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Primary education students' beliefs about the nature of mathematics, self-efficacy, and mathematics educators; a descriptive study from Indonesia

Achmad Hidayatullah [a], Radius Setiyawan [b] and Syarifuddin [a]

[a]Program Studi Pendidikan Matematika Universitas Muhammadiyah Surabaya, Surabaya, Indonesia; [b]Program Studi Desain Komunikasi Visual, Universitas Muhammadiyah Surabaya, Surabaya, Indonesia

ABSTRACT

The significant role of mathematical belief studies has been recognised several decades later. These beliefs have been found to be significantly associated with performance and problem-solving. However, empirical studies of these beliefs in Indonesia are scarce. This study investigates students' beliefs on the nature of mathematics, self-efficacy, and their perceptions of mathematics educators. The findings of this study revealed that Indonesian students strongly believe anyone could attain proficiency in mathematics. At the same time, students had less confidence that they could understand difficult mathematical tasks and less confidence in showing that they were good at mathematics. Notably, boys' students exhibit stronger beliefs in their understanding of the course, including the most challenging topics in mathematics, compared to their girls' counterparts. The implications of this study significantly contribute to the existing literature and inform teaching practices.

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Beliefs; mathematics; nature; self-efficacy; educators

Introduction

The significant role of mathematics in human civilisation has been acknowledged for a long time. With mathematical knowledge, humankind has been able to develop sophisticated technologies and shape the modern world (O'Regan 2016). Recently, the presence of artificial intelligence (AI) systems, such as ChatGPT, has elicited considerable amazing due to their ability to provide rapid responses to a myriad of questions. As we know, the creation of this technology also requires mathematical knowledge, such as algorithms (Mubeen 2022). This means that mathematical knowledge still continues to play a critical role in human civilisation, and students should understand it to help their future. A critical issue is how to motivate students to succeed in studying mathematics. Prior studies indicated that students' success, motivation, engagement, and attitudes toward mathematics are significantly influenced by their beliefs about mathematics education (Hu and Zhang 2024; Hidayatullah, Csíkos, and Syarifuddin 2023). Therefore, examining students' beliefs about mathematics education is imperative. By evaluating these beliefs, we can obtain a wealth of information on how to increase students' achievement, motivation, and interest in mathematics learning.

In the context of Asian countries, there is a noticeable gap in mathematics proficiency between Indonesia and its neighbouring countries, such as Singapore and Malaysia (OECD 2022; Mullis et al. 2016). Hofer (2008) noted that Asian students, particularly those in Japan, tend to hold less sophisticated beliefs regarding knowledge compared to their counterparts in the US. On the other hand,

CONTACT Achmad Hidayatullah achmadhidayatullah@um-surabaya.ac.id
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the majority of Chinese students regard mathematics as practical (Hill and Seah 2023). In Indonesia, the government, through the Ministry of Education, has implemented the *Merdeka* curriculum (Kurikulum Merdeka) to enhance the quality of education (Kemdikbud 2022). This curriculum places more attention on self-efficacy and beliefs about mathematics. Despite this, there needs to be more research on how primary education students in Indonesia perceive the nature of mathematics learning, their self-efficacy, and their perspectives on mathematics educators since this research has rarely been studied. Previous studies noted that personal factors such as gender, parents' educational background, and grade level have been identified as influential in shaping these beliefs (Haataja et al. 2024; Reyes et al. 2016; Perez-Felkner, Nix, and Thomas 2017; Suherman and Vidákovich 2024; Hidayatullah and Csíkos 2023a). Therefore, this study aims to investigate primary education students' beliefs concerning the nature of mathematics learning, self-efficacy, and mathematics education while also examining the impact of personal factors such as gender, grade, and parental educational attainment.

Theoretical framework

Epistemological beliefs about mathematics

Research on epistemological beliefs has attracted the attention of psychologists and educational researchers from various field studies. Although it has been extensively researched, there is no consensus among researchers regarding the structure of epistemological beliefs (Mason, Boldrin, and Zurlo 2006; Limón 2006). There were various types of epistemological beliefs in the literature review. Mason, Boldrin, and Zurlo (2006) argued that some researchers are interested in viewing epistemological beliefs as the development of a thinking process. These beliefs ranged from absolutist view to evaluativist view. In the level absolutist view, one tends to perceive knowledge as absolute, certain, right, or wrong and has no need to be justified because knowledge has been perceived as an absolute value from the source of authority. In the level of multiple views, one tends to perceive knowledge as idiosyncratic, where different people have their own references and truth. Accordingly, multiple people tend to receive the truth or knowledge depending on the subjective conception. The last level is evaluativist, where in this level, one will perceive that there is a shared norm of inquiry and knowing. Also, people with this level will use some scientific support and reason to evaluate the authenticity of knowledge. Limón (2006) stated that the model of these beliefs does not consider context differences.

Using different approaches, other researchers view epistemological beliefs as the system of knowledge. These beliefs focus on explaining the belief systems, nature, structure, or features of epistemological beliefs (Limón 2006). For instance, Schommer (1990) states that the epistemology belief system is more or less independent. She argued that the belief system of knowledge may be independent, and the connection of each belief depends on the development of individual cognition. Emphasising the system beliefs approach, Hofer (2008) proposed that the framework of epistemological beliefs consists of the nature of knowledge, which focuses on what one thinks about knowledge and the nature of knowing that relates to how people obtain and judge knowledge.

