



Empirical Study of Factors Affecting the Students' Mathematics Learning Achievement

Wawan

Yogyakarta State University, Yogyakarta, Indonesia, wawan4.2017@student.uny.ac.id

Heri Retnawati

Prof., Yogyakarta State University, Yogyakarta, Indonesia, heri_retnawati@uny.ac.id

Student achievement in learning mathematics is considerably low in Indonesia. This study aims to discuss factors affecting learning achievements in mathematics in Indonesia, including direct and indirect influences, such as students' perception of teacher competence, learning anxiety, problem-solving ability, learning motivation, and mathematical connection ability. Quantitative approach and correlational method were used with a sample comprising 171 class XI students of Senior High School in Purworejo Regency, Central Java. The stratified cluster random sampling technique was used to determine the sample composition based on the National Examination scores for the 2018/2019 academic year. The results showed that four variables, except anxiety, significantly influence learning achievement. Furthermore, mathematical connection ability had the greatest direct impact on learning success at 0.38. Other indirect factors, such as influence through learning motivation and problem-solving ability, were at 0.140 and 0.133, respectively. These results are in line with previous studies which stated that mathematical connection ability is an important aspect in achieving student learning achievement. The ability to connect various materials studied with topics inside and outside mathematics has helped students understand the material to improve learning achievement. Furthermore, teachers can use these results as references in learning management by paying attention to various aspects, especially mathematical connection ability.

Keywords: mathematics learning achievement, anxiety, students' perception, teacher competence, mathematical connections, learning motivation, problem-solving

INTRODUCTION

Based on 2018 examination results, the PISA (Programme for International Student Assessment) (OECD, 2019) classified Indonesian learning achievement as low. On average, the students' scores are far from meeting the international standards since they did not pass 400 marks. The country average mathematics score is 379, ranking 72 out of 78 countries surveyed. The 2018 PISA results also highlighted that Indonesian

Citation: Wawan., & Retnawati, H. (2022). Empirical study of factors affecting the students' mathematics learning achievement. *International Journal of Instruction*, 15(2), 417-434. <https://doi.org/10.29333/iji.2022.15223a>

students have a challenge in formulating, using and interpreting mathematical concepts in different contexts.

Many students have difficulty in learning mathematics, both the basic material and its application. Based on the study carried out by Jupri et al. (2014), many students in Indonesia still have difficulty learning basic mathematics materials such as arithmetic skills, use of equal signs, understanding algebraic expressions, and variable concepts. In learning geometry, they tend to face difficulties expressing mathematical solutions and drawing (Sumaji et al., 2019). Also, in solving National Examination questions, students generally face problems in understanding concepts, solving calculations, and contextual problems in the form of narrative (Retnawati et al., 2017). Furthermore, in solving High Order Thinking (HOT) problems, students have difficulty understanding, transformation, process skills, and coding (Hadi et al., 2018). These facts certify the claim that Indonesian students rank low in mathematics learning achievements.

Therefore, it is interesting and important to determine the factors which affect students learning achievement. Teachers may use this as a consideration in implementing planned improvement programs. According to Ganal & Guiab (2014), poor mathematics achievement is due to problems and difficulties, which could be personal. Meanwhile, Tambychik & Meerah (2010) stated that internally, many students tend to be deficient in many mathematics skills such as number-facts, visual-spatial skills, and information. Based on these two results, it was further discovered that internal factors are one of the main causes of students' low achievement in learning mathematics.

Studies by Pipere & Mierina (2017), Toraman et al. (2020), and Brezavšek et al. (2020) suggested that several external and internal factors determine mathematics learning achievement. