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The Effect of Mathematical Problem-Solving Ability and Mathematics Self-Concept on Learning Achievement

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ABSTRACT

Several studies generalized that mathematical problem-solving ability, mathematics self-concept, and learning achievement were interconnected. This research investigated the direct effect of mathematical problem-solving ability on learning achievement, the direct effect of mathematics self-concept on learning achievement and mathematical problem-solving ability, as well as the indirect effect of mathematics self-concept on learning achievement through mathematical problem-solving ability. A total of 449 eighth-grade students from 12 public high schools in Yogyakarta were selected using proportional stratified random sampling. Mathematical problem-solving data was collected through a test, whereas mathematics self-concept data was collected through questionnaires. In addition, learning achievement data was collected from mathematics scores on mid-semester examinations. Descriptive statistics and structural equation modeling were used to analyze the data. This research concludes that (1) mathematical problem-solving ability, mathematics self-concept, and learning achievement are categorized as moderate, (2) mathematics self-concept has a significant direct effect on learning achievement but has no significant direct effect on mathematical problem-solving ability, (3) mathematical problem-solving ability has a significant direct effect on learning achievement, and (4) there is no significant indirect effect of mathematics self-concept on learning achievement through mathematical problem-solving abilities.

Beberapa penelitian menunjukkan kemampuan pemecahan masalah matematis, konsep diri matematika, dan prestasi belajar saling berhubungan. Penelitian ini bertujuan untuk menganalisis pengaruh langsung kemampuan pemecahan masalah terhadap prestasi belajar, pengaruh langsung konsep diri terhadap prestasi belajar dan kemampuan pemecahan masalah, serta pengaruh tidak langsung konsep diri matematika terhadap prestasi belajar melalui kemampuan pemecahan masalah. Sebanyak 449 siswa kelas VIII dari 12 SMP Negeri di Yogyakarta yang mengikuti penelitian ini dipilih dengan menggunakan *Proportional Stratified Random Sampling*. Data pemecahan masalah matematika dikumpulkan melalui tes, sedangkan data konsep diri matematika dikumpulkan melalui kuesioner. Selain itu, data prestasi belajar dikumpulkan dari nilai matematika pada ujian tengah semester. Statistik deskriptif dan *structural equation modeling* digunakan untuk menganalisis data penelitian. Hasil penelitian menyimpulkan bahwa (1) kemampuan pemecahan masalah, konsep diri, dan prestasi belajar peserta didik tergolong sedang, (2) konsep diri mempunyai pengaruh langsung yang signifikan terhadap prestasi belajar tetapi tidak mempunyai pengaruh langsung yang signifikan terhadap kemampuan pemecahan masalah, (3) kemampuan pemecahan masalah mempunyai pengaruh langsung yang signifikan terhadap prestasi belajar, (4) tidak terdapat pengaruh tidak langsung yang signifikan dari konsep diri terhadap prestasi belajar melalui kemampuan pemecahan masalah.

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INTRODUCTION

Mathematics is one of the mandatory subjects learned at elementary and secondary schools in Indonesia, as stated in Depdiknas (2003) concerning National Education System. Mathematics is crucial in preparing students' competency to solve mathematics and numeracy problems through its content and process standards (Mendikbudristek, 2022a). Content standards include number and operations, algebra, geometry, measurement, data analysis, and probability, whereas process standards include problem-solving, reasoning, connection, mathematical communication, and representation (NCTM, 2000). Problem-solving ability that combines reasoning ability, connection ability, representation ability, as well as mathematical communication ability is fundamental to finding the problems' solution not only in a mathematical context but also in other sciences and daily life (Butterworth & Thwaites, 2013; Sinaga et al., 2023). Hence, students' ability in problem-solving is a critical aspect that should be emphasized in mathematics education.

Problem-solving is the process of finding the meaning of a problem to be clearly understood by understanding the problem, planning the solution, implementing the solution plan, and rechecking (Polya, 1973). In problem-solving processes, individuals use prior knowledge, skills, and understanding to solve the problems presented (Krulik & Rudnick, 1988). The problem-solving process includes identifying the information stated in a problem, combining known and unknown information, and connecting the information from the given problem with prior knowledge to solve the problem (Butterworth & Thwaites, 2013). Similarly, Passolunghi et al. (2019) suggested the problem-solving process in three stages consist of understanding the presented problem, distinguishing relevant and irrelevant information, and knowing the procedures applied to solve the problem.