In mathematics, Op 't Eynde and Corte (2003) argued that mathematical beliefs develop in situations where students have experience with mathematics. Consequently, how students shape their mathematical beliefs is determined by three factors: the nature of mathematical knowledge, self-efficacy in mathematics, and mathematics class (Corte 2015). The framework of these beliefs is similar to the system beliefs approach, which is focused on the nature and features of beliefs but more specifically on mathematics learning. The framework of mathematical beliefs entailed beliefs about the nature of mathematics. These beliefs refer to students' conception of the nature and problem-solving of mathematics. For instance, students may believe that mathematics knowledge is only a group of facts, formulas, and numbers (Hidayatullah, Csíkos, and Syarifuddin 2023). Self-efficacy refers to the student's confidence in their ability in mathematics. These beliefs are rooted

in the derivative of social cognitive theory (Bandura 1997), which states that academic performance is determined by the level of one's confidence about one's ability. Mathematics class beliefs relate to the students' conception of their interactions with their mathematics teachers in mathematics lessons (Hidayatullah and Csíkos 2023a). For instance, how far students believe that their mathematics teachers explained the importance of mathematics and demonstrated the systematic way to solve mathematics problems. Since this framework addressed the more comprehensive and more specific information about mathematical beliefs in the schools, we decided to use this beliefs framework in the current study.

There were differences in mathematical beliefs among countries worldwide, as cultural differences may influence students' beliefs (Hofer 2008). A survey by Hofer (2008) suggested that US secondary school students hold more sophisticated beliefs about knowledge than Japanese students. For instance, US students perceive knowledge as more dynamic than Japanese students. Half of Canadian students in the study by Vanayan et al.(1997) believe mathematics learning is mostly memorising. Research by Pedersen and Haavold (2023) suggested that Norwegian students strongly believe that everyone can become proficient in mathematics and that understanding mathematics well would help their future. Vattøy and Gamlem (2023) pointed out that secondary school students in Norway were confident to get good grades in mathematics. While some mathematical beliefs have been conducted in Asian countries, few studies have explained the level of students' mathematical beliefs in the Indonesian context. Although the study by Hidayatullah, Csíkos, and Syarifuddin (2023) pointed out that elementary students hold strong self-efficacy and beliefs about the nature of mathematics, this study did not explain the extent to which the level of students' response to the mathematical beliefs indicator (i.e. the statement of mathematics is mostly memorising, and I can understand even the most challenging material). Accordingly, more empirical studies are needed to explain students' beliefs about mathematics in Indonesia.

Gender, grade study, and mother education

Personal factors such as gender, grade, and mother education level differences have attracted researchers' interest over the decades. Some research explained the level of students' beliefs and their relations with personal factors, such as gender (Jenifer et al. 2024; Starr et al. 2023), grade study (Perez-Felkner, Nix, and Thomas 2017; Hidayatullah and Csíkos 2023a) and parents educational level because those with higher level education tend to more involved in their children education (Douglas and Ann 2024). Empirical research by Starr et al. (2023) revealed the connection between beliefs and gender differences among secondary schools, and this study revealed that boys hold stronger self-efficacy beliefs, such as they are better than girls at math. Mozahem et al.(2021) pointed out that older girls tend to receive more negative information, causing them to develop a lower level of self-efficacy in mathematics. A study by Van der Beek et al.(2024) revealed the same result where they found that female students have lesser mathematics enjoyment and higher anxiety than male students in math. However, neither study explained whether boys and girls differ in beliefs about the nature of mathematics learning and the conception of mathematics educators.

Many studies have closely associated grade studies with the development of students' cognition. Perry's work pointed out that a higher level of study is related to the sophistication of epistemological beliefs. In higher levels of study, students tend to perceive knowledge as more dynamic rather than static (Hofer 2000). Notable research has shown that older students tend to have more information because they have more experience (Mozahem, Boulad, and Ghanem 2021). Gilligan-Lee et al. (2021) reported that students tend to have higher performance at 6 compared to 8, 9, and 10 years in terms of mathematics and spacial language. The study of mathematical beliefs in Indonesia was conducted by Hidayatullah and Csíkos (2023a) among students in grades 8 and 9. This study suggested that there were significant differences between grade 8 and 9 students in terms of beliefs about the role of their mathematics teacher. Nevertheless, the exploration of students'

beliefs about the nature of mathematics, self-efficacy, and beliefs about mathematics educators across levels of study would provide a wealth of information on how to improve students' performance.

Parents' educational level has been recognised as an important part of students' mathematics performance, including their beliefs. Mother's educational level is significantly associated with students' creative thinking in mathematics across levels of study (Suherman and Vidákovich 2024). Hidayatullah and Csíkos (2023b) pointed out that in elementary students, the level of parents' educational level significantly predicted mathematics achievements. However, there is a scarcity of information on whether the differences in mothers' educational levels affect students' mathematical beliefs. Accordingly, the investigation of the relationship between the two is imperative.

Study context

According to international surveys such as PISA (OECD 2022) and TIMMS (Mullis et al. 2016), Indonesian students obtained low scores in terms of mathematics. There is no single answer to why students' achievements in mathematics are low and even lower compared to neighbouring countries, such as Singapore and Malaysia. Some empirical research from Indonesian scholars, such as a study by Juniati and Budayasa (2020), reported that many Indonesian students were afraid of learning math and perceived it as a difficult course. Tambunan, Sinaga, and Widada (2021) revealed that the inability of mathematics teachers to build this motivation may be a factor in the low interest of students in studying math. Many teachers also focus on transferring knowledge and ignore students' self-efficacy (Muhtadi, Assagaf, and Hukom 2022).

