathematical sciences. Al-Adwi (2008) argued that teachers' beliefs about teaching and learning vary according to what they study during the preparation programs of courses that include modern educational theories and trends.

Some scholars classify mathematics teachers' beliefs about learning and teaching mathematics according to cognitive theories such as behavioral theory or constructivist theory. Others classify such beliefs according to whether they situate the teacher at the center of the educational process, or instead emphasize the importance of the learner in obtaining information and view the teacher as a facilitator and guide (Gales & Yan, 2001).

Behavioral teachers are those whose beliefs about learning and teaching mathematics are classified according to behavioral theory. They are concerned during teaching with certain procedures such as attracting students' attention, informing students of the objectives, stimulating memory, providing learning guidelines, providing feedback, and evaluating performance. Constructivist teachers are those whose beliefs about learning and teaching mathematics are classified according to constructivist theory. They recognize the importance of students dealing with diverse problems and contend that the role of the teacher is to provide an appropriate environment that makes students responsible for their learning and enables them to solve educational problems using cognitive and metacognitive strategies (Gales & Yan, 2001).

Barkatsas and Malone (2005) developed a classification system based on which teachers were categorized into four groups according to their mathematics teaching and learning beliefs:

(1) teachers who think that mathematics learning can be optimized when the nature of mathematics is introduced and explained to students by teachers,

(2) teachers who think that mathematics learning is optimized when the nature of mathematics is introduced and explained to students by teachers, but they have conflicting beliefs,

(3) teachers who think that mathematics learning is optimized when students have the opportunity to solve problems and participate in discussions about appropriate solutions, and

(4) teachers who think that problem-solving is something students can do without formal instruction, and that students' abilities should be the basis of mathematics curricula design.

According to Ryan's (2011) classification of beliefs regarding teaching and learning mathematics, some beliefs conform with the contemporary perception that the learner is situated at the core of the educational process, while others align with the classical perception of mathematics learning and teaching that everything should revolve around the teacher in the process. According to Ryan (2011), beliefs regarding mathematics learning and teaching can be grouped into three categories: the teacher's role, mathematics teaching, and mathematics learning.

In this research, the researchers adopted the classification of teachers' beliefs about learning and teaching mathematics according to both behavioral theory and constructivist theory. The research questions were formulated, as follows.

### Research Questions

1. What cognitive beliefs do mathematics teachers hold about gifted students (MTCBGS)?
2. What cognitive beliefs do mathematics teachers hold about learning and teaching mathematics (MTCBLTM)?
3. What is the relationship between mathematics teachers' cognitive beliefs about gifted students (MTCBGS) and mathematics teachers' cognitive beliefs about learning and teaching mathematics (MTCBLTM)?
4. What is the difference in MTCBGS between mathematics teachers who rank high and who rank low in their cognitive beliefs about learning and teaching mathematics according to behavioral theory?
5. What is the difference in MTCBGS between mathematics teachers who rank high and who rank low in their cognitive beliefs about learning and teaching mathematics according to the constructivist theory?

## METHOD

The researchers utilized a descriptive analytical approach to reveal the MTCBGS, as well as MTCBLTM, and to identify the nature of the relationship between MTCBGS and MTCBLTM. The research community consisted of all mathematics teachers in Dammam, Eastern Province, Kingdom of Saudi Arabia (KSA). After obtaining official approval, the respondents received an invitation to participate in the research via email and text messages. Links to the two research tools were sent to all mathematics teachers in Dammam during the academic year 2024. The purpose of the research and how to participate were explained, and the respondents registered their consent to participate prior to commencing the study. Overall, 131 male and female teachers (65 males and 66 females) completed the research tools. **Table 1** presents descriptive statistics regarding the demographic characteristics of the research sample.

