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Mathematics Related Belief System and Word Problem-Solving in the Indonesian Context

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Abstract
The purpose of the present study is to provide empirical evidence on the adaptation of the mathematics-related beliefs questionnaire (MRBQ) supplemented by info-communication technology-related items. Besides, we also investigate the relationship between their beliefs about mathematics and their ability in problem-solving mathematics. 234 grade eight students from five schools in Java, Indonesia, participated in this study. The questionnaire has appropriate reliability. To examine the validity of the questionnaire, factor analysis was applied, and regression analysis was conducted to explore students' beliefs and their relation to their performance. Factor analysis revealed a good fit of the model; therefore, confirming the validity of MRBQ in the Indonesian context. Descriptive statistics showed students' tendency to follow the nonrealistic approach when doing word problems. Regression analysis indicated the significant role of beliefs in mathematics predicting students' performance on mathematical word problems.

Keywords: mathematics-related beliefs, ICT, problematic word problems

INTRODUCTION

Studies on students' beliefs in mathematics have attracted significant interest for several decades (Grootenboer & Hemmings, 2007). Beliefs have been recognized as the most potent aspect of student performance (Habók et al., 2020).

According to Yin et al. (2020), beliefs are the most central in demonstrating individuals' power to control themselves, serving as the director of individuals' thoughts and behavior. Students' mathematics-related beliefs drive them to select specific strategies, which significantly influence their performance in mathematics (Buehl & Alexander, 2005; Csíkos et al., 2011; Wang et al., 2019).

Beliefs study was begun by Perry's work in 1978 that inspired many researchers in the various domain (Buehl & Alexander, 2005; Schommer, 1990). Interestingly, researchers were debatable regarding the generality-specificity of beliefs structure in the current field (Limón, 2006). Researchers in mathematics education tried to discover the more specific beliefs structure that comprehensively described students' conceptions about mathematics education.

One of the most influential studies on beliefs in mathematics education is the mathematics-related belief questionnaire (MRBQ), developed by Op't Eynde and De Corte (2003). MRBQ offers a more specific and comprehensive belief framework in mathematics learning than others. MRBQ was adapted in different cultures and countries such in the European countries; Spain, England, Slovakia, and Ireland (Andrews & Diego-Mantecón, 2015; Diego-Mantecón & Andrews, 2008; Diego-Mantecón et al., 2007b) and American Latin; Columbia (Diego-Mantecón & Córdoba-Gómez, 2019) and Ecuador (De Corte, 2015). Those studies revealed that the MRBQ has consistency in the validity and reliability in different countries. However, most of those studies only used exploratory factor analysis (EFA) to examine the complexity of MRBQ. Its means more procedures such as confirmatory factor analysis (CFA) are still needed to clarify this instrument's fit model and validity.

Almost all of the psychometric characteristics of MRBQ available are based on data obtained in Western region countries. The stability of MRBQ in other areas, such as Asian countries, still requires to be clarified whether the structure is fit or not. In Southeast Asia, beliefs studies that involve MRBQ are limited. We found

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Contribution to the literature

- Mathematics-related beliefs questionnaire (MRBQ) was adapted in Indonesia supplemented by items on the role of info-communication technologies. MRBQ in the Indonesian version has a fitted model and high reliability.
- A test of problematic word problems has been developed for eighth-grade students. The reliability was excellent. Students tend to use a nonrealistic approach when solving word problems.
- MRBQ items had significant connections with students' word problem-solving performance.

few mathematics-related beliefs research, for instance, in China by Wang et al. (2019) and Malaysia by Tarmizi & Tarmizi (2010). In Indonesia, there has not been an empirical study conducted either on ICT-related beliefs within the structure of mathematics-related beliefs or on the connection between mathematics-related beliefs and mathematical performance.

Assessing students' beliefs in mathematics in Indonesia may contribute to a better understanding of their mathematical performance. Interestingly, there is a disparity in students' performance among countries in the Southeast Asian region. Based on several international surveys, students in developed countries, such as Singapore, perform high in mathematics, whereas students in developing countries, such as Indonesia, have poor performance in mathematics (Asadullah et al., 2020; Fenanlampir et al., 2019; OECD, 2013, 2016). Indonesian is ranking 46 from 51 countries in TIMSS, and ranking 74 from 79 countries in PISA (Fenanlampir et al., 2019; Mullis et al., 2015; OECD, 2019). Although almost all countries in the Southeast Asian region, such as Indonesia, have invested in their public education, including digital technology to support students' performance (Chen et al., 2017).

MRBQ does not cover information on the info-communication technology (ICT) aspect. ICT, such as mobile devices or smartphones (Das, 2019), plays an essential role in mathematics education because education stakeholders use it to support learning processes in the school (Verschaffel et al., 2019). Mobile technology could improve students' participation, motivation, and cognitive ability in learning mathematics (Attard, 2018; Kyriakides & Mavrotheris, 2018). Integrating ICT in the mathematics classroom is determined by teachers' and students' beliefs about the ICT (Das, 2019). Nonetheless, we couldn't find mathematical beliefs studies involved the role of ICT. Therefore, there is a need to incorporate ICT beliefs into MRBQ to comprehensively determine students' thinking about mathematics in the 21st century. Integrating ICT beliefs will measure students' thinking and perceptions about mathematics learning in the digital age.

There have been numerous studies investigating how students' beliefs may affect their word problem-solving performance (e.g., see Csíkos et al., 2011; Reusser & Stebler, 1997); an achievement indicator that is considered highly important in mathematics, at least from the viewpoint of taking realistic aspects into account when applying purely mathematical knowledge and skills (Greer, 1997). However, research is scarce on quantifying the relations of two distinctive and measurable constructs, i.e., math-related beliefs and word problem-solving performance. As a result, the present study examines the psychometric characteristics of MRBQ supplemented by beliefs items about ICT as a new aspect in the Indonesian context. Besides, to gain further reinforcement on the influential role of beliefs on mathematical performance, we analyze the correlation between students' MRBQ and their performance in solving word problems.