According to the Programme for International Student Assessment (PISA) 2018 report by OECD (2019), an assessment of 15 years old students, Indonesia students obtained a low average mathematics score of 379 which was 52 points below the ASEAN student average (431) and 111 points below OECD average (490). This result is categorized into level 1C (above 358), where the students can only answer an obvious question that covers the usual context with the relevant information provided, carry out routine procedures based on direct instructions in vivid situations, and carry out actions that are usually very clear. Most items on the PISA tasks are problem-solving on the reasoning level (Wulandari & Jailani, 2015). It indicates that students in Indonesia faced difficulties when solving non-routine mathematics problems. Likewise, the research by Utami and Wutsqa (2017) and Annisa et al. (2021) showed that the mathematical problem-solving ability of eighth-grade high school is in the low category.

The students' problem-solving low achievement might have been caused by the unfamiliarity of the students to solve PISA-like tasks in their learning activity (Ahyan et al., 2014). The problem-solving task often uses long sentences that students do not common (Alhassora et al., 2017). The Indonesia Ministry of Education, Culture, Research, and Technology has encouraged innovation strategies and projects based on contextual problems in mathematics learning to enhance students' problem-solving ability in real life (Mendikbudristek, 2022b). This is in line with the national assessment framework Minimum Assessment Competency (AKM) that the student should be able to solve contextual problems related to mathematics content (Mendikbudristek, 2021).

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Mathematical problem-solving ability directly impacts learning achievement (Kamalimoghaddam et al., 2016; Ndiung et al., 2021). Siswono (2018) explained four aspects that influence the individual ability to solve problems, which are prior experience, mathematical background, motivation and interest, as well as the problems' structure. Students might already know their mathematics ability background, their experience in the learning content and context, as well as their motivation and interest in learning mathematics but did not understand how to express it to the teacher to get a better experience in the learning activity (Harackiewicz et al., 2000). The problem-solving ability, which is part of the cognitive aspect of students, is closely connected to self-concept (Batchelor et al., 2019; Schindler & Bakker, 2020). Tan (2019) conveyed that high achievement in problem-solving ability implied a high mathematics self-concept.

Self-concept is an assessment based on individual evaluation and respect for their abilities (Pajares & Miller, 1994). Byrne (1984) explained that self-concept involves attitudes, feelings and knowledge about skills, abilities, and other social acceptance. Self-concept is a multidimensional construct encompassed self-perception formed through comprehensive experiences and relationships with others (Marsh et al., 2012). Mathematics self-concept might be a predictor that determines mathematics learning achievement (Martin & Debus, 1998). Jaiswal and Choudhuri (2017) found a positive correlation between self-concept and academic achievement. This finding is supported by Möller et al. (2020), who concluded a positive significance in the path coefficient between mathematics self-concept and learning achievement. On the contrary, the research by Cahyawati et al. (2023) found that mathematics self-concept has no impact on mathematics learning achievement.

It is important to measure students' mathematics self-concept, which describes the ability of students to reflect on their mathematics ability (Seaton et al., 2014). Reflecting on their mathematical ability can help students understand their position in mathematics learning and prepare themselves better to obtain the best learning outcomes. Mathematics self-concept can be assessed through students' self-assessment questionnaires and interviews but might be inaccurate since the students could overestimate or underestimate their mathematics ability (Dunning et al., 2004). A low-ability student can judge himself to have good ability, while a high-ability student can judge himself to have low ability. To make the measurements accurate, analysis of mathematical ability is not only carried out based on mathematics self-concept but also problem-solving ability and learning outcomes.

Yogyakarta Special District (DIY) province, famously known as the city of students, attained the highest PISA score in Indonesia with 430, categorized into level 2 (above 420). At this level, students can interpret and recognize situations in a context that only requires direct inference, carry out basic algorithms, formulas, procedures or conventions to solve problems that use whole numbers, and be able to make a literal interpretation of the results obtained (OECD, 2019). The Government of DIY, through the Department of Education, Youth, and Sports, has implemented the Regional Education Standard Assessment (*Asesmen Standarisasi Pendidikan Daerah* or ASPD) as one of the instruments used to assess academic abilities at the final stage of the educational level. Yogyakarta city, one of five regions in DIY province, has achieved the highest score of ASPD. However, the students' mathematics self-concept and mathematical problem-solving were not measured in ASPD.

Considering the previous research, it is necessary to measure mathematics self-concept along with mathematical problem-solving ability and learning achievement. The researcher aims to investigate mathematical problem-solving ability, mathematics self-concept, learning achievement, and the effects of mathematics self-concept on learning achievements mediated by mathematical problem-solving ability for eighth-grade junior high school students in Yogyakarta. Therefore, this research will analyze the direct effects of mathematical problem-solving ability on learning achievement, the direct effects of the self-concept on learning achievement, and the direct effect of students' self-concept on mathematical problem-solving ability. Furthermore, this research also analyzes the indirect effects of students' self-concept on learning achievements mediated by mathematical problem-solving ability.