### Materials & Design

#### *CBMTGS scale & MTCBLTM scale*

After reviewing the literature and studies related to CBMTGS and determining the purpose of the CBMTGS scale, an initial version of the scale was prepared that consisted of two parts. The first part included

**Table 1.** Participating teachers' demographic characteristics (n = 131)

| Variable | | N | Percentage |
|---|---|---|---|
| Gender | Male | 65 | 49.6 |
| | Female | 66 | 50.4 |
| Qualification type | Educational | 119 | 90.8 |
| | Non-educational | 12 | 9.2 |
| Qualification | BA | 110 | 84.0 |
| | Dip | 5 | 3.8 |
| | MA | 13 | 9.9 |
| | PhD | 3 | 2.3 |
| Education stage | Primary | 60 | 45.8 |
| | Intermediate | 30 | 22.9 |
| | Secondary | 41 | 31.3 |
| Years of experience | Less than 5 years | 14 | 10.7 |
| | 5 to 9 years | 31 | 23.7 |
| | 10 to14 years | 29 | 22.1 |
| | More than 14 years | 57 | 43.5 |

**Table 2.** Numerical rating and arithmetic mean of the response gradation on the CBMTGS scale and the MTCBLTM scale

| Numerical rating | Degree of agreement | M |
|---|---|---|
| 5 | Very high | ≥ 4.2 |
| 4 | High | > 3.4 or < 4.2 |
| 3 | Moderate | > 2.6 or < 3.4 |
| 2 | Low | > 1.8 or < 2.6 |
| 1 | Very low | ≤ 1.8 |

demographic questions, and the second part comprised 49 statements expressing CBMTGS about the characteristics of gifted students (mental, emotional, and social), as well as problems related to school, family, and the students themselves.

After reviewing the literature and studies related to MTCBLTM and determining the goal of the MTCBLTM scale, an initial version of the scale was prepared that consisted of two parts. The first part included demographic questions, and the second part comprised 30 phrases expressing MTCBLTM according to constructivist theory or behavioral theory.

The participants responded to items on each of the two scales using a five-point Likert scale (1-5). **Table 2** presents the numerical rating and arithmetic mean of the response gradation on the two scales.

### Validity and Reliability

The validity of the two instruments was verified by presenting them to a group of specialists in curricula, teaching methods and psychology in several colleges of education in the KSA and the Arab Republic of Egypt. These experts were asked to express their opinions on the scientific and linguistic validity of each instrument, its suitability for the purpose and its importance, as well as suggesting the addition, deletion or modification of particular phrases. Modifications were then made based on their opinions. The researchers modified some

**Table 3.** Distribution of dimensions of the CBMTGS scale

| Dimension | Subdimension | Number of statements |
|---|---|---|
| Characteristics of gifted students | Mental traits | 12 |
| | Emotional traits | 7 |
| | Social traits | 9 |
| Gifted students' problems | Family-specific | 7 |
| | School-specific | 8 |
| | Student-specific | 6 |
| Total | 6 | 49 |

**Table 4.** Distribution of dimensions of the MTCBLTM scale

| Dimension | Number of statements |
|---|---|
| Constructivist theory | 16 |
| Behavioral theory | 14 |
| Total | 30 |

statements in the instruments, deleted and added some statements according to the opinions of the specialists, and the agreement rate was adopted at 80% to adopt the modifications as well as the researchers' experience.

To determine the internal validity of the two scales, the scales were administered to a survey sample of 33 teachers. Pearson's correlation coefficients between the score for each statement and the total score for the scale were calculated. The values of the correlation coefficients ranged between 0.518 and 0.672 for the CBMTGS scale, and between 0.803 and 0.831 for the MTCBLTM scale. These were statistically significant at 0.01, indicating a high degree of internal consistency. The reliability coefficient for the two scales was calculated using Cronbach's alpha. This reached 0.904 for the CBMTGS scale and 0.778 for the MTCBLTM scale, indicating an acceptable level of reliability for both scales.

**Table 3** and **Table 4** present the distributions of the dimensions of the two scales.

## FINDINGS

### MTCBGS

The results revealed that MTCBGS was very high (mean [M] = 4.49, standard deviation [SD] = 0.44, rank 1); MTCBGS regarding emotional traits was very high (M = 4.21, SD = 0.60, rank 2); MTCBGS regarding social traits was high (M = 4.07, SD = 0.60, rank 4); MTCBGS regarding problems related to the family was high (M = 3.40, SD = 0.88, rank 6); MTCBGS regarding problems related to the school was high (M = 4.11, SD = 0.65, rank 3); MTCBGS regarding problems related to the students themselves was high (M = 3.63, SD = 0.83, rank 5); and MTCBGS overall was high (M = 4.05, SD = 0.39). The results are presented in **Table 5**.