THEORETICAL FRAMEWORK

Students' Beliefs About Mathematics Education

There is no consensus concerning the definition of beliefs, although empirical evidence reported that beliefs influence students' motivation, behavior, and achievement (Mcleod & Mcleod, 2003; Sangcap, 2010). Nonetheless, Pajares (1992) reported beliefs legitimate in various domains, such as biology, mathematics, medicine, and social science. Bonne and Johnston (2016) defined beliefs in mathematics as the confidence in one's ability to solve a given problem. Meanwhile, Schoenfeld (1985) stated that belief systems are mathematical views that dictate how a person understands mathematics and solves mathematical problems. Greer et al. (2003) defined beliefs as personal subjective knowledge held to be true about mathematics, mathematics task, and mathematics education that may be explicit and implicit. In 1990-2005, a relevant portion of the literature expressed debates among researchers regarding domain-generality or domain-specificity of belief.

One of the most influential belief studies in a domain-specific environment used the mathematics-related beliefs questionnaire (MRBQ), developed by Op't Eynde and De Corte (2003). The framework of MRBQ consists of (i) beliefs about mathematics education, which constitute beliefs about mathematics, mathematics learning and problem-solving, and mathematics teaching; (ii) beliefs about the self as a mathematician; and (iii) beliefs about mathematics in the class context. MRBQ was first developed in Belgium and is administered to 14-year-old students in Flemish Junior High School. With exploratory factor analysis (EFA), four scales, including beliefs about (i) the role and function of teachers, (ii) the mathematics self-competence, (iii) mathematics as a social activity, and (iv) mathematics as domain excellent, and forty-four items have been identified (De Corte, 2015; Op't Eynde et al., 2006; Op't Eynde & De Corte, 2003). The theoretical model on which the MRBQ is based is an influential theory that reflects mathematics beliefs in different contexts. Nevertheless, these scales do not constitute beliefs about the role of ICT in mathematics learning. Since emerging digital technology is essential in mathematics education, this study includes beliefs about the importance of ICT or digital technology to complement the missed aspects of MRBQ.

Beliefs About the Role of ICT

Info communication technology (ICT) refers to disseminating, storing, and managing various technical tools and resources (Das, 2019). ICT is a wide range of multiple forms such as computer programs, the internet, ICT hardware, digital learning resource (Turel et al., 2015). Because ICT is crucial for education in the 21st century, almost all countries worldwide have invested in ICT infrastructure to support ICT integration in education. However, integrating ICT in mathematics learning depends on students' and teachers' beliefs concerning ICT. Nevertheless, only a few studies of the students' or teachers' beliefs about ICT in the mathematics domain provided information about ICT integration.

Although there is no precise definition and structure of beliefs about ICT in mathematics, previous studies can be split into two groups. The first group of studies on beliefs about ICT is related to the value of beliefs about technology. For instance, a study by Vekiri (2010) investigated boys' and girls' beliefs about ICT in Greek. The researcher did not clearly define the definition of beliefs about ICT itself. She described that individuals' self-efficacy and value of beliefs about ICT drove the ICT use. She cited the Bandura point of view that self-efficacy is someone's perception about their ability to perform successfully on a task. At the same time, the value of beliefs is related to someone's perception about the importance, usefulness, enjoyment, or interest and the cost in the particular domain. For instance: my knowledge about computers is helpful for my daily life. In their research about teachers' ICT-related beliefs, Atman Uslu & Usluel (2019) defined the value of beliefs about ICT as teachers believe that technology can help them achieve the teaching goal that is important to students. Chen et al. (2021) describe beliefs about ICT as teacher attitudes towards and preferences for ICT integration in education. This belief system features teachers' receptivity to ICT in teaching practices and teachers' attitudes towards the effectiveness of ICT use.

The second group of studies emphasizes the individual perception about their ability to use the technology. Turel et al. (2015) investigated students' self-efficacy beliefs about ICT. In this study, beliefs about ICT are illustrated with students' perception of their ability to use a computer. For instance: "I think I can use a computer efficiently." Hammer et al. (2021) observed parents' beliefs and relations to students' digital media self-efficacy. They represent students' self-efficacy about digital media as the extent to which they believe they can successfully operate it. Consequently, previous studies on ICT-related assessed two constructs; the value of beliefs about ICT and self-efficacy of ICT. In the mathematics learning context, students' beliefs about ICT can be defined as the extent to which students perceive they can operate ICT in mathematics learning and how ICT can support their mathematics learning.

The Relation Between Word Problem Solving and Beliefs About Mathematics

A word problem is a verbal explanation of a question that someone can answer by employing numerical information (Verschaffel et al., 2010). The simple type of word problem involves only combining, comparing, changing, and equalizing problems. Word problems are also various kinds, ranging from mere routine tasks to more complicated realistic problems (Csíkos & Szitányi, 2020). As mentioned earlier, word problems provide the means for integrating real-world experiences and knowledge and applying purely mathematical knowledge and skills (Greer, 1997). Consequently, in an educational environment where students' real-world experiences are to be used and integrated into the mathematics classroom, word problems and beliefs about the solvability of word problems play their important role. Beliefs drive students to identify word problems to cope with the problem's type (Csíkos & Verschaffel, 2011).

In our current study, math-related beliefs (enriched by ICT-related beliefs) and mathematical word problems are two distinct measured constructs. Of course, several individual items we apply can be directly related to each other. For example, "there are several ways to solve the mathematics problem," "I can understand even the most difficult material presented in a mathematics course," "those who are good in mathematics can solve any problem in a few minutes," there is only one way to find the correct solution to a mathematics problem" (MRBQ).