METHOD

Survey research was used in this study to explain how each variable consisting of mathematics self-concept, mathematical problem-solving ability, and learning achievement influences each other (Creswell, 2012). This research was conducted on eighth-grade class of 2022/2023 academic year students from 16 public junior high schools in Yogyakarta, Indonesia. The proportionated stratified

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random sampling was used to get research participants from 3.442 students. The first step of the sampling was to determine the number of participants according to the Slovin formula that attained a minimum 359 participants or about 12 classes that consist of 30 students. The second step was to categorize schools following Ebel and Frisbie (1991) criteria based on the 2021 ASPD resulted in three high-level schools, seven moderate-level schools, and six low-level schools. The third step was proportionated randomly selected 12 of 16 schools attained 2 of 3 high-level schools, 5 of 7 moderate-level schools, and 5 of 6 low-level schools. The last step was randomly selecting two classes from each selected school because the number of students in each class was less than 30. A total of 449 students participated in this research because several participants did not attend on the examination day.

To answer this research objective, the data on mathematics self-concept were collected through mathematics self-concept questionnaires on the indicator view on self-mathematics ability (KD1), interest in mathematics learning (KD2), the goal in learning mathematics (KD3), view on the relationship between self-mathematics ability and the ideal mathematics ability (KD4), and view on teacher or colleague perspective to self-mathematics ability (KD5). The questionnaire consists of 20 items with 5 Likert scale answers from 1 (Always) to 5 (Never). Meanwhile, the data on mathematical problem-solving ability were collected through essay tests consisting of 4 items on the content of numbers, geometry, and algebra. The indicator of mathematics content are solving problems related to pattern number, solving problems related to the position of a point in the Cartesian coordinate, solving problems related to linear function, and solving problems related to system of linear equation with 2 variables. The mathematical problem-solving test was developed based on the problem-solving indicator Polya (1973), understanding the problem (TK1), planning the solution (TK2), implementing the solution plan (TK3), and rechecking (TK4). The students' learning achievement used in this research is the mid-semester examination results for the second semester. The mathematics self-concept questionnaires (ω = .89) and mathematical problem-solving test (ω = .75) developed by the authors are reliable (ω > .65) according to (Kalkbrenner, 2021).

The data analysis conducted in this research includes descriptive analysis and inferential analysis. The descriptive statistics function was used to analyze data by describing or providing an overview of the collected data by measuring central tendency and score dispersion (Cohen et al., 2018; Creswell, 2012). The maximum score for mathematical problem-solving, self-concept, and learning achievement is 100. The minimum score for mathematical problem-solving and learning achievement is 0, whereas the minimum score for mathematics self-concept is 20. In addition, the categorization of mathematical problem-solving ability, mathematics self-concept, learning achievement, and its indicators were categorized in Table 1, adapted from (Azwar, 2016).

Table 1. Categorization of students scores achievement

Category	Mathematical Problem-Solving Ability	Mathematics Self-Concept	Learning Achievement
Very high	$90 < X \leq 100$	$80 < X \leq 100$	$90 < X \leq 100$
High	$75 < X \leq 90$	$66.7 < X \leq 80$	$75 < X \leq 90$
Moderate	$55 < X \leq 75$	$53.33 < X \leq 66.7$	$55 < X \leq 75$
Low	$30 < X \leq 55$	$40 < X \leq 53.33$	$30 < X \leq 55$
Very low	$0 < X \leq 30$	$20 < X \leq 40$	$0 < X \leq 30$

The inferential analysis in this research used Structural Equation Modeling (SEM) to analyze the relationship between latent variables and the indicators through the measurement model and structural model (Hoyle, 2012). The first step of SEM was to conduct Confirmatory Factor Analysis (CFA) on the second order. The second-order CFA involved the first-order CFA to explain the latent variables in the second-order CFA. Second-order CFA latent variables in this research are mathematical problem-solving ability and mathematics self-concept measured by its indicators. The indicators of mathematical problem-solving abilities and mathematics self-concept are the first-order CFA measured by the items of indicators.

The second step of SEM was conducted degree of fit or goodness of fit (GOF) analysis from the SEM model using *Root Mean Square Error of Approximation* (RMSEA), *Goodness of Fit Index* (GFI), and *Comparative Fit Index* (CFI) (Hair et al., 2010; Hoyle, 2012). The parameters interpretation of the fitted model is performed on the path coefficients by examining direct effects and indirect effects. The direct effects tested included the direct effect of mathematical problem-solving abilities on learning

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achievement, the direct effect of mathematical self-concept on learning achievement, and the direct effect of self-concept on mathematical problem-solving abilities. Meanwhile, the indirect effect from the variable mathematical self-concept to learning achievement through the mediating variable of mathematical problem-solving abilities was conducted using the steps formulated by Sobel (Abu-Bader & Jones, 2021). The model are fit when the GOF of RMSEA ≤ 0.8, GFI ≥ 0.9, and CFI ≥ 0.9. Data analysis in this research was used the *R Studio* program that employed the *Lavaan* package to perform multivariate model analysis, the *semPlot* package to draw SEM visualization, and the *psych* package to calculate reliability estimation (Epskamp, 2022; R Core Team, 2021; Revelle, 2023; Rosseel, 2012).