The education system in Indonesia has a long history in terms of curriculum. The curriculum has been changed several times in every new Ministry of Education. In curriculum 13 (K13), mathematics teachers should help students to pass the minimum completeness criteria. For mathematics learning, the students' scores should be higher than 65. Accordingly, many teachers focus on helping students pass the score (Kemdikbud 2022). Later, the Indonesian Ministry of Education introduced the *Merdeka* curriculum (*Kurikulum Merdeka*) in 2022 to improve the quality of education because of the learning crisis during the pandemic (Kemdikbud 2022). In this curriculum, mathematics is taught in the school in several phases, and these are phases A (age $\leq$ 7 or grade 1-2), B (age $\pm$ 8 or grade 3- 4), C (age $\pm$ 8 or grade 5-6), D (age $\pm$ 9 or grade 7-8), E (age $\pm$ 10 or grade 10), and F (age $\pm$ 10 or grade 11-12). The general objective of mathematics courses is to help students develop their understanding of mathematics, proving, reasoning, communication and mathematics representations, mathematics connections, and perception about the usefulness of mathematics, including curiosity, motivation, self-efficacy, creativity, and beliefs about ability in problem-solving mathematics, etc. This study attempted to provide a descriptive elaboration of students' beliefs about the nature of mathematics, self-efficacy, and their conception of the role of mathematics teachers in the primary education context.

Research questions

The main objective of this study is to explore the descriptively of students' conception of the nature of mathematics learning, self-efficacy, and their conception of mathematics educators in mathematics learning in Indonesia. Also, this study explores the differences of these variables in terms of background factors such as gender, grade study, and parents' educational level. Four research questions were proposed to accomplish these objectives as follows:

RQ1: What is the level of Indonesian students' beliefs about the nature of mathematics, self-efficacy, and mathematics educators?

RQ2: Do gender variations exist in the beliefs about the nature of mathematics, self-efficacy, and mathematics educators?

RQ3: Are there differences in grade-level study beliefs about the nature of mathematics, self-efficacy, and mathematics education?

RQ4: Do students' beliefs about the nature of mathematics, self-efficacy, and mathematics educators vary based on their parents' educational background?

Method

Participants

This cross-sectional study involved five elementary schools in Surabaya, Indonesia. In each school, two classes of grade 5 students and two classes of grade 6 students were randomly selected to participate in the present study. A total of 256 grade 5 and 238 grade 6 students participated in the present study. 51.4% of participants were boys, and 48.6% of them were girls. The age of our sample were 9 years old (1.6%), 10 years old (0.8%), 11 years old (30.6%), and 12 years old (67%). Table 1 summarises the demographics of our participants.

Instruments

This study measured students' beliefs about the nature of mathematics, self-efficacy beliefs in mathematics, and students' beliefs about mathematics educators. This study also measured the impact of demographic participants on their beliefs in mathematics. Accordingly, students were asked to complete the questions related to their profile, such as gender, grade, age, and parents' educational level. Concerning parents' educational level, we asked students about their mother's education level (1 = Elementary Education, 2 = Junior High school, 3 = Senior High school, 4 = Higher Education).

In the second step, students were asked to respond to each of the questionnaire items related to mathematical beliefs. To measure these beliefs, the researchers adapted 20 items from a mathematics-related beliefs system questionnaire (Op 't Eynde and Corte 2003). These items have been categorised into three sections. 7 items were included to measure beliefs about the nature of mathematics. For example: 'Mathematics learning is mainly memorizing' and 'There is only one way to find the correct solution to a mathematics problem.' 8 items were used to measure students' self-efficacy in mathematics. For instance, 'I am confident I will get good grades in mathematics' and 'If I try really hard, I will understand very well in math.' Beliefs about mathematics educators were measured using five items, which focus on students' perceptions of their mathematics teachers. For instance, 'My teacher explains step by step in mathematics lessons' and 'My teacher perceives mistakes as not a big problem in mathematics learning.' The items were rated using 5 point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).

Table 1. Demographic of participants.

Demographics	Category	Frequency	%
Gender	Boys	254	51.4%
	Girls	240	48.6%
Grade	Grade 5	256	51.8%
	Grade 6	238	48.2%
Parents educational level	Primary education	6	1.2%
	Junior high school	7	1.4%
	Senior high school	141	28.5%
	Higher Education	340	68.8%
Age	9 years	8	1.6%
	10 years	4	0.8%
	11 years	150	30.6%
	12 years	332	67%
Total		*494*	

Procedure

This study was conducted in several steps. First, the ethical approval of this study was obtained by the *Lembaga Penelitian dan Pengabdian Masyarakat* (LPPM) or Research and empowerment institute (LPPM) at Universitas Muhammadiyah Surabaya *(Appendix 1)*. Second, a letter of permission was sent to each school. The data of this study were collected using a paper-pencil test. Some research assistance helped with the data collection. We also asked the mathematics teacher in each school to help with the data collection. The teacher has been informed how to complete the questionnaire. Students were permitted to bring the paper of the questionnaire to their homes.

Data analysis

The data of this study was analyzed to evaluate four research questions. The data was processed using JASP Software. First, the construct validity and reliability of the questionnaire were assessed. For construct validity, we examine the fit model and indicator reliability. The fit model of the questionnaire was evaluated using the Tucker – Lewis index (TLI), comparative fit index (CFI), and root mean square error of approximation (RMSEA). The TLI, CFI > 0.90, and RMSEA < 0.08 indicated the model was acceptable (L. T. Hu and Bentler 1999; van de Schoot, Lugtig, and Hox 2012). Indicator reliability was evaluated by referring to loading factors. Ho (2006) suggested that loading factors should be greater than 0.3. Then, we assessed the internal reliability of the instrument by performing Cronbach alpha. Reliability relates to the consistency of a series measurement (Gliner, Morgan, and Leech 2017). Second, descriptive statistics was conducted to explore students' beliefs about the nature of mathematics learning, self-efficacy beliefs, and beliefs about mathematics educators. Third, in each of the beliefs dimensions, we also evaluated the impact of personal differences on mathematical beliefs by performing a t-test. Gender and grade differences in mathematical beliefs were investigated by employing an independent sample t-test. At the same time, one-way ANOVA was conducted to examine whether the differences in mathematical beliefs exist regarding parental education.