More complicated real word problems require students to use their imageries rather than regular operations; namely, problematic word problems (so-called P-items) developed by Verschaffel et al. (1994) required students to deviate from the usual superficial solution strategy. In this type of word problem, students must understand the semantic structure and dynamic network of implicit rules (Greer et al., 2003). A semantic structure refers to the sense of connecting experience about known and unknown objects (Pongsakdi et al., 2020). P-items typically contain irrelevant data or lack data for a straightforward (superficial) solution. Students need to recognize that there is not a single solution, or the task cannot be solved. A study on P-items by Verschaffel et al. (1994) revealed that students tend to use nonrealistic reactions when solving word problems. This study inspired other researchers in various countries to analyze students' approaches in solving mathematics. For example, Reusser & Stebler (1997) replicated the research using P-items for students across Swiss and Germany, and they found that most students use nonrealistic reactions in solving mathematics. Furthermore, their investigation revealed some of the strong beliefs that may be responsible for the nonrealistic solutions. Csíkos et al. (2011) conducted an empirical study to analyze fifth-grade Hungarian students' tendency to use P-items with a multiple-choice model with three options (*nonrealistic, realistic estimation, realistic reaction telling that there is not enough information*). In that study, students were asked to complete the task with choose which option they agreed with. Nonrealistic answers are based on routine operations and numerical responses, with the accompanying statement that this assignment is unambiguously the correct answer. A numerical response that takes into account realistic aspects and considerations is known as a realistic estimation. The realistic reaction, on the other hand, is a sort of response, non-numerical response, that acknowledges the problem's situational complexity while stating that the problem is unsolvable. By using three options in a closed-question format, we would not claim that the tasks measure the problem-solving process, but the closed-question format emulates the test format used in many countries to assess mathematical performance. The research found that most students choose nonrealistic responses. Dewolf et al. (2013) investigated the solution process for the P-items in Turkey and yielded similar results and tendencies.

Indonesian Students' Performance in Mathematics

Indonesia is an archipelago with a population of 270 million in the Southeast Asia region. Because of the large population and geographical position, Indonesia has a complex educational challenge. The government has enacted a regulation on the use of the K-13 program in public schools. According to international surveys, such as Program for International Students Assessments (PISA) and Trends in International Mathematics and Science Study (TIMSS), Indonesian students perform poorly in mathematics, ranking 46 from 51 countries in TIMSS, and ranking 74 from 79 countries in PISA (Fenanlampir et al., 2019; Mullis et al., 2015; OECD, 2019). Also, students in Asian countries show lower self-efficacy and self-concept than those in Western nations (Pedrero & Manzi, 2020).

Nevertheless, Chen et al. (2017) found that students in developing countries (Indonesia, Malaysia, and Thailand) of Southeast Asia believe that the motivation to work hard affects their future success. Besides that, nearly 80% of schools in developing countries are at a poor performance level. Students in developing countries, such as Indonesia, need high motivation to match high-performance students.

RESEARCH AIMS

We conducted an adaptation study with MRBQ in Indonesia and constructed problematic word problems in mathematics tests. The questionnaire was extended by 21st-century learning supported by digital ICT. Thus, this study aims to reveal the structural validity of MRBQ in the Indonesian context, students' approaches to word problems in mathematics, and the connections between MRBQ and important mathematical performance indicators.

METHODS

Sample

This empirical study involved 234 eighth grade students (121 boys and 113 girls) in the first semester from 15 classes in five East and West Java, Indonesia. There are three classes in each school, representing low, moderate, and high math abilities. The students' home is close to the school in the distance because of the zonation system that impacts and shapes the heterogeneous sample of the present study. The mathematics teacher in the school helped to determine the sample in the present study based on their insight into the students' performance. The data of students' mathematics abilities are available in the schools. The sampling units were the schools that were purposively selected in the urban area in Surabaya and Bogor. The unit school in the present study characteristically allowed students to bring their own device because this research also assesses students' beliefs about the role of ICT in mathematics learning particularly. We used Google Forms to collect data because of the pandemic situation. In this research, all students completed the questionnaire and the problematic word problem test in mathematics learning.

Measures

Mathematics-related beliefs questionnaire

In this study, we used the original MRBQ, which has four subscales, including beliefs about the role and functions of teachers (16 items), the significance of their own competence in mathematics (13 items), mathematics as a social activity (9 items), and mathematics as a domain of excellence (6 items). We added one further scale containing two subscales and twelve items that constitute students' perception of ICT in mathematics learning. The belief about ICT in mathematics learning consisted of two dimensions, self-efficacy and value of beliefs about ICT. Self-efficacy ICT is the extent to which students perceive they can operate ICT (Hammer et al., 2021; Turel et al., 2015) in mathematics learning, as follows:

(1) Solving a mathematics problem is demanding and requires skill to operate digital technology.

(2) I can use technology easily in mathematics learning.

(3) I can operate digital technology easily to support my mathematics learning everywhere.

(4) I think I can get good grades on assignments and tests of mathematics with the support of digital technology.

(5) I think I can use digital technology to help me learn mathematics.

Value of beliefs about ICT refers to the perception about the function of ICT (Atman Uslu & Usluel, 2019; Chen et al., 2021; Vekiri, 2010) to support mathematics, as follows:

(6) I think digital technology can help me to learn mathematics.

(7) I think my understanding of math is better when I am using digital technology.

(8) I believe digital technology enables people to understand mathematics better.

(9) I think digital technology is essential for me.

(10) Digital technology is used by a lot of people in their daily life.

(11) Digital technology is the solution for me when I have math problems and difficulties in learning mathematics.