RESULTS AND DISCUSSION

The description of students' mathematical problem-solving abilities, mathematics self-concept, and learning achievement data aims to explain the scores achieved by eighth-grade junior high school students in Yogyakarta.

Table 2. Descriptive analysis

Description	Mathematical Problem-Solving Ability	Mathematics Self-Concept	Learning Achievement
Mean	62.54	61.65	65.33
Category	Moderate	Moderate	Moderate
Maximum Score Obtained	92.5	90	100
Minimum Score Obtained	7.5	25	10
Standard Deviation	19.22	10.62	19.56

The mathematical problem-solving ability, mathematics self-concept, and learning achievement of eighth-grade students in public junior high schools in Yogyakarta City are in the moderate category (Table 2) as the difference in mean is less than 4 points. The average score of students' mathematical problem-solving ability and learning achievement are higher than the national minimum achievement criteria (60). Meanwhile, the mathematics self-concept has the lowest standard deviation. This means students' mathematics self-concept is more evenly distributed (SD = 10.62) than students' mathematical problem-solving ability (SD = 19.22) and students' learning achievement (SD = 19.56). This result aligns with the findings of Jatmiko (2015), stating that the majority of the surveyed students (58%) fall into the moderate self-concept category. Moreover, this study revealed the improvement in junior high school students' mathematical problem-solving ability from the previous research (Annisa et al., 2021; Utami & Wutsqa, 2017). The distribution of students' achievement is presented in Table 3.

Table 3. Distribution of students' achievement categories

Category	Mathematical Problem-Solving Ability		Mathematics Self-Concept		Learning Achievement	
	F	%	F	%	F	%
Very High	3	0.67	22	4.90	25	5,57
High	126	28.06	116	25.84	151	33.63
Moderate	166	36.97	216	48.11	130	28.95
Low	110	24.50	85	18.93	116	25.84
Very Low	44	9.80	10	2.24	27	6.01

Most students achieved moderate categories on the mathematical problem-solving ability (36.97%) and mathematics self-concept (48.11%). The differences occurred in the learning achievement where most students achieved high category (33.63%). Less than 10% of the students achieved very high and very low categories on mathematical problem-solving ability, mathematics self-concept, and learning achievements. Thus, it can be interpreted that the data is centered on the high, medium, and low categories. Furthermore, the breakdown of mathematical problem-solving ability and mathematics self-concept score on each indicator is presented in Table 4.

Table 4. Mathematical problem-solving ability and mathematics self-concept on each indicator

Variable	Indicator	Mean
	Understanding the problem (TK1)	22.14
	Planning the solution (TK2)	20.45

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Mathematical problem-solving ability	Implementing the solution plan (TK3)	19.66
	Rechecking (TK4)	0.29
Mathematics self-concept	Students' view on their mathematics ability (KD1)	11.37
	Students' interest in mathematics learning (KD2)	11.32
	Students' goal in learning mathematics (KD3)	13.30
	Students' view on the relationship between their mathematics ability and the ideal mathematics ability (KD4)	12.22
	Students' view on their teacher or colleague perspective to their mathematics ability (KD5)	13.53

There is a significant difference between indicator TK4 and the other indicators on mathematical problem-solving ability (Table 4). The students attained low scores on indicator TK4 because they did not write the rechecking process on their works. There are many possibility that caused students did not write the recheckin process such as over confident, limited test time, and simpy did not recheck their answer. Another possibility is the students might have rechecked their answers but did not know how to write in the answer sheet (Widodo et al., 2021). On the other hand, the student's scores on the indicators TK1, TK2, and TK3 were categorized into high categories as the students were enabled to solve all the problems. Students with high mathematical problem-solving ability have an advantage in facing complex mathematical situations, both academic and everyday life situations (Beswick, 2011). Mathematical problem-solving ability can accommodate students to understand, apply, and master concepts more deeply (Schukajlow et al., 2018).

There are two indicators of mathematics self-concept with high category, namely KD3 and KD5. Students who know their goals in learning might have higher achievement (Harackiewicz et al., 2000). The students with goals can self-motivate and increase their study hours to gain competence (Palapa, 2023). The students also felt that the teachers and their colleague respected their ability. The lowest score of the mathematics self-concept indicator is KD2 and KD1. According to the results, it shown some students lack interest in learning mathematics. The perception that mathematics is a complex subject is ingrained in students, impacting their lack of interest in learning mathematics (Ignacio et al., 2006; Usher, 2009).