Result

Confirming validity

We evaluated the normality data of our instruments by performing the skewness and kurtosis. According to Kline (2005), the combination of skewness +/−3 and Kurtosis +/−7 indicated that the data was not severe from non-normality data. The result showed that skewness ranged between – 1.08–1.13, while the kurtosis ranged between 1.05–1.52. Accordingly, the distribution of our data matches the requirement of normality data.

Confirmatory factor analysis (CFA) was employed to evaluate the validity of the instruments. The fit model of this questionnaire has been found: Chi-Square = 135.94, $p < 0.001$, CFI = 0.93, TLI = 0.91, RMSEA = 0.05, SRMR = 0.04. The loading factors ranged between – 0.41–0.41 for the nature of mathematics, 0.39-0.62 for self-efficacy mathematics, and 0.56-0.67 for mathematics educators. Concerning the internal reliability of the nature of mathematics learning, self-efficacy, and mathematics educators, Cronbach alpha results were 0.51, 0.63, and 0.68, respectively. Accordingly, all of the factors of our instruments were valid and reliable.

Beliefs about the nature of mathematics

Seven items were included in the beliefs about the nature of mathematics (See Table 2). The mean score indicated that students somewhat agree with the statement that mathematics is mainly memorising (M 3.29, SD = 1.24), but it is not really strong. Most students expressed agreement that

'Anyone can become proficient in mathematics' (M = 3.83, SD = 1.07), and there are various strategies to find correct solutions in mathematics learning (M = 3.97, SD 0.97). The mean score for the statement 'there is only one way to find the correct solution of a mathematics problem (M 2.45, SD = 1.19)' indicated disagreement with this belief. Students generally showed moderate agreement with the idea that only intelligent students can solve math problems (M = 3.28, SD = 1.18). This mean score, which is below the midpoint of the 5-point Likert scale, is consistent with the mean result for the statement 'There are several ways to find a mathematics solution' (M = 3.97, SD = 0.97), suggesting that students generally acknowledge and agree with the variety of problem-solving approaches in mathematics.

Independent sample t-tests were conducted to evaluate whether there were significant differences between gender and grade in terms of beliefs about the nature of mathematics. We evaluated whether boys and girls and whether grade 5 and grade 6 differ in terms of beliefs about the nature of mathematics. T-test revealed statistically significant differences only for items 5, t (492) = −2.18, $p <$ 0.05, and items 6, t (492) = 2.84, $p < 0.001$. Girls are indicated to hold higher beliefs than boys with the statement 'There is only one way to find the correct solution in mathematics (M = 2.57, SD = 1.17 for girls, and M = 2.33, SD = 1.19 for boys)'. Girls (M = 3.93, SD = 1.04) also hold stronger beliefs than boys (M = 3.65, SD = 1.17) that mathematics is used by a lot of people in daily life. Figure 1 and Figure 2 illustrate the differences between boys and girls for item 5 and item 6. The differences in beliefs about the nature of mathematics items by grade were not identified. Grade 5 and grade 6 were equal across items of these beliefs. For instance, grade 5 and grade 6 were equal in perceiving mathematics as mainly memorising (t (492) = −1.59, $p = 0.11$). We further examine whether mother education affects this belief by performing one-way ANOVA. The differences between these beliefs regarding mother education level were also not found.

Self-efficacy beliefs

Eight items were included in these beliefs (See Table 3). The descriptive statistics result with the items of 'If I try really hard, I will understand very well in math (M = 4.13, SD = 0.98)' suggested that students strongly agree with this belief. Students expressed disagreement with the belief that they understood the most difficult topic in math (M = 2.91, SD = 1.14). Students also expressed somewhat agree they will get good grades in math (M = 3.73, SD = 1.04), and their concern in studying math is to get good grades (M = 3.81, SD = 1.10).

The differences in these beliefs by gender have been identified only in item 11 and item 12 (See Figure 3 and Figure 4). Independent sample t-test results indicate that boys exhibit slightly stronger beliefs regarding their understanding of mathematical course material compared to girls (t (492) = 2.98, $p < 0.05$, M = 3.59, SD = 1.08 vs. M = 3.30, SD = 1.02, respectively). Moreover, boys exhibit slightly stronger beliefs about their understanding of the most difficult material of mathematics than girls compared to girls. (t (492) = 2.36, $p < 0.05$, M = 3.02, SD = 1.112 vs M = 2.78, SD = 1.15, respectively).

We did not find differences in self-efficacy belief items between grade 5 and grade 6. For instance, grades 5 and 6 are equal in the perception of satisfaction with good grades in math (t (492) = −0.07,

Table 2. The level of student's beliefs about the nature of mathematics.

No	items	Mean	SD
1	Mathematics learning is mainly memorising	3.29	1.14
2	Anyone can become proficient in mathematics	3.83	1.07
3	There are several ways to find mathematics solutions	3.97	0.97
4	Mathematics enables me to understand the world better	3.23	1.16
5	There is only one way to find the correct solution of a mathematics problem	2.45	1.19
6	Mathematics is used by a lot of people in daily life	3.78	1.12
7	Only smart students can solve mathematics problems	3.28	1.18

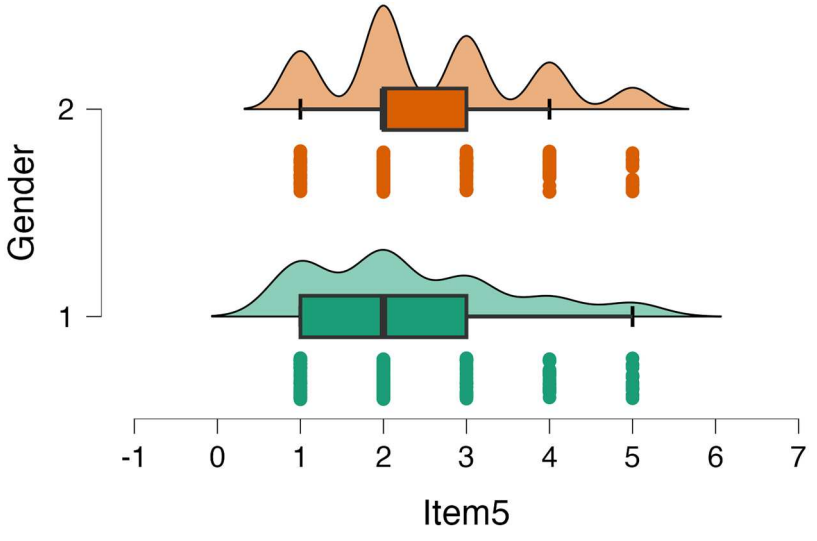

Figure 1. The illustration of the differences between boys and girls for item 5.