**Table 5.** Descriptive statistics for MTCBGS (n = 131)

| Subdimension | M | SD | Rank | Degree of agreement |
|---|---|---|---|---|
| Mental traits of gifted students | 4.49 | 0.44 | 1 | Very high |
| Emotional traits of gifted students | 4.21 | 0.60 | 2 | Very high |
| Social traits of gifted students | 4.07 | 0.56 | 4 | High |
| Gifted students' problems related to the family | 3.40 | 0.88 | 6 | High |
| Gifted students' problems related to school | 4.11 | 0.65 | 3 | High |
| Gifted students' problems related to the students' themselves | 3.63 | 0.83 | 5 | High |
| MTCBGS: Total | 4.05 | 0.39 | | High |

**Table 6.** Descriptive statistics for MTCBLTM (n = 131)

| Subdimension | M | SD | Rank | Degree of agreement |
|---|---|---|---|---|
| MTCBLTM according to behavioral theory | 3.86 | 0.46 | 2 | High |
| MTCBLTM according to constructivist theory | 4.32 | 0.33 | 1 | Very high |
| MTCBLTM: Total | 4.10 | 0.32 | | High |

**Table 7.** Correlations between mathematics teachers' cognitive beliefs about gifted students (MTCBGS) and their cognitive beliefs about learning and teaching mathematics (MTCBLTM) (n = 131)

| | MTCBLTM according to behavioral theory | MTCBLTM according to constructivist theory | MTCBLTM: Total |
|---|---|---|---|
| Mental traits of gifted students | 0.282** | 0.533** | 0.479** |
| Emotional traits of gifted students | 0.353** | 0.401** | 0.454** |
| Social traits of gifted students | 0.313** | 0.393** | 0.423** |
| Gifted students' problems related to the family | 0.043 | 0.045 | 0.053 |
| Gifted students' problems related to school | 0.033 | 0.307** | 0.190* |
| Gifted students' problems related to the students themselves | 0.230** | 0.434** | 0.390** |
| MTCBGS: Total | 0.319** | 0.546** | 0.511** |

Note. *Correlation is significant at the 0.05 level (2-tailed) & **Correlation is significant at the 0.01 level (2-tailed)

### MTCBLTM

The results indicated that MTCBLTM was moving towards being in alignment with constructivist theory. Specifically, MTCBLTM according to behavioral theory was high (M = 3.86, SD = 0.46); MTCBLTM according to constructivist theory was very high (M = 4.32, SD = 0.33); and MTCBLTM overall was high (M = 4.10, SD = 0.32). The results are presented in **Table 6**.

### The Relationship Between MTCBGS and MTCBLTM

To identify the relationship between MTCBGS and MTCBLTM, Pearson correlation coefficients were computed. The results revealed that MTCBGS was positively correlated with cognitive beliefs about learning and teaching mathematics ($r = 0.511$, $p < 0.01$).

Furthermore, the results indicated that the MTCBLTM according to constructivist theory correlated more strongly with cognitive beliefs about gifted students ($r = 0.546$, $p < 0.01$) than MTCBLTM according to behavioral theory ($r = 0.319$, $p < 0.01$), and this was the case for all dimensions of the MTCBGS scale.

According to the Pearson correlation coefficients, MTCBGS regarding problems related to school was not correlated with CBLTM according to behavioral theory ($r = 0.033$, $p > 0.05$), but was positively correlated with CBLTM according to constructivist theory ($r = 0.307$, $p < 0.01$). Moreover, MTCBGS regarding problems related to the family was not correlated with overall CBLTM, CBLTM according to behavioral theory, and CBLTM according to constructivist theory ($r = 0.053$, $r = 0.043$, $r = 0.045$, $p > 0.05$). The results are presented in **Table 7**.

### High and Low Cognitive Beliefs About Learning and Teaching Mathematics According to Behavioral Theory

Subsequent to determining the relationship between MTCBGS and MTCBLTM, a further examination of the data was conducted for the purpose of comparing the MTCBGS for teachers with high and low scores for cognitive beliefs regarding mathematics learning and teaching based on behavioral theory. Teachers were assigned to specific groups based on the scores they received for the MTCBLTM scale based on behavioral theory according to the following ranges: high from M + 1 SD to maximum degree, middle from > M - 1 SD to < M + 1 SD, and low from minimum degree to M - 1 SD). The comparison between the high and low belief groups was made using independent t-tests.