Measurement of Model Fit Test for Mathematical Problem-Solving Ability

The model fit test for the mathematical problem-solving ability variable resulted in the model did not fit well (RMSEA = 0.277 and CFI = 0.495). The only analysis that was obtained in marginal fit was GFI = 0.841. In this model, each item in the indicators TK1, TK2, and TK3 has a significant contribution to the model as standard loading factor value > 0.3 (Figure 1). In contrast, 3 out of 4 items in the indicator TK4 have no significant contribution due to a weak loading factor (standardized loading factor < 0.3). Hence, to improve the model fit, modifications are needed in the constructed measurement model of mathematical problem-solving ability (Thakkar, 2020).

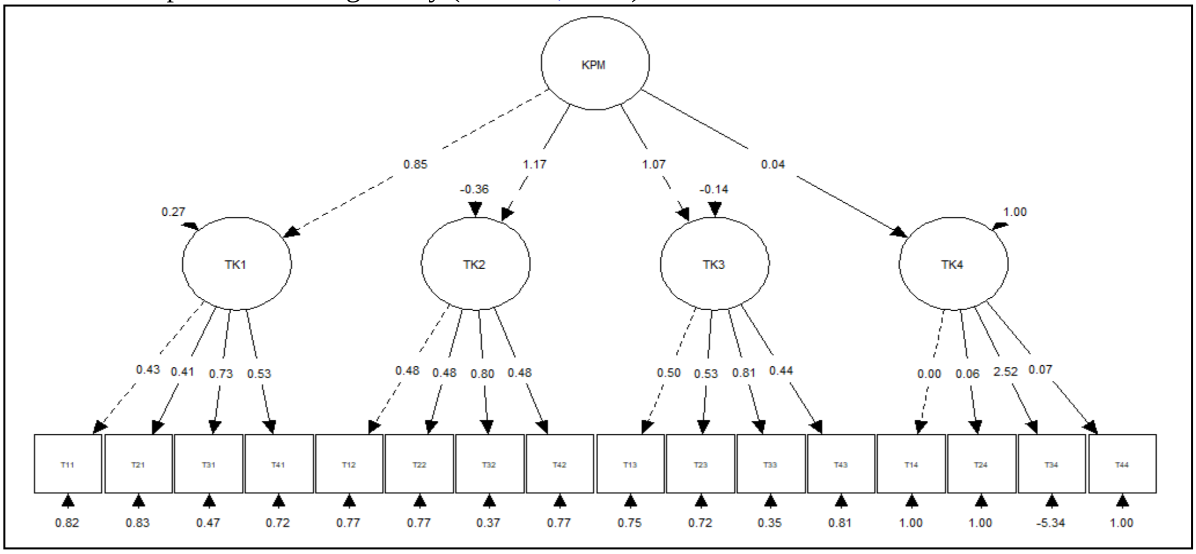

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Figure 1. Visualization of measurement model of problem-solving ability variable

The modification model was conducted by elimination of the indicator TK 4. The modification means that the indicator used to describe students' mathematical problem-solving ability is similar to Aljaberi (2015) who examined students' understanding of the problem, devising the plan, and performing the calculations. There are difficulties in measuring the rechecking indicators on mathematical problem-solving abilities using tests as students tend not to write (Widodo & Turmudi, 2017). The metacognition questionnaire application with dichotomous answers of yes or no to measure rechecking indicators might contain bias because students may answer yes but not recheck it (Purnomo & Bekti, 2017). The rechecking stage in problem-solving is crucial to avoid mistakes in planning or calculating the answer that should be taught appropriately in the learning process (Widodo et al., 2019).

The model fit test for the modification model for the problem-solving ability variable resulted in the model fitting the data well (RMSEA = 0.065, GFI = 0.963, and CFI = 0.980). Moreover, each item in the indicator of mathematical problem-solving ability has a strong loading factor (standardized loading factor > 0.3), range from 0.40 to 0.76 (see Figure 2). It means the assessed items represent the mathematical problem-solving ability.