(12) There is only one way to solve my math difficulties, and I have to use digital technology.

As a result, the questionnaire in the present study consisted 56 items, combination the original MRBQ (44 items) and beliefs about ICT in mathematics learning (12 items) were rated on a 5-point likert scale with anchors of strongly disagree (1) to strongly agree (5). We provide clear instruction to participants that they should answer the questionnaire's items based on their personal beliefs about mathematics. We also informed the participants that all the information they completed in the questionnaire would be kept confidential and be used for research purposes only.

Problematic word problem in mathematics

As we discussed previously, word problems in closed-question format were administered to the students. These tasks primarily intend to detect students' choices out of three different solution strategies. Besides the usability of word problems in assessing students' capabilities to integrate real-world experiences and purely mathematical knowledge, we used word problems because word problems are represented in a variety of topics for students in secondary schools. The topics in the present study were established to follow the Indonesian K-13 curriculum for the first semester of grade 8, containing 12 items, three items per topic (pattern number, set, straight-line equation, and linear equation with two variables), see Appendix A.

We used the problematics word problem model (P-items) to measure students' ability in mathematics and its relation to their beliefs about mathematics. We established 12 P-items for the grade 8 version using a multiple-choice model developed by Csíkos et al. (2011). Researchers modified P-items into multiple-choice format questions; *a*: nonrealistic are those that are based on routine operations and numerical responses, with the accompanying statement that this assignment is unambiguously the correct answer., *b*: realistic estimation or consideration is a numerical response that takes into account realistic aspects and considerations, and *c*: a sort of response, non-numerical response, that acknowledges the problem's situational complexity while stating that the problem is unsolvable. For example:

"Temperature:" The temperature in Indonesia is 30 °C at 08.00 WIB in February 2021. Then, at 11.00, the temperature decreases to 28 °C, and at 14.00, it drops further to 26 °C. What is the temperature at 17:00?

a. *It is unambiguous. The temperature changes every 3 hours. 30, 28, 26, … Then, 3 hours later (i.e., at 17:00), the temperature will be 24 °C.*
b. *The temperature will be 24 °C at 17.00 if the temperature decreases continuously*
c. *We do not have enough data. Consequently, this problem cannot be solved.*

"Buyers:" An online store gives a 25% discount to the first 400 buyers in the new year. There are 100 buyers at 7:00 am. The number of buyers increased to 150 at 7:10 am. Then, the number of buyers increased to 200 people at 07:20 am. What time will the buyers reach 400 people?

a. *It is unambiguous. Every 10 minutes, there are 50 people: 1st minute (100 people), 10th minute (150 people), 20th minute (200 people). 100, 150, 200, 250, 300, 350, 400. That means the buyers will reach 400 people in 60 minutes (08.00 am).*
b. *The buyers will reach 400 people in 60 minutes (i.e., 08.00 am) if the buyers increase regularly*

c. *We do not have enough data. Consequently, this problem cannot be solved.*

Procedure

MRBQ was translated to the Indonesian language, and twelve items of beliefs about the role and function of ICT were added to measure students' tendency toward mathematics. We also developed 12 problematics word problems in mathematics (P-items) for grade 8 students to measure their performance on realistic word problem-solving. Several Indonesian teachers and other researchers reviewed and verified both the MRBQ and the word problems test. We administered both MRBQ and instrument test (P-item) to 234 grade 8 students using Google Forms. Data collection took place from February 8 to March 18, 2021. To avoid the students' fatigue when completing the instruments, we separate the process of collecting data into two sessions. MRBQ was distributed in the first session from February8 to 24 February 2021, and P-item was distributed in the second session from 25 March to 18 February 2021. The collecting data process uses an online system where the researcher sends both instruments to all the math teachers in the schools. Then, mathematics teachers in these schools helped the collecting data process.

Data Analysis

Exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and Cronbach's alpha estimation were used to examine the construct validity and reliability of MRBQ. EFA is used earlier to explore the construct validation, whereas we use CFA later after an underlying structure has resulted on prior empirical (EFA) and theoretical background. First, we perform the exploratory factor analysis to examine the sample adequacy and the number of factors. EFA is a fundamental tool for investigating construct validity (Kim et al., 2016; Watkins, 2018). We used several rules to determine the factor and to compress the item for the Indonesian version. This study used the maximum likelihood parameter estimate since the distribution of our data normal, Kaiser-Meyer-Olkin, includes orthogonal Varimax rotation to determine the factor structure matrix (Henson & Roberts, 2006). Kaiser-Meyer-Olkin measure the sampling adequacy from the ratio of correlations and partial correlations that reflects the extent to which correlations are a function of the variance shared across all variables rather than variance share. KMO values range from 0.00 to 1.00 (Watkins, 2018), which the KMO value ≥0.9 is desired (Lloret et al., 2017), while the values ≤0.5 are unacceptable. Eigenvalue >1 (Kaiser, 1960) is used to condense the variance in the correlation matrix, scree test (Cattell, 1966), Barlett's Chi-square test, and the factor loadings ≥0.4 indicated good structural validity (Malakouti et al., 2006; Zhang et al., 2018).

Second, CFA was used to examine the goodness of fit and stability measurement of structure model MRBQ supported ICT in the Indonesian context. According to Brown (2015), verify the number of underlying dimensions of the instruments or the factors and the pattern of item factor relationship (factor loading). CFA assists in determining how the test should be scored. The degree to which the actual or observed covariance input matrix conforms to (or differs from) that anticipated by the proposed model was measured by goodness-of-fit. In the present study, we used absolute fit measures consist root mean square error of approximation (RMSEA) and incremental fit measures consisting of comparative fit index (CFI), Tucker Lewis index (CFI), non-normed fit index (NNFI), incremental fit index (IFI), and relative non-centrality fit index (RNI). RMSEA values <0.8 suggest adequate model fir, values <0.05 suggest good model fit, and values ≥1.00 should be rejected (Hu & Bentler, 1999). Even though there is no clear consensus regarding what constitutes a good fit, a widely applied guideline for the incremental fit indices is 0.90 (Ho, 2006). We performed Cronbach's alpha to measure the reliability of each factor MRBQ that resulted from CFA.