$p = 0.95$). One-way ANOVA was performed to evaluate whether the mother's educational level affects self-efficacy beliefs. The slight differences have only been identified on item 11 by the mother's educational level (See Figure 5). Dunett test result indicated that students with the lowest parental education (M = 2.50, SD = 0.55) tend to have the weakest beliefs that they can understand the most difficult topic in mathematics ($F = 2.83$, $p < 0.05$) compared to students whose mother with educational level of junior high school (M = 2.71, SD = 1.38), senior high school (M = 3.48, SD = 1.09), and higher education (M = 3.47, SD = 1.04).

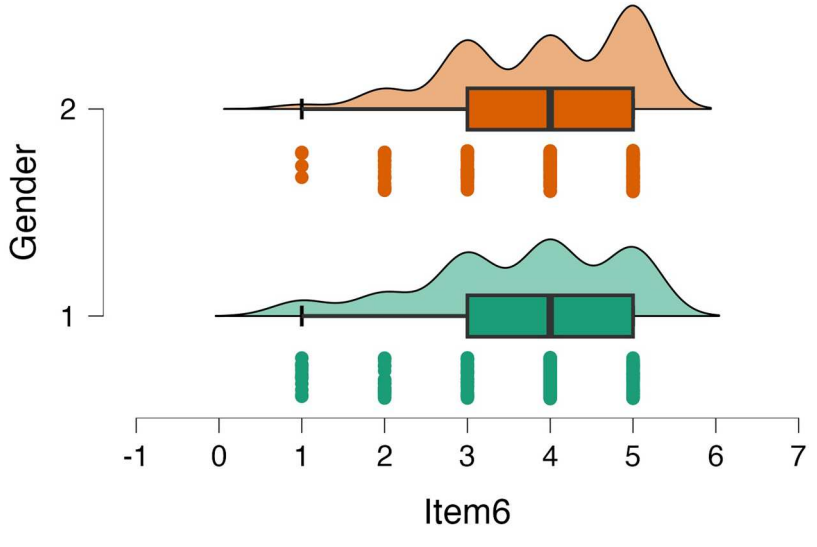

Figure 2. The illustration of the differences between boys and girls for item 6.

Table 3. The level of students' self-efficacy beliefs in mathematics.

No	Items	Mean	SD
8	I'm only satisfied when I get a good grade in mathematics	3.54	1.19
9	I want to show the teacher that I am better than other students	3.00	1.22
10	I want to show the teacher and my friends how good I am at math	3.18	1.14
11	I can understand course materials in mathematics	3.45	1.06
12	I can understand even the most difficult material	2.91	1.14
13	My concern when studying mathematics is to get a good grade	3.81	1.10
14	If I try really hard, I will understand very well the math	4.13	0.98
15	I am confident I will get good grades in mathematics	3.73	1.04

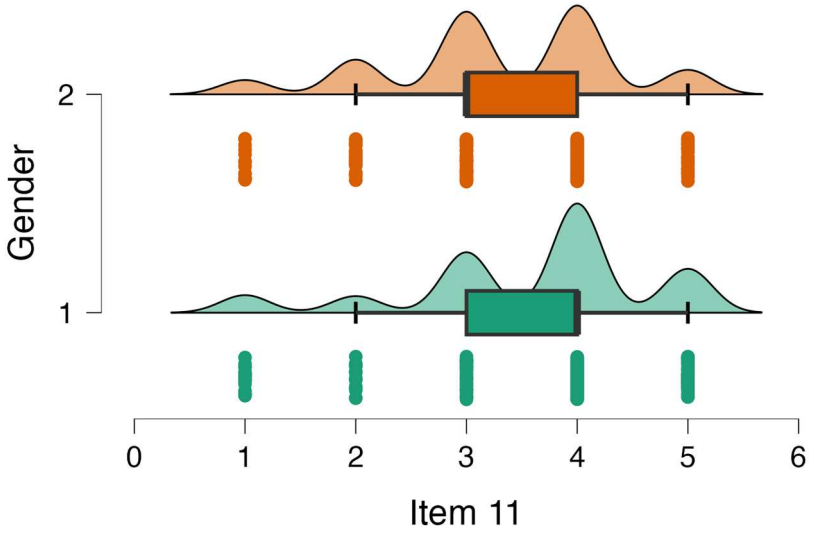

Figure 3. The differences between boys and girls for item 11.