The low group included 14 teachers whose scores in the MTCBLTM subscale based on behavioral theory were in the 2.07 to 3.36 range, while the high group contained 17 teachers whose scores were in the 4.36 to 5 range (M = 3.86, SD = 0.46). In order to identify any significant differences between the respective groups in

**Table 8.** t-test results for high and low cognitive beliefs about learning and teaching mathematics according to behavioral theory

| Variable | Group | M | SD | n | t (df) | p | $r^2$ |
|---|---|---|---|---|---|---|---|
| Mathematics teachers' cognitive beliefs about gifted students | High-scoring group | 4.42 | 0.41 | 14 | 2.45 (29) | 0.02 | 0.17 |
| | Low-scoring group | 4.09 | 0.34 | 17 | | | |

**Table 9.** t-test results for high and low cognitive beliefs about learning and teaching mathematics according to constructivist theory

| Variable | Group | M | SD | n | t (df) | p | $r^2$ |
|---|---|---|---|---|---|---|---|
| Mathematics teachers' cognitive beliefs about gifted students | High-scoring group | 4.40 | 0.38 | 20 | 6.40 (37) | 0.00 | 0.53 |
| | Low-scoring group | 3.72 | 0.27 | 19 | | | |

terms of their cognitive beliefs regarding gifted students, independent t-tests were used (see **Table 8**).

For teachers in the group with low cognitive beliefs regarding mathematics learning and teaching based on behavioral theory, the mean score for cognitive beliefs regarding gifted students was 4.09 (SD = 0.34), while for the teachers in the group with high cognitive beliefs regarding mathematics learning and teaching based on behavioral theory, the mean score was 4.42 (SD = 0.41). According to the t-test results, ($t = 2.45$, $p = 0.02$, $r^2 = 0.17$) the cognitive beliefs of the two groups regarding gifted students were significantly different. It was determined that the aforementioned differences were large based on the effect size.

### High and Low Cognitive Beliefs About Learning and Teaching Mathematics According to Constructivist Theory

In the next stage, the data were re-examined to compare teachers who scored high on cognitive beliefs about learning and teaching mathematics according to constructivist theory with those who scored low on such beliefs.

The low group comprised a total of 19 teachers whose scores were in the 3.4 to 3.94 range on the MTCBLTM subscale based on constructivist theory (M = 4.32, SD = 0.33), while the high group included 20 teachers whose scores were in the 4.69 to 5 range for the subscale. To identify whether the scores of the two groups in terms of their cognitive beliefs regarding gifted students were significantly different, independent t-tests were applied (see **Table 9**).

For the teachers with low cognitive beliefs regarding mathematics learning and teaching based on constructivist theory, the mean score for cognitive beliefs about gifted students was 3.72 (SD = 0.27), while those in the high group had a mean score of 4.40 (SD = 0.38). Based on the results of the t-test ($t = 6.40$, $p = 0.00$, $r^2 = 0.53$), the cognitive beliefs of the two groups regarding gifted students were significantly different. It was determined that these differences were large based on the effect size.

## DISCUSSION AND CONCLUSION

The current research first aimed to identify the MTCBGS, and the results revealed that was high. This can be explained by the interest of the KSA in the gifted, as the education policy has since 1389 AH emphasized the discovery and care of the gifted, while in 1417 AH the program for discovering and caring for the gifted was established, and in 1421 AH the General Administration for Gifted Care, Ministry of Education, Kingdom of Saudi Arabia (2001). This is evidenced by the cooperation of the Ministry of Education with various entities regarding the gifted such as its partnership with the King Abdulaziz and His Companions Foundation for Giftedness and Creativity 'Mawhiba' and the Education Evaluation Commission represented by the National Centre; the implementation of the National Program for Giftedness Discovery for 14 years; the fact that during the academic year 2024 AD the number of registered students exceeded 100,000 male and female students, and the gifted discovery scale identified more than 91,000 male and female students from different regions of the KSA (Ministry of Education, Kingdom of Saudi Arabia, 2024). An introduction to the program is given to the students, and they are then instructed that registration can be made via their schools and teachers. These programs incorporate training targeted at informing those attending about the topic of creativity and giftedness, the attributes of gifted learners and what approach should be adopted when dealing with them, and how to create a suitable learning environment that allows gifted children to flourish in the classroom, school and community in general. Additionally, one of its objectives is to present strategies that teachers can use to address the Mawhiba curricula which can be incorporated into the Ministry of Education curricula, as well as increasing the understanding of teachers responsible for educating gifted students, specifically in terms of the activities included within the Mawhiba curricula. Stakeholders included in the training are school coordinators, principals, teachers, as well as parents.