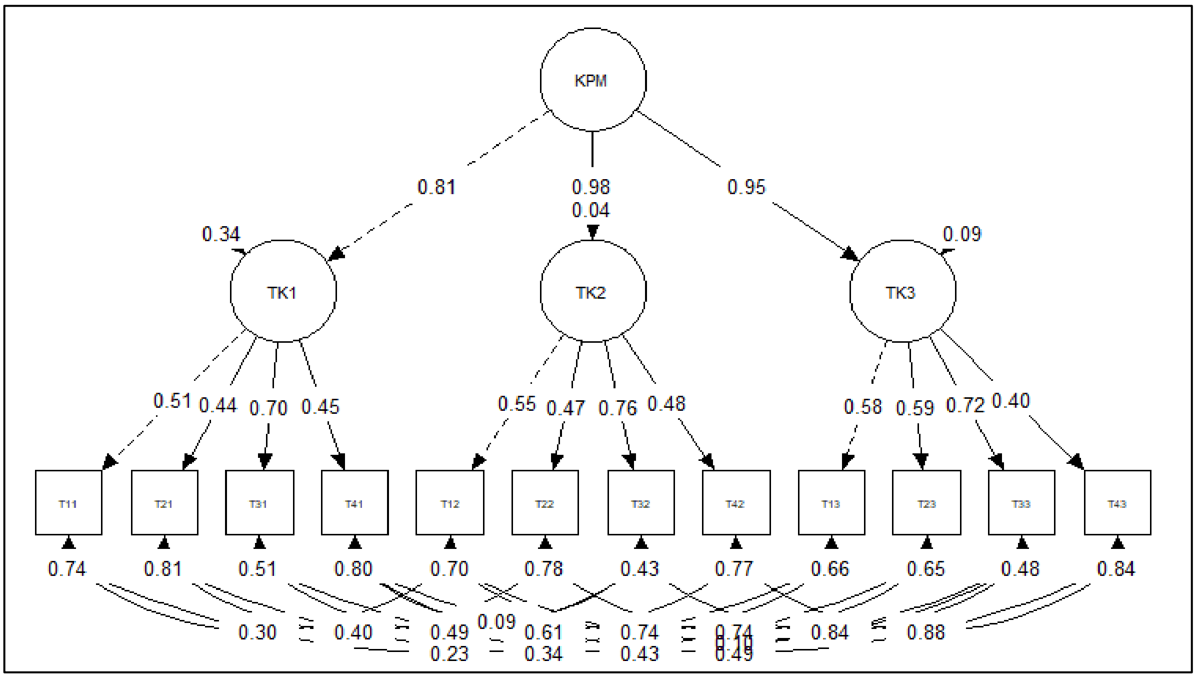

Figure 2. Visualization of modification model of problem-solving ability variable

Measurement of Model Fit Test for Mathematical Self-Concept

The students' mathematics self-concept measurement model fits the data well (RMSEA = 0.069, GFI = 0.985, and CFI = 0.851). Furthermore, 18 of 20 items have strong loading factor (standardized loading factor > 0.3), range from 0.33 to 0.79 (see Figure 3). It means the assessed items represented the mathematics self-concept. Meanwhile, two items with low loading factor (standardized loading factor < 0.3) are items K6 (standardized loading factor = 0.26) and K10 (standardized loading factor = 0.26). As a result, items K6 and K10 were eliminated from further analysis.

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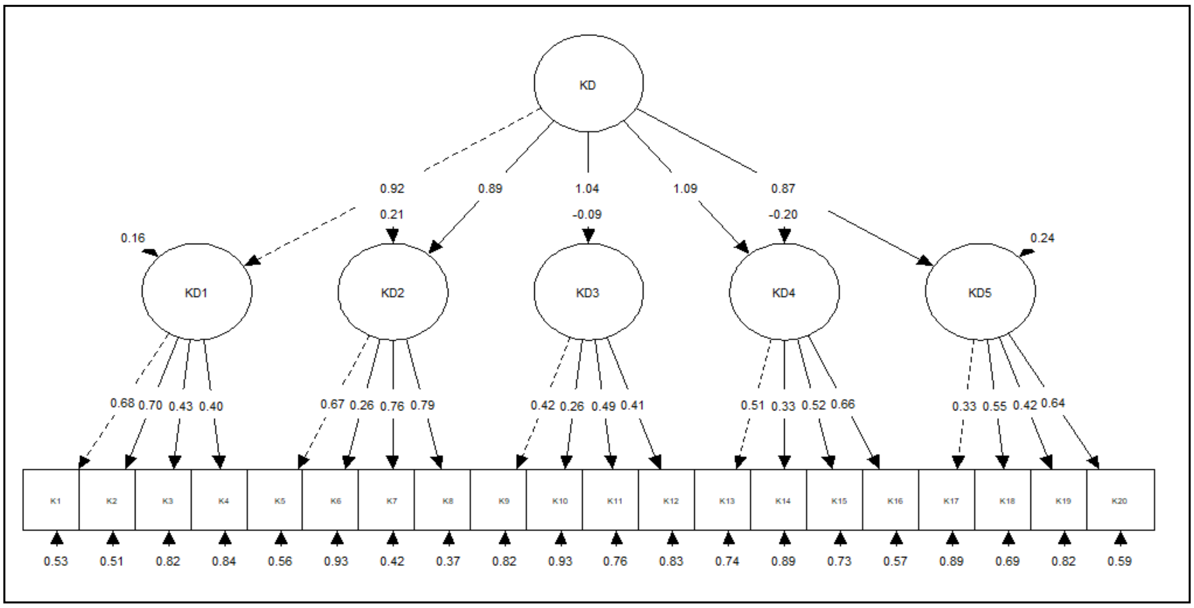

Figure 3. Visualization of measurement model of mathematical self-concept variable

Testing The Overall Fit of The Structural Equation Model

The structural model was constructed from the research variables, namely mathematical problem-solving ability, mathematics self-concept, and learning achievement, by excluding the low loading factor items on the variables. The constructed structural model of the variables in this research fits the data well (RMSEA = 0.051, GFI = 0.978, and CFI = 0.919). The visualization of the structural model is presented in Figure 4.