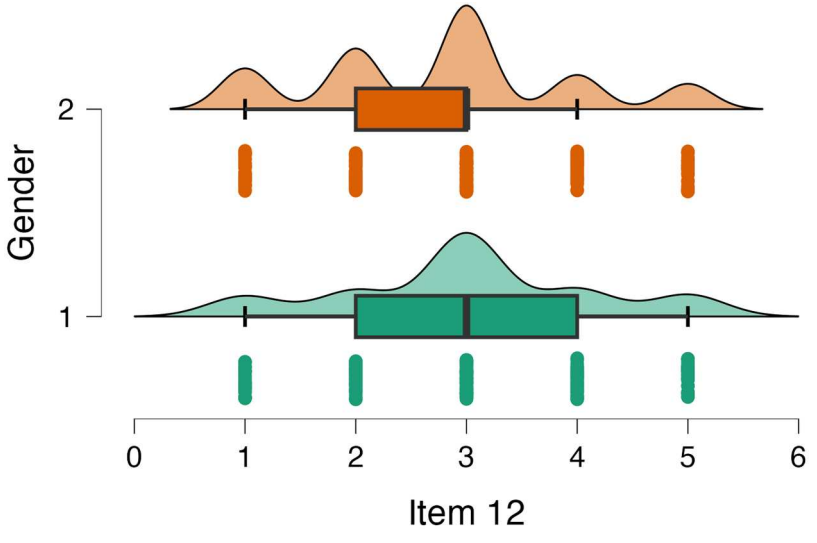

Figure 4. The differences between boys and girls for item 12.

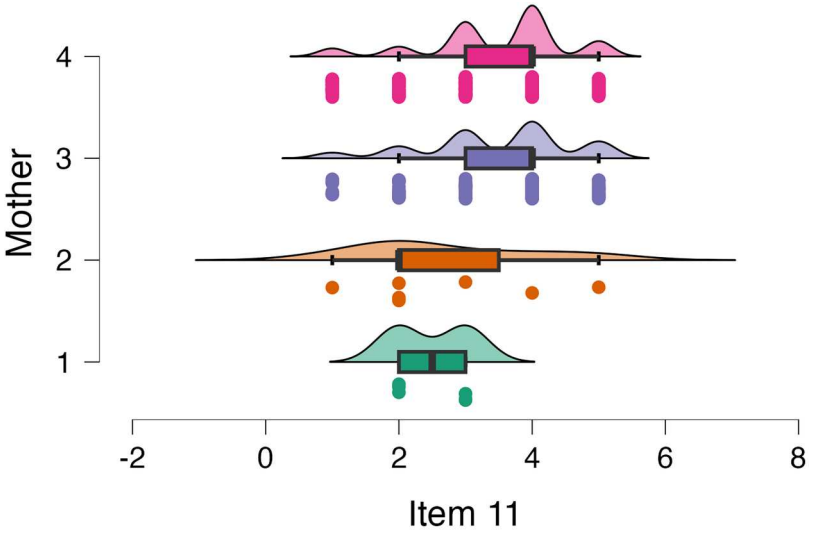

Figure 5. The differences in self-efficacy beliefs (item 11) by mother education.

Mathematics educator

To evaluate students' conception of mathematics class context, we included 6 items of students' beliefs about their mathematics teachers (See Table 4). The descriptive statistics indicated that most students somewhat agree that their mathematics teacher perceives mistakes as not serious problems in mathematics learning (M = 3.60, SD = 1.07). Students moderately believe their teacher cares about their difficulties (M = 3.50, SD = 1.08). Students indicated strongly agree that their mathematics teachers listen carefully to every question from students (M = 4.07, SD = 0.91) and explain mathematics lessons step by step (M = 4.04, SD = 0.94).

There were statistically significant differences in the responses of boys on the statement 'my teacher explained step by step in mathematics lesson' (M = 3.94, SD = 0.01) compared with girls students (M = 4.15, SD = 0.86, t (492) = −2.58, $p < 0.05$). It means that girls students agree significantly more strongly that their mathematics teacher explains step by step in mathematics lessons. Independent sample t-test notable that boys (M = 3.97, SD = 0.98) were significantly different from girls (M = 4.17, SD = 0.83) in the statement 'my teacher listens carefully about my questions' (t (492) = −2.52, $p < 0.05$). Figures 6 and 7 illustrate the differences between boys and girls for item 17 and item 19. We did not find significant differences in beliefs about mathematics educator items by students' grade level study. This means that grades 5 and 6 were equal in these beliefs. ANOVA result indicated that there were slight differences in the beliefs about mathematics educators found in item 18 by mother education level (F (3) = 3.25, $p < 0.05$). Students whose mothers have a junior high school education level (M = 4.71, SD = 0.49) have the highest beliefs that mathematics teachers care about the difficulties of students compared to students whose mothers have elementary schools (M = 3.17, SD = 1.47), senior high school (M = 3.48, SD = 1.07), and higher educational level (M = 3.49, SD = 1.07). Figure 8

Table 4. Beliefs about mathematics educator.

No	Items	Mean	SD
16	My teacher perceived mistake is not a big problem in mathematics learning	3.60	1.07
17	My teacher explains step by step in mathematics lesson	4.04	0.94
18	My teacher cares about my difficulties	3.50	1.08
19	My teacher listens carefully to my question	4.07	0.91
20	My teacher really wants me to learn new things	3.54	1.07

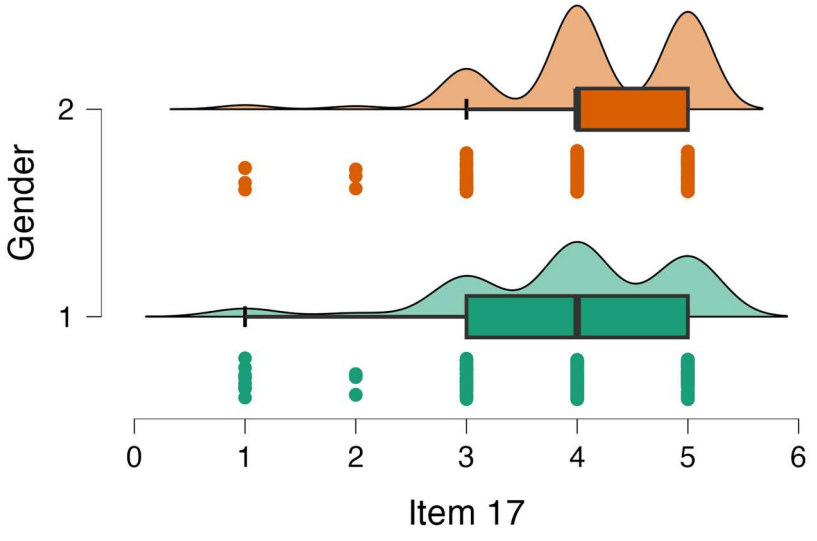

Figure 6. The differences in beliefs about mathematics educators (item 17) by gender.

illustrates the differences of students' beliefs about the mathematics teachers roles (item 18) by mother's educational level.