The second aim of the current research was to identify the MTCBLTM, and the results revealed that the MTCBLTM was high; MTCBLTM according to behavioral theory was high; and MTCBLTM according to constructivist theory was very high. This is consistent with the results of previous studies by Barkatsas and Malone (2005), Anderson et al. (2005), Al-Adwi (2008), and Ryan (2011), who found that teachers' beliefs in learning and teaching mathematics tend towards the modern vision of learning and teaching mathematics where the learner is situated at the center of the educational process. However, there is also a degree of overlap with beliefs in learning and teaching mathematics according to the traditional vision of learning and teaching mathematics where the teacher lies at the center of the educational process.

The finding that regarding MTCBLTM was very high according to constructivist theory can be interpreted in view of the KSA's interest in training and developing teachers through multiple programs and initiatives. Among these are programs that form part of the National Institute for educational professional development, which were launched in 2021. These aim to achieve the strategic objectives of the human capacity development program, which form part of the Kingdom's vision 2030 and include stimulating self-professional development for teachers, providing them with diverse knowledge and skills to perform their tasks effectively, thereby supplying flexible professional development opportunities for teachers according to a time and place that suits them, as well as benefiting from local and international expertise in professional development, and supporting those in educational positions by providing accredited professional development opportunities to achieve professional development milestones (National Institute for Professional Education Development, Kingdom of Saudi Arabia, 2024).

The fact that the MTCBLTM according to behavioral theory was high can be attributed to the years of experience of the research sample, as 43.5% had at least 14 years of experience; therefore, they were likely to be influenced by behavioral theory (see **Table 1**). The results also revealed a statistically significant positive relationship between MTCBGS and MTCBLTM, whether this was according to behavioral theory or constructivist theory, although the correlation between MTCBGS and MTCBLTM according to constructivist theory was stronger. The results also uncovered differences in MTCBGS between teachers with high and low MTCBLTM, whether this was according to constructivist theory or behavioral theory. This result can be explained by the fact that teachers' views on mathematics affect their teaching behavior (Abu Zeina, 2003), and that cognitive beliefs in general constitute individuals' perceptions and awareness of the nature of knowledge and learning (Chrysostomou & Philippou, 2010), also that cognitive beliefs guide individuals' behavior in daily life and affect their performance and responses to different situations (Hassan, 2010; Schommer-Aikins et al., 2005). Thus, teachers' beliefs about learning and teaching mathematics affected their beliefs about gifted students.

## Implications and Limitations

The current research focused on mathematics teachers and investigated two important aspects, MTCBGS and MTCBLTM. The research results revealed that levels of agreement regarding MTCBGS and MTCBLTM were both high, and hence can be used to develop mathematics teaching for the gifted. For instance, mathematics curriculum developers can use the results to develop mathematics curricula to meet the needs of the gifted, whereas mathematics teacher training program developers can use the results to design training programs for teachers on teaching mathematics to the gifted.

The current research revealed a statistically significant positive relationship between MTCBGS and MTCBLTM. This illustrates to researchers, policymakers, mathematics curriculum developers, mathematics teacher preparation, and training program developers the importance of MTCBLTM and its impact on MTCBGS, as well as the importance of identifying MTCBGS and MTCBLTM in addition to developing mathematics curricula, mathematics teacher preparation and training programs in accordance with these beliefs.

One of the limitations of the current research is the small sample size, the non-random selection, and the fact that all participants were mathematics teachers in Dammam; hence, their views and responses may differ from mathematics teachers in other cities in the KSA. However, the research attempted to overcome this limitation and reach the largest number of mathematics teachers in Dammam by sending the two study tools electronically to the largest number of teachers possible. Moreover, the researchers believe that this city was an ideal place in which to conduct this study because it has an enormous population drawn from different parts of the KSA. This could be observed based on the origins of the participating mathematics teachers, which included the center of the country, the western region of the KSA, as well as both the north-western and south-western areas of the country.

Another limitation was the reliance on quantitative tools to collect data. The researchers attempted to overcome this limitation by preparing the tools following a review of educational literature and the tools utilized in previous studies. The tools were arbitrated by a group of specialists, and their validity and reliability were verified before applying them. The researchers recommend that future research should consider using qualitative tools to collect data on MTCBGS and MTCBLTM and conduct research on samples of mathematics teachers in other cities. In addition, the researchers recommend building training programs for mathematics teachers according to MTCBGS and MTCBLTM and measuring their effectiveness, as well as paying attention to spreading awareness about gifted students and about teaching mathematics according to constructivist theory.