Third, we explained the description of data analysis (mean, standard deviations) of MRBQ. In this step, we also attempted to find the extent to which each factor is related by Pearson correlation. The value of the correlation coefficients ranges from +1.00 to -1.00 which the both of these extremes represent the perfect relationship between the factors (Gliner et al., 2017; Ho, 2006). We also used Pearson correlation and Cronbach's alpha to investigate the correlation among items and the internal consistency of problematic word problems. We used descriptive statistics to provide the data of students' approaches to solving school word problems. Finally, using multiple regression analysis will correlate students' beliefs about mathematics and their ability in problem-solving mathematics.

RESULTS AND FINDINGS

Factor Analysis MRBQ with Supported ICT

EFA with maximum parameter likelihood was applied on 56 items forming the MRBQ. We found that KMO=0.949, Barlett's test of sphericity=2,123.129, and the associated level was significantly smaller than 0.001, indicating that the sample was adequate for EFA and applied to the obtained data set.

Using eigenvalues >1, maximum iteration for convergence of 25, factor loading 0.4, five factors represent the variance of all elements with almost all items obtained factor loadings above 0.4.

We performed confirmatory factor analysis to examine the good fitness of compliance between items of MRBQ with the new factor beliefs about the role of ICT consisted value of beliefs about ICT and self-efficacy

Table 1. Five factors with their mean values, standard deviation, skewness, and kurtosis, and the simple correlation result

Variable	Mean	SD	Skewness	Kurtosis	F 1	F 2	F 3	F 4	F5
F1	60.92	10.87	0.03	0.04	1	.47	.68	.63	.53
F2	43.74	8.96	0.06	0.30		1	.43	.44	.46
F3	46.33	8.87	0.28	0.50			1	.65	.54
F4	35.09	6.36	-0.42	0.90				1	.53
F5	22.07	4.58	-0.09	0.12					1

ICT, the factor that resulted by EFA. Eight items of MRBQ (44, 46, 49,51, 24, 29, 4, and 18) and two items about the role of ICT items (8, 12) were eliminated from the analysis because the loading factor was less than 0.4 because the factor loading ≥0.4 indicated the indicator system has a good structural validity (Malakouti et al., 2006; Zhang et al., 2018). As a result, we kept forty-six items as the new structure of MRBQ in the Indonesian context. We found the fitted model, CFI=0.924; TLI=0.919; NNFI=0.919; IFI=0.925; RNI=0.924, and RMSEA=0.052. According to Hu & Bentler (1999), the value of TLI and CFI above 0.9 is acceptable. The value of RMSEA and SRMR below 0.05 indicated a close approximation of the data by the structure model (Browne & Cudeck, 1992).

We found factor 1 was beliefs about the role, and functioning teachers consisted of 13 items with alpha=0.942. Factor 2 was beliefs about the role of ICT in mathematics constitute ten items with alpha=0.887, factor 3, beliefs about the significance of and competency in consisted of ten items with coefficient alpha=0.932, beliefs mathematics as a social activity consisted eight items with alpha=0.932 and the last factor was beliefs about mathematics as a domain excellent constitutes six items with alpha=0.903. Interestingly, the second factor, beliefs about the role of ICT as a new factor, has high reliability with alpha=0.887. This factor was typically intended to complement an essential aspect of mathematics education in the 21st century. The factor's elements are related to the perceived usefulness of ICT in mathematics learning. The coefficient of Cronbach's alpha also showed all the factors have high reliability (0.887-0.942). As a result, MRBQ with new scale beliefs about the role of ICT was fitted in the Indonesian context and can be used to examine students' beliefs. See Appendix B.

Descriptive Analysis and Inter-Correlation Between Factors of Mathematics-Related Beliefs System

Table 1 shows the mean, standard deviation, the normality assumption, and the Pearson correlation coefficient for students' mathematics-related beliefs system factors in Indonesia.

According to Table 1, the value of Z-skewness and Z-Kurtosis of all the factors fell in the -2 and +2 when computed using the Z-test. Z-score could be obtained by dividing the skew values or excess Kurtosis by their standard errors. For the medium-size sample (50<n<300), alpha level 0.05, the absolute Z-values over 3.29 is not normal distribution (Kim, 2013). Concerning the inter-correlation between factors, the data showed all the factors had a significant relationship. Overall, the correlation ranged from 0.43 to 0.68, where the pair of factors 3 and 1 had the highest correlation (r=0.68) among the other correlations. It means students who believe in the role and functioning of their own teacher are favorable to beliefs about the significance of and competence in mathematics. The pair of factors 4 and 3 also showed a strong correlation (r =0.65). While the pair factors 3 and 2 had the lowest correlation (r=0.43). It means students with beliefs about the role of ICT in mathematics are favorable to beliefs about the significance of and competence in mathematics. Furthermore, the data Table 1 also showed the mean differences between factors, M=60.92 (SD=10.87) for F1, M=43.74 (SD=8.96) for F2, M=46.33 (SD=8.87) for F3, M=35.09 (SD=6.36) for F4, and M=22.07 (SD=4.58) for F5.