Discussion

This study aimed to examine the level of students' beliefs about the nature of mathematics, self-efficacy, and beliefs about mathematics educators. This study also evaluated these beliefs by gender, grade study, and mother educational level differences. Overall, the findings of this study provided the answers to all of the research questions.

The descriptive statistics presented in Tables 2–4 outline the mathematical beliefs held by Indonesian students in elementary education. The initial findings of this study indicate that primary

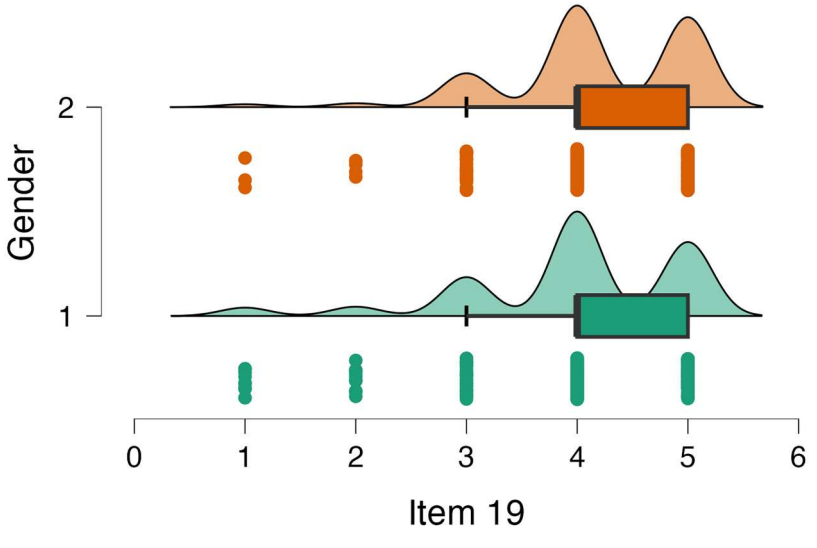

Figure 7. The differences in beliefs about mathematics educators (item 19) by gender.

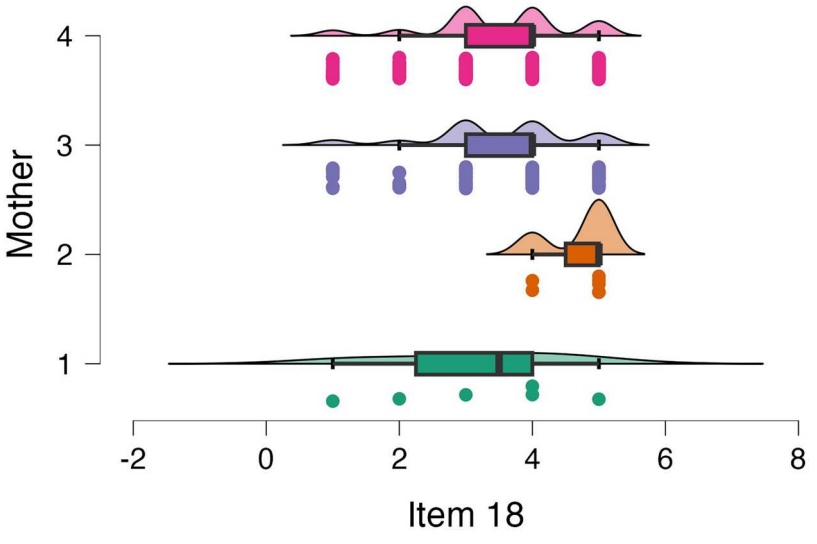

Figure 8. The differences in beliefs about mathematics educators (item 18) by mother educational level.

education students in Indonesia somewhat agree with the statement 'mathematics is mainly about memorization,' but not really strong, although in reality, mathematics skills beyond memorising and calculation (Mubeen 2022), a trend consistent with the observations made by Vanayan et al.(1997) regarding Canadian students. This finding may provide valuable insights that mathematics teachers should assist students in shaping their beliefs by emphasising that mathematics learning is beyond memorising, but it also includes critical thinking, creativity, and reasoning. Furthermore, the study reveals a strong belief among Indonesian students that everyone can achieve proficiency in mathematics (item 2), a sentiment that parallels the findings of Pedersen and Haavold (2023) in their research on Norwegian students' beliefs. Furthermore, Indonesian students generally hold the belief that the ability to solve mathematical problems is reserved for individuals with high intelligence (item 7). This suggests that Indonesian students may exhibit less advanced beliefs about mathematics compared to their counterparts in other countries, such as Australia. Research conducted by Grootenboer and Marshman (2016) indicates that elementary school students in Australia are less likely to believe that only intelligent individuals can tackle mathematical problems.

With respect to self-efficacy beliefs in mathematics, the finding of this study suggested that Indonesian students tend to perceive mathematics ability as dependent on effort. Students were really confident about getting good grades in math, and their concern in studying math was to get good grades. At the same time, students had less confidence that they could understand difficult topics in math and less confidence to show that they were good at math to their teachers. This finding is consistent with Juniati and Budayasa (2020), who suggested that many Indonesian students were afraid of learning math and perceived it as a difficult course. A possible explanation for this finding is that Indonesian students may think the indicator of success in studying mathematics is the score. The long history of the minimum criteria for mathematics scores to be higher than 65 that applied in the curriculum 13 (K13) may also still encourage teachers to focus on students' scores rather than help them build students' confidence to overcome mathematical challenges even though this standard is not used anymore in the current curriculum. As a result, students are more motivated to obtain high scores rather than to develop their confidence in understanding the challenging topic of mathematics learning (Tambunan, Sinaga, and Widada 2021; Muhtadi, Assagaf, and Hukom 2022). However, further investigation is necessary to confirm this finding.