**Author contributions: NHY:** conceptualization, methodology, analysis, writing - original draft; MSA: data curation, writing - review & editing; **NHY & MSA:** investigation and project administration. Both authors have sufficiently contributed to the study and agreed with the results and conclusions.

**Funding:** No funding source is reported for this study.

**Ethical statement:** The authors stated that the study was approved by the Institutional Review Board at Imam Abdulrahman Bin Faisal University on 1 May 2024 with approval number IRB-2024-15-341. Written informed consents were obtained from the participants.

**Declaration of interest:** No conflict of interest is declared by the authors.

**Data sharing statement:** Data supporting the findings and conclusions are available upon request from the corresponding author.

## REFERENCES

Abbasi, S. (2011). The level of pedagogical knowledge of mathematics teachers at the secondary education stage. *Journal of Humanities and Social Sciences, 4*, 406-420.

Abu Zaid, K. M., & Mustafa, A. A. (2015). *Talent and creativity* (2nd ed.). Dar Al Zahra.

Abu Zeina, F. K. (2003). *School mathematics curricula and teaching*. Al-Falah Library for Publishing and Distribution.

Abu, N. K., Akkanat, Ç., & Gökdere, M. (2017). Teachers' views about the education of gifted students in regular classrooms. *Talent, 7*(2), 87-109.

Aksoy, K. (2015). What you think is not what you do in the classroom: Investigating teachers' beliefs for classroom management in an EFL classroom. *Social and Behavioral Sciences, 199*, 675-683. https://doi.org/10.1016/j.sbspro.2015.07.597

Al-Adwi, S. M. (2008). *Mathematics teachers' knowledge of how to teach the algebra unit for the eighth grade: A case study* [Master's thesis, Birzeit University].

Anderson, J., White, P., & Sullivan, P. (2005). Using a schematic model to represent influences on, and relationships between, teachers' problem-solving beliefs and practices. *Mathematics Education Research Journal, 17*(2), 9-38. https://doi.org/10.1007/BF03217414

Asr, R. M. (2001). *Enrichment activities and their impact on teaching mathematics at the preparatory stage.* Supreme Council of Universities, Permanent Scientific Committee for Education and Psychology.

Ayebo, A. (2011). Voices from the trenches: Teachers' perspectives on teaching mathematics to gifted/talented students. In *Proceedings of the 33rd Annual Conference of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 1260-1266).

Bain, S. K., Bliss, S. L., Choate, S. M., & Brown, K. S. (2007). Serving children who are gifted: Perceptions of undergraduates planning to become teachers. *Journal for the Education of the Gifted, 30*(4), 450-478. https://doi.org/10.4219/jeg-2007-506

Barkatsas, A., & Malone, J. (2005). A typology of mathematics teachers' beliefs about teaching and learning mathematics and instructional practices. *Mathematics Education Research Journal, 17*(2), 69-90. https://doi.org/10.1007/BF03217416

Buchanan, T., Burts, D. C., Bidner, J., White, V. F., & Charlesworth, R. (1998). Predictors of the developmental appropriateness of the beliefs and practices of first, second, and third grade teachers. *Early Childhood Research Quarterly, 13*(3), 459-483. https://doi.org/10.1016/S0885-2006(99)80052-0

Byrnes, M. (2008). Educators' interpretations of ambiguous accommodations. *Remedial and Special Education, 29*(5), 306-315. https://doi.org/10.1177/0741932507313017

Carroll, A., Forlin, C., & Jobling, A. (2003). The impact of teacher training in special education on the attitudes of Australian preservice general educators towards people with disabilities. *Teacher Education Quarterly, 30*(3), 65-79.

Chrysostomou, M., & Philippou, G. N. (2010). Teachers' epistemological beliefs and efficacy beliefs about mathematics. *Procedia-Social and Behavioral Sciences, 9*, 1509-1515. https://doi.org/10.1016/j.sbspro.2010.12.357

Coleman, M. R., & Gallagher, S. (2015). Meeting the needs of students with 2E: It takes a team. *Gifted Child Today, 38*(4), 252-254. https://doi.org/10.1177/1076217515597274

Cooper, M. E. (2012). Everything I ever wanted to learn about teaching, I learned from gifted boys. *Gifted Child Today, 35*(3), 171-178. https://doi.org/10.1177/1076217512445991

Daugherty, M. (2010). *Supporting the needs of gifted students: The perspectives, perceptions, and experiences of general education teachers*. Walden University.