Validity and Reliability of the Word Problem Test

The test of problematic word problems for eighth-grade students consisted of 12 multiple-choice items. Table 2 shows the Pearson correlations and Cronbach's alpha values. The coefficient of significant correlation for the sample size 234 must be larger than 0.129 (t=0.129 for sample 234). The data in Table 2 showed all of the items had moderate correlation, except the P-item 11 and 12 had low correlation. However, the r value for both of them was still larger than 0.129 for sample size 234.

Overall, Cronbach's alpha was 0.728, indicating moderate internal consistency among the twelve items of word problems. The data also revealed that all p-items have good reliability (α=0.700-0.726). According to Cohen et al. (2007), the alpha coefficient 0.67 or above is acceptable.

Students' Approaches to a Problematics Word Problem

The data in Table 3 suggest that for twelve items of problematics word problem in mathematics result, answer *option a* was the most frequently chosen, and *option b* was mostly chosen for P-item 7 "buying angle fish," P-item 8 "buying a hamster," and P-item 11 "Gojek." *Option c* was chosen the least for all items. *Option a* of item 5, "survey sport," got the highest frequency, 157 or 67.1%, while the lowest option a was 88 or 37.6% for P-item 8," buying a hamster." However, the comparison of all frequencies was an option a=54%, option b, and c=46%.

Table 2. Validity and reliability of problematic word problems

Problematics word problems	Pearson correlation (r)	Cronbach's alpha
P-item 1 (Temperature)	0.516	0.708
P-item 2 (Buyers)	0.512	0.709
P-item 3 (Save money)	0.482	0.713
P-item 4 (Hobbies and training)	0.466	0.714
P-item 5 (Votes activity)	0.492	0.710
P-item 6 (Survey sport)	0.560	0.700
P-item 7 (Buying angle fish)	0.444	0.719
P-item 8 (Buying hamster)	0.558	0.701
P-item 9 (Buying bracelet)	0.555	0.702
P-item 10 (Painting and brushes)	0.536	0.705
P-item 11 (Gojek)	0.346	0.712
P-item 12 (Vacation)	0.392	0.726

Table 3. The frequency of students answers every for each of twelve P-item

Problematics word problem	Type of answer		
	a	b	c
P-item 1 (Temperature)	126 (53.8%)	100 (42.7%)	8 (3.4%)
P-item 2 (Buyers)	129 (55.1%)	88 (37.6%)	17 (7.3%)
P-item 3 (Save money)	124 (53%)	97 (41.5%)	13 (5.6%)
P-item 4 (Hobbies and training)	156 (66.7%)	59 (25.2%)	19 (8.1%)
P-item 5 (Votes activity)	157 (67.1%)	64 (27.4%)	13 (5.6%)
P-item 6 (Survey sport)	152 (65%)	72 (30.8%)	10 (4.2%)
P-item 7 (Buying angelfish)	97 (41.5%)	126 (53.8%)	11 (4.7%)
P-item 8 (Buying hamster)	88 (37.6%)	131 (56%)	15 (6.4%)
P-item 9 (Buying bracelet)	131 (56%)	93 (39.7%)	10 (4.3%)
P-item 10 (Painting and brushes)	113 (48.3%)	105 (44.9%)	16 (6.8%)
P-item 11 (Gojek)	107 (45.7%)	114 (48.7%)	13 (5.6%)
P-item 12 (Vacation)	110 (47.2%)	91 (39.1%)	32 (13.7%)

Note. a: Non-realistic answer; b: Realistic estimation answer; c: Real answer

Students' Beliefs Predicting Mathematical Performance

We conducted multiple regression analyses to determine the beliefs about mathematics and ICT in mathematical problem-solving. Beliefs about mathematics and beliefs about ICT and mathematics problem-solving in problematic word problems competed for entry. The result, r was 0.519, indicated the moderate relation between beliefs about mathematics and problem-solving problematics word problem. While the R^2 was 0.27, implying that 27% of each factor's beliefs about mathematics and ICT contributed to predicting students' ability in mathematics. The data in Table 4, model multiple regressions, also show that the p-value was 0.001 ($F=10.342$, $p<0.05$), indicating a significant correlation between each factor's beliefs about mathematics and ICT on students' approach to the problematic word problem in mathematics. As expected, the beliefs about the self as mathematics learner predicts students' performance ($\beta=0.472$), $F=10.342$, $t=5.685$, $p<0.005$. Beliefs about mathematics as a domain excellent predicted students' performance as well ($\beta=0.181$), $t=2.257$, $p<0.05$.

DISCUSSION AND CONCLUSION

This study provides empirical evidence on the adaptation of the MRBQ in the Indonesian context. Furthermore, items on beliefs about the role of ICT were added to the original questionnaire since students are known for using technology in their daily life activities. Five factors have been identified using exploratory factor analysis (EFA), maximum likelihood parameter estimate, and factor load absolute values above 0.4. Having removed nine items, we then used confirmatory factor analysis (CFA) with maximum likelihood parameter estimate, using factor loading 0.4 on the entire data and following modification indices also residual co-variances to reach the fit model. We found a fit model with all indexing coefficients was above 0.9 and RMSEA=0.052. Interestingly the sequence of the structure of MRBQ was changed because beliefs about the role of ICT in mathematics as a new factor lie in the second sequence factor.

Interestingly, beliefs about the role of ICT in mathematics learning fit as a new factor of MRBQ structure with high reliability ($\alpha=0.887$). Also, the other factors had high-reliability estimates: beliefs about the role and functions of teachers ($\alpha=0.942$); beliefs about

Table 4. Results of regression analysis

Variable	Unstandardized	Standardized	t	p-value
Constanta	4.197			
Belief about teacher	-0.009	-0.027	-0.321	0.749
Belief in the usefulness of ICT	-0.014	-0.052	-0.623	0.534
Beliefs about the significance of and competence in mathematics	0.214	0.472	5.685	0.001
Beliefs about mathematics as a social activity	-0.130	-0.267	-3.204	0.002
Beliefs about mathematics as a domain excellent	0.142	0.181	2.257	0.026
F	10.342			0.001

mathematics as a social activity (α=0.932); and beliefs mathematics is a domain excellent (α=0.903).