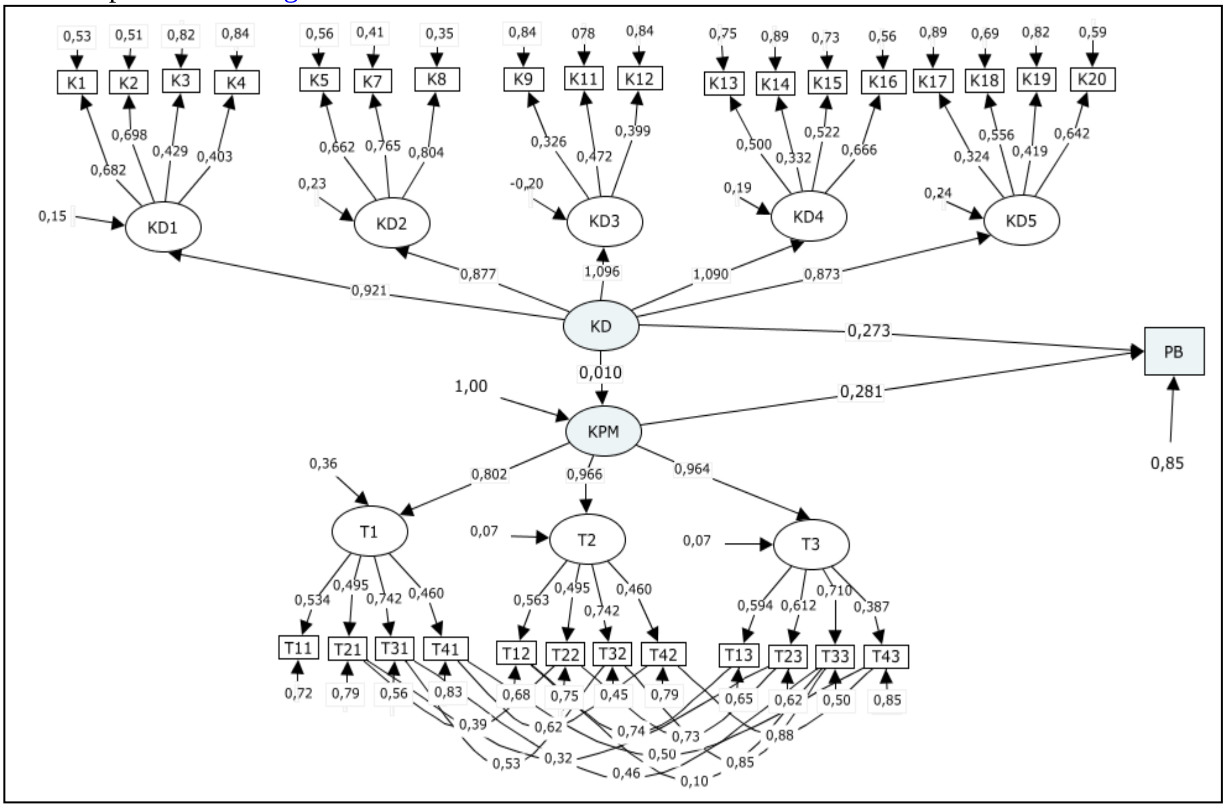

Figure 4. Visualization of measurement model of mathematical self-concept variable

According to the analysis and visualization in Figure 4, mathematical problem-solving ability (KPM) has a significant direct effect on learning achievement (PB) with standardized direct effect = 0.281 and $p < 0.05$. This finding indicates that mathematical problem-solving skills contribute positively

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to student learning achievement. Students' ability to solve mathematical problems can help them become better learners, understand mathematics better, and achieve higher learning outcomes (Schukajlow et al., 2018). Students with better mathematical problem-solving skills tend to achieve higher learning outcomes than those with weaker mathematical problem-solving abilities (Pratikno & Retnowati, 2018). This relationship suggests a positive correlation between mathematics problem-solving ability and learning achievement.