Delisle, J. (2006). *Once upon a mind: The stories and scholars of gifted education*. Thomson & Wadsworth.

Esterly, E. (2003). *A multi-method exploration of the mathematics teaching efficacy and epistemological beliefs of elementary pre-service and novice teachers* [PhD thesis, The Ohio State University].

Foley-Nicpon, M., Doobay, A. F., & Assouline, S. G. (2010). Parent, teacher, and self perceptions of psychosocial functioning in intellectually gifted children and adolescents with autism spectrum disorder. *Journal of Autism and Developmental*

*Disorders, 40*(8), 1028-1038. https://doi.org/10.1007/s10803-010-0952-8

Gales, M., & Yan, W. (2001). Relationship between constructivist teacher beliefs and instructional practice to students' mathematical achievement: Evidence from TIMMS. In *Proceedings of the Annual Meeting of the American Educational Research Association*. ERIC.

Gavin, M. K., Firmender, J. M., & Casa, T. M. (2013). Recognizing and nurturing math talent in children. *Parenting for High Potential, 3*(2), Article 22.

General Administration for Gifted Care, Ministry of Education, Kingdom of Saudi Arabia. (2001). *The journey of gifted care in the Kingdom of Saudi Arabia.* http://search.mandumah.com/Record/34223

Greenes, C. (1981). Identifying the gifted student in mathematics. *The Arithmetic Teacher, 28*(6), 14-17. https://doi.org/10.5951/AT.28.6.0014

Güçyeter, S. (2015). Investigating middle school math and primary teachers' judgments of the characteristics of mathematically gifted students. *Turkish Journal of Giftedness and Education, 5*(1), 44-66.

Hashweh, M. Z. (2005). Teacher pedagogical constructions: A reconfiguration of pedagogical content knowledge. *Teachers and Teaching, Theory and Practice, 11*(3), 273-292. https://doi.org/10.1080/13450600500105502

Hassan, S. M. (2010). *Modeling the relationships between cognitive beliefs, goal orientations, learning styles, and coping strategies among high and low achievers* [PhD thesis, Benha University].

Heid, M. K. (1983). Characteristics and special needs of the gifted student in mathematics. *Mathematics Teacher, 76*, 221-226. https://doi.org/10.5951/MT.76.4.0221

Hekimoglu, S. (2004). Conducting a teaching experiment with a gifted student. *Journal of Advanced Academics, 16*(1), 14-19. https://doi.org/10.4219/jsge-2004-466

Jarwan, F. A. (2021). *Talent and excellence* (8th ed). Dar Al Fikr.

Kholodnaya, M. A. (1997). *Intellectual endowments as manifestation of features of the organization of individual mental experience: Main modern concepts of creativity and endowments*. Young Guard.

Kontoyianni, K., Kattou, M., Pitta-Pantazi, D., & Christou, C. (2013). Integrating mathematical abilities and creativity in the assessment of mathematical giftedness. *Psychology Science, 55*(3), 289-315.

Kronborg, L. G., & Plunkett, M. M. (2012). Examining teacher attitudes and perceptions of teacher competencies required in a new selective high school. *Australasian Journal of Gifted Education, 21*(2), 33-46.

Krutetsky, V. A. (1988). *Psychology of mathematical abilities of school students*. Institute of Practical Psychology.

Kutálková, K. (2017). Teachers' beliefs in the Czech Republic: Review study. *Procedia-Social and Behavioral Sciences, 237*, 1352-1358. https://doi.org/10.1016/j.sbspro.2017.02.224

Levin, T., & Wadmany, R. (2006). Teachers' beliefs and practices in technology-based classrooms: A developmental view. *Journal of Research on Technology in Education, 39*(2), 157-181. https://doi.org/10.1080/15391523.2006.10782478

Lucas, R., & Norbury, C. F. (2014a). Levels of text comprehension in children with autism spectrum disorders (ASD): The influence of language phenotype. *Journal of Autism and Developmental Disorders, 44*(11), 2756-2768. https://doi.org/10.1007/s10803-014-2133-7