With respect to the inter-correlation between factors, all the factors of the mathematics-related beliefs system in Indonesia have a strong correlation with each other. The highest correlation observed, 0.68 between factors 1 and 3, indicated students who believe the role and functioning of their own teacher favorable to beliefs about the significance of and competence in mathematics (r=0.68). This finding is in line with the research by Diego-Mantecón et al. (2007a) in England and Spain that found a significant correlation between beliefs about the role of teachers and beliefs competence in mathematics (r=0.516). The significant correlation of 0.65 between factors 3 and 4 suggests that students who have more positive beliefs significant of and competence in mathematics tend to believe about mathematics as a social activity. The finding of inter-correlation between factors in the present study differed from previous research by De Corte (2015) in Ecuador that found the four factors represent relatively independent dimensions of students' mathematics-related beliefs.

A descriptive statistical table regarding students' approaches to problematic word problems indicated students' inclination towards excluding real-world experiences and knowledge and insisting on a superficial arithmetic solution. Our findings are consistent with those of previous studies in several countries. For example, similar to the study by Csíkos et al. (2011) in Hungary, Indonesian students mainly chose the nonrealistic (option a) answer when solving word problems in school. However, in certain tasks, option b was chosen the most frequently. The tasks "buying angle fish" and "buying a bracelet" could activate students' real-world experiences. Option c was the lowest frequently chosen, indicating the option referring to the lack of data was not popular among them.

We further employed multiple regression analysis to assess the correlation between each factor of MRBQ and students' approaches to word problems. We found the four elements of beliefs about mathematics and ICT contribute to the students' performance in mathematics. This finding agrees with previous studies, which states that the MRB system predicts students' performance in mathematics. For example, Pajares and Graham (1999) reported a modest contribution of self-efficacy on students' performance with coefficient regression performance (β=0.267), $p<0.05$. Schommer-Aikins et al. (2005) found beliefs quick learning contributes 2% (R^2=0.02) to the students' problem-solving performance. Ozkal (2019) reported student self-efficacy beliefs with other aspects together to contribute 26% to students' mathematics performance (β=0.31), $p < 0.05$. At the same time, Habók et al. (2020) did not find a direct impact of self-efficacy on students' performance.

Nonetheless, the present study indicated that only two factors; beliefs about the significance of and competence in mathematics (β=0.472, p=0.008) and beliefs about mathematics as domain excellent (β=0.181, p=0.026,) could predict students' performance in solving mathematical word problems. In contrast, other factors herein did not contribute to predicting students' ability in mathematics. We did not find the relation between teachers' functioning and beliefs about ICT with students' mathematical performance. In contrast, beliefs about mathematics as a social activity negatively correlate to students' performance in the present study. In other words, students' beliefs about mathematics as a social activity encourage them to use routine operations when doing problematics word problems in mathematics, probably because they never try different comprehensive strategies.

Concerning beliefs about the role of info-communication technology, no significant contribution to mathematical performance was found. However, previous research mentions that the use of ICT in mathematics classrooms increases students' performance. For example, a meta-analysis study by Talan (2020) discovers that mobile learning positively affects students' learning performance. Kiger et al. (2012) also reported the use of mobile device increase student performance to compare students who did not use mobile device. Therefore, students' beliefs about the role of ICT can and should support their mathematics learning.

In general, adopting MRBQ with items on beliefs about ICT and using problematic word problems as an indicator of mathematical performance yielded some novel findings in the Indonesian context that may be generalizable for further research. Thus besides revealing connections between the mathematics-related quantitative variables, our results contribute to the possible explanation of the current situation of mathematics education in Indonesia. Overemphasis on routine algorithms may be a hindrance to being tackled for improving achievement. However, this research is limited to the 234 grade 8 Indonesian students in their first semester. Besides, we only analyzed the relationship between students' beliefs about mathematics and their ability in problematic word problems. Some further and more general factors that may also determine students' performance, such as metacognition, self-regulation, family background, geographical regions, and locations, are to be investigated to get an even more complete picture. Future studies can also consider students in other grades and use other school subjects.