Surprisingly, this study's result revealed a strong agreement on the role of mathematics educators among primary education students. For instance, students strongly believe their mathematics

teachers really want them to learn new things. They believe their mathematics teacher systematically explains mathematics problem solving and perceives the mistakes in mathematics learning as mathematics lessons, not serious problems. This finding revealed the same result as the previous study in Indonesia (Hidayatullah and Csíkos 2023a), which revealed that secondary schools tend to hold strong beliefs about the role of their mathematics teachers. The possible explanation is that in the primary education context, students are less independent in studying mathematics. They still need more guidance and instructions from their teacher in mathematics. Accordingly, in this stage, their beliefs about mathematics educators' roles were really strong.

The second research question is about gender differences in terms of beliefs about the nature of math, self-efficacy, and mathematics educators. Overall, we found girls were more sophisticated in terms of beliefs about the usefulness of mathematics than boys (item 6). Girls more strongly agreed than boys about items such as 'My teacher explains step by step in mathematics lessons' and 'My teacher listens carefully about my questions.' At the same time, girls were also less sophisticated than boys since they held stronger beliefs that there was a one-way solution to finding the correct answer in math (item 5). Furthermore, girls have been shown to have lower self-judgment about their ability to understand mathematics courses (item 11) and the most difficult topics (item 12) in math compared to boys. This finding is in line with Starr et al. (2023), who found that boys tend to hold stronger self-judgment about their mathematics ability than girls. It can be interpreted with the fact that girls seem to focus more on work-developing skills, whereas men are more focused on intellectual value (Vanayan et al. 1997). Accordingly, when girls face difficulties in math, their confidence to study math decreases.

The third research question concerns grade-level study differences in beliefs about the nature of mathematics, self-efficacy, and beliefs about mathematics educators. Contradicting the previous study (Hidayatullah and Csíkos 2023a) in Indonesian secondary schools, the finding of this study suggested no significant differences in beliefs about the nature of mathematics, self-efficacy, and belief about mathematics educators by grade level study. This finding also contradicted Mozahem, Boulad, and Ghanem (2021) and Gilligan-Lee et al. (2021), who found students at a higher level of the study had higher self-efficacy in math and mathematics achievements. However, further empirical studies are necessary to confirm this finding.

The fourth research question examines the differences in beliefs about the nature of mathematics, self-efficacy, and beliefs about mathematics educators related to the mother's educational level. Significant differences in these beliefs by mother's educational level were found in self-efficacy and beliefs about mathematics educators. In the study of self-efficacy, the data revealed the same result as the prior studies (Hidayatullah and Csíkos 2023b; 2023a; Suherman and Vidákovich 2024) that students with the lowest mother education level tend to show less agreement with understanding the most difficult topic in mathematics learning. In the study of beliefs about mathematics educators, we found that those with a mother's educational level in junior high school tend to have the lowest beliefs with the items 'My teacher cares about my difficulties.' It could be that mothers with a low level of education tend to be less involved in their children's studies compared to mothers with a higher level of study.

Conclusion and implications

The findings of this study provided empirical data about the descriptive mathematical beliefs level of elementary education students in Indonesia. In elementary education, students expressed some agreement but were not really strongly with the beliefs about the nature of mathematics, such as mathematics is mainly memorising and everyone can be proficient in mathematics. Students expressed strong agreement with the belief that ability depends on that mathematical effort. Students tend to show some moderate agreement with the beliefs that they can understand mathematics courses, get good grades, and satisfaction with good grades in mathematics. This study also revealed that some differences in beliefs about the nature of mathematics, self-efficacy, and

mathematics educators by gender have been identified. Students' self-efficacy and beliefs about mathematics education differ based on their mother's educational level.

This study enriches the literature review of students' beliefs about the nature of mathematics, self-efficacy, and beliefs about mathematics educators among elementary schools in Indonesia. This finding also contributed to the teaching practices. Teachers need to reinforce students' self-efficacy. For instance, persuading student that they can understand mathematics well will increase their efficacy. Mathematics teachers need to increase students' beliefs about the usefulness of mathematics and believe that there are many strategies to solve mathematics problems by demonstrating the function of mathematics and how to solve mathematics problems. With respect to the differences in self-efficacy, mathematics teachers can help the girls student increase their self-efficacy with an innovative approach, such as by appreciating their students' work.

Limitations and future directions

Although this study provides a wealth of information and suggestions, several limitations should be noted for future directions. First, the study only examined the level of students' mathematics-related beliefs and their differences by their personal factors and did not include the significant role of these beliefs in another aspect, such as mathematics achievements. Accordingly, future research should consider mathematics achievement and its relations with these beliefs. Second, the limitations of the research methodology should be noted, too. The present study only uses descriptive statistics and t-tests to evaluate the differences in students' beliefs. Also, the study uses a cross-sectional method where the level of these beliefs and their differences based on personal factors may not be known, and whether they are stable across time. Accordingly, longitudinal studies may provide more comprehensive results in the future. This study only evaluated students' beliefs in elementary education in one of the cities in Indonesia. There is a generalizability issue with the findings of this study. Future research needs to expand the sample and compare the differences of this belief based on cultural differences.

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No potential conflict of interest was reported by the author(s).

ORCID

Achmad Hidayatullah http://orcid.org/0000-0002-7223-6771
Radius Setiyawan http://orcid.org/0000-0002-1221-196X
Syarifuddin http://orcid.org/0009-0007-2750-7038

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