Lucas, R., & Norbury, C. F. (2014b). Orthography facilitates vocabulary learning for children with autism spectrum disorders (ASD). *Quarterly journal of Experimental Psychology, 67*(7), 1317-1334. https://doi.org/10.1080/17470218.2013.859714

Lucas, T. (2011). Language, schooling, and the preparation of teachers for linguistic diversity. In T. Lucas (Ed.), *Teacher preparation for linguistically diverse classrooms: A resource for teacher educators* (pp. 3-17). Routledge. https://doi.org/10.4324/9780203843239

Ministry of Education, Kingdom of Saudi Arabia. (2024). *Ministry of Education announces the results of the gifted students identification program in partnership with Mawhiba and the Education Evaluation Commission.* https://moe.gov.sa/ar/mediace nter/MOEnews/Pages/news1-14032024.aspx

National Institute for Professional Education Development, Kingdom of Saudi Arabia. (2024). *About programs.* https://niepd.futurex.sa/about

Navarro, S. B., Zervas, P., Gesa, R. F., & Sampson, D. G. (2016). Developing teachers' competences for designing inclusive learning experiences. *Educational Technology & Society, 19*(1), 17-27.

Noble, K. D., & Childers, S. A. (2009). Swimming in deep waters: 20 Years of research about early university entrance at the University of Washington. In L. V. Shavinina (Ed.), *International handbook on giftedness* (pp. 1345–1364). Springer.

Purcell, J., & Eckert, R. (2006). *Designing services and programs for high ability learners: A guidebook for gifted education*. Corwin. https://doi.org/10.4135/9781483329307

Rotigel, J. V. (2000). *Exceptional mathematical talent: Comparing achievement in concepts and computation* [PhD thesis, Indiana University of Pennsylvania].

Rotigel, J. V., & Fello, S. (2004). Mathematically gifted students: How can we meet their needs? *Gifted Child Today, 27*, 46-655. https://doi.org/10.4219/gct-2004-150

Ryan, A. (2011). The extent to which mathematics teachers practice constructivist teaching and its relationship to their teaching effectiveness beliefs. *Al-Quds Open University Journal for Research and Studies, 24,* 85-116.

Sah, F., & Shah, P. (2020). Teachers' beliefs and practices in teaching listening. *Creative Education, 11* (2), 182-195. https://doi.org/10.4236/ce.2020.112013

Schommer-Aikins, M., Duell, O., & Hutter, R. (2005). Epistemological beliefs, mathematical problem-solving beliefs, and academic performance of middle school students. *The Elementary School Journal, 105*(3), 289-304. https://doi.org/10.1086/428745

Schwab, S. (2021). Inclusive and special education in Europe. In U. Sharma, & S. J. Salend (Eds.), *The Oxford encyclopedia of inclusive and special education* (pp. 807-819). Oxford University Press. https://doi.org/10.1093/acrefore/9780190264093.013.1230

Sharma, U., & Nuttal, A. (2016). The impact of training on pre-service teacher attitudes, concerns, and efficacy towards inclusion. *Asia-Pacific Journal of Teacher Education, 44*(2), 142-155. https://doi.org/10.1080/1359866X.2015.1081672

Sheffield, L. J. (1994). The development of gifted and talented mathematics students and the National Council of Teachers of Mathematics standards. *University of Connecticut, The National Research Center on the Gifted and Talented*. https://nrcgt.uconn.edu/research-based_resources/sheffiel/

Shuhua, A. (2002). The use of alternative assessment leads to increased understanding in math pre-service teacher's pedagogical content knowledge. In *Proceedings of the International Conference on Transforming Math and Science Education in the K16 Continuum*.

Soliman, M. S. S. (2016). Misconceptions about gifted students among general education teachers in both the Arab Republic of Egypt and the Kingdom of Saudi Arabia. *International Journal for the Development of Excellence, 7*(12), 3-29. https://doi.org/10.20428/IJTD.7.1.1

Tatto, M. T. (1998). The influence of teacher education on teachers' beliefs about purposes of education, Roles and practice. *Journal of Teacher Education, 49*, 66-77. https://doi.org/10.1177/0022487198049001008

Turnuklu, E. B., & Yesildere , S. (2007). The pedagogical knowledge in mathematics: Preservice primary mathematics teachers' perspectives in Turkey. *Issues in the Undergraduate Mathematics Preparation of School Teachers, 1*.