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APPENDIX A

Problematics Word Problem in Mathematics

1. *"Temperature:" The temperature in Indonesia is 30 °C at 08.00 WIB in February 2021. Then, at 11.00, the temperature decreases to 28 °C, and at 14.00, it drops further to 26 °C. What is the temperature at 17:00?*
2. *"Buyers:" An online store gives a 25% discount to the first 400 buyers in the new year. There are 100 buyers at 7:00 am. The number of buyers increased to 150 at 7:10 am. Then, the number of buyers increased to 200 people at 07:20 am. What time will the buyers reach 400 people?*
3. *"Save Money:" Caksono saves his money at the school cooperation every month. In the first month, he saves Rp. 500,000, in the second month, he saves Rp. 500,000 so that his money reaches Rp. 1,000,000, and in the third month, his money becomes Rp. 1,500,000. What month does Caksono's savings become Rp. 3,000,000?*
4. *"Hobbies and Training:" A football team has 20 key players and substitutes. The players have various hobbies beyond mandatory training. Six people like to swim, and eight like to run in the morning. How many people do not like both exercises?*
5. *"Votes Activity:" The school of innovation votes for students reading activities. The school has 1,200 students. The voting shows that 600 students like reading textbooks and 400 like reading using an e-book. Then, how many students do not like both?*
6. *"Survey Sport:" The government surveys 450,000 students' sports activities in Surabaya city. The survey shows that 150,000 students like badminton and 200,000 like football. Then, how many students do not like both?*
7. *"Buying Angelfish:" Hadi buys an Angelfish in October 2020 for Rp. 10. In November, the price of the Angelfish in the market rose to Rp. 4. What is the Angelfish price after four months?*
8. *"Buying Hamster:" Jarwo buys a Hamster in November 2020 for Rp. 1,500. In 2020 he wanted to sell his Hamster. He sees the price of Hamster in the market go up Rp. 500 in December. He postpones selling the Hamster. He decides to sell the Hamster after four months. What is the price of the Hamster after four months?*
9. *"Buying Bracelet:" A mother buys a 1 kg bracelet for 500,000 rupiahs. Usually, the price goes up to 100,000 rupiahs every year. How much is the price after five years?*
10. *"Painting and Brushes:" Mr. Budi buys three paintings and brushes in a shop for Rp. 15 at different times. Mr. Samsul buys two paintings and one brush for Rp. 12. How much does a painting cost?*
11. *"Gojek:" Mr. Jono takes a break in a stall after half a day looking for *Gojek customers. Later in the stall, he asks for a glass of milk and two fried foods. He paid Rp. 5,000. Mr. Sentot also stops at the stall to buy a glass of milk and one fried food at different times; he spent Rp. 4,000. What is the price for one fried food?*
12. *"Vacation:" Mr. Samad's family is going on a vacation in Bali. Mr. Samad buys a ticket for two children and two adults for Rp. 4,000,000. At a different time, Mr. Guntur's family buys the ticket for two children and one adult for Rp. 3,000,000. How much does one ticket for an adult cost?*

APPENDIX B

Loadings Factor Mathematics-Related Beliefs System Questionnaire Supported ICT

Code	Items beliefs	Factor				
		1	2	3	4	5
Beliefs about the role and functioning of their own teacher (α=0.942)						
52	My teacher is very friendly when teaching mathematics in the class	0.722				
48	My teacher listens carefully when I ask or say something	0.776				
47	My teacher understands my problems and difficulties	0.748				
57	My teacher does not care how I feel in class. They are soared with the content of this mathematics course	0.613				
43	My teacher cares about students when I have difficulties	0.728				
55	My teacher wants me to understand the content of a mathematics course, not just memorize it	0.817				
53	My teacher tries to make mathematics lessons interesting	0.810				
50	My teacher gives me time to really explore new problems and to try out possible strategies	0.728				
42	My teacher thinks mistakes are okay as long as we are learning	0.751				
54	My teacher thinks I know everything about mathematics	0.735				
45	My teacher provided me with a thorough step-by-step explanation before handing me an assignment	0.811				
56	My teacher do not allow me to ask fellow students for helping me during class work	0.737				
Beliefs about the functioning ICT in mathematics (α=0.887)						
6	I think digital technology can help me to learn mathematics		0.786			
7	I think my understanding of math is better when I am using digital technology;		0.857			
8	I believe digital technology enables people to understand mathematics better;		0.839			
3	I can operate digital technology easily to support my mathematics learning everywhere		0.855			
2	I can use technology easily in mathematics learning		0.778			
9	I think digital technology is essential for me		0.752			
1	Solving a mathematics problem is demanding and requires skill to operate digital technology		0.829			
11	Digital technology is the solution for me when I have math problems and difficulties in learning mathematics		0.732			
12	There is only one way to solve my math difficulties, and I have to use digital technology		0.809			
4	I think I can get good grades on assignments and tests of mathematics with the support of digital technology		0.809			
Beliefs about the significance of and competence in mathematics (α=0.932)						
34	I can understand even the most difficult material presented in a mathematics course			0.801		
27	I like to learn mathematics every time			0.801		
40	I am very interested in mathematics learning			0.827		
41	Taking into account level of difficulty of our mathematics course, teacher, and my knowledge and skills, I am confident that I will get a good grade for mathematics.			0.769		
31	I can understand course materials in mathematics			0.829		
37	If I try really hard, I will understand the course material well in mathematics classes			0.752		
32	To me, mathematician important subject			0.780		
33	I prefer mathematics tasks for which I have to exert myself to find the solution			0.611		
6	Mathematics learning is mainly memorizing			0.644		
7	I think it is a waste of time when teachers ask me to tackle mathematics problems on my own			0.701		
Mathematics as a social activity (α=0.932)						
23	I think I will be able to use what I learn in mathematics in other courses				0.797	
11	Mathematics enables men to understand better the world he lives in				0.745	
13	Solving mathematics problems is demanding and requires thinking, even for smart students				0.785	
18	Mathematics is used by many people in their daily life				0.782	
16	Mathematical knowledge continues to expand, & new things are found all the time				0.822	
10	There are several ways to find the correct solution to a mathematics problem				0.820	

Loadings Factor Mathematics-Related Beliefs System Questionnaire Supported ICT (Continued)

Code	Items beliefs	Factor				
		1	2	3	4	5
8	Anyone can learn mathematics				0.768	
38	When I have the opportunity, I choose mathematical assignments that I can learn from even if I am not at all sure of getting a good grade				0.785	
9	Making mistake is a part of learning mathematics				0.690	
Mathematics as a domain excellent (α=0.903)						
25	By doing the best I can in mathematics, I want to show the teacher that I am better than most other students					0.724
30	I want to do well in mathematics to show the teacher and my fellow students how good I am at it					0.751
35	My major concern when learning mathematics is to get a good grade					0.813
17	There is only one way to find the correct solution to a mathematics problem					0.780
19	Those who are god in mathematics can solve any problem in a few minutes					0.772
20	I am only satisfied when I get a good grade in mathematics					0.790

Mathematics Related Belief System and Word Problem-Solving in the Indonesian Context

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