The analysis result also generates that mathematics self-concept has a significant direct effect on learning achievement (standardized direct effect = 0.273, $p < 0.05$). It means, the higher students' mathematics self-concept, the higher students' learning achievement. This finding aligns with the study by Koshkouei et al. (2016), which found a direct effect of mathematics self-concept to learning achievement. Additionally, several previous study also found a significant positive correlation between mathematical self-concept and mathematical learning achievement (Hanifah & Abadi, 2019; Jaiswal & Choudhuri, 2017; Kirmizi, 2015; Möller et al., 2020; Timmerman et al., 2017; VeisiKahre et al., 2015). Students with a positive mathematics self-concept tend to feel more confident in mathematics learning and tests, thereby impacting student learning achievement (Calhoun & Acocella, 1995). The expectation dimension of mathematical self-concept involves students' views on what they hope to achieve in mathematics, including expectations for academic achievement. Furthermore, the assessment dimension of mathematical self-concept encompasses how students evaluate themselves in mathematics, such as assessing performance in mathematical tasks. Students with a positive assessment of their mathematical abilities tend to have better learning achievements and are more confident in answering mathematical problems given (Bandura, 1997). Thus, psychological factors such as a positive self-concept has crucial role in students' learning achievement in mathematics.

However, the mathematics self-concept has no significant direct effect on mathematical problem-solving ability (standardized direct effect = 0.010, $p = 0.888$). This finding corresponds with Julius (2022) who found no significant relationship between mathematics self-concept and problem-solving ability. Nevertheless, this finding contradicts the study conducted by Cai et al. (2018) that showed that students' self-concept directly affects their mathematical problem-solving skills. The study by Tan (2019) also concluded that the higher students' mathematics self-concept, the higher their ability to solve mathematical problems. The lack of a significant direct effect of mathematical self-concept on problem-solving skills might be attributed to several factors that have to be considered such as students understanding of problem solving activity and their problem solving ability..

Following the direct effect analysis, the indirect effect analysis found that mathematics self-concept has no significant indirect effect on learning achievement through mathematical problem-solving ability (standardized indirect effect = 0.003, $p = 0.892$). This result is consistent with Yengimolki et al. (2015) that mathematics self-concept did not affect learning achievement indirectly. On the other hand, this result differs from research by Koshkouei et al. (2016) in the structural model analysis on mathematics self-concept and learning achievement that proved mathematical self-concept has both a direct and an indirect effect on learning achievement. Usher and Pajares (2009) emphasized that students with a high perception of their competence are more engaged in problem-solving and achieve better achievement because of the connection between students' perception of competence and achievement.

Problem-solving skills emphasize the thinking process and methods used in solving mathematical problems are more related to understanding mathematical concepts than mathematics self-concept (Julius, 2022). Mathematics self-concept can motivate students to learn mathematics but might not directly affect their ability to solve problems systematically without an intermediary (Cai et al., 2018). Students with a high mathematical self-concept have strong beliefs in their mathematics ability and motivation in learning (Fin & Ishak, 2014; Skaalvik & Skaalvik, 2006). The students might think that mathematics ability differs from mathematical problem-solving (Krawec, 2014). Students often think mathematics is about operating procedures and calculating to obtain the results (Liu & Niess, 2006). Meanwhile, good problem-solving skills require a deep understanding of the problems, an ability to formulate appropriate strategies and critical thinking.

Activities based on reality or real-like materials and situations in mathematics learning are recommended to improve students' mathematical problem-solving ability (Yavuz Mumcu, 2018). The ability of students to solve mathematical problems can impact students' learning achievement. Students' learning achievement, including knowledge and skills, is a crucial point for students, reflecting the efforts made by students during the learning process.

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CONCLUSION

Based on the results and discussion, it can be concluded that the mathematical problem-solving ability, mathematics sef-concept, and learning achievement are categorized as moderate. There was a modification to the model of mathematical problem-solving ability to fit the data well by eliminating the rechecking indicator (TK4). The direct effect analysis shows that mathematical problem-solving skills have a significant direct effect on learning achievement. The mathematics self-concept has a significant direct effect on learning achievement but has no significant direct effect on mathematical problem-solving ability. Furthermore, mathematics self-concept has no significant indirect effect on the learning achievement mediated by mathematical problem-solving ability. The students need to realize their mathematics ability, especially in mathematics problem-solving ability, to suggest what they need the most in the problem-solving activity in learning mathematics. Thus, it can be a reference in implementing effective mathematics learning.

Indicators of understanding the problem (TK1), planning the solution (TK2), and implementing the solution plan (TK3) are appropriate to measure mathematical problem-solving ability. Teachers can apply assessments on mathematics self-concept before learning to identify how students view their abilities, interests, goals, and motivation in learning mathematics. This research was far from optimal due to various obstacles, such as students' participation and views on their mathematics abilities that had not been included in the questionnaires. Therefore, future research opportunities are a deep analysis of students' self-concept of their problem-solving ability and how it can affect the learning outcome.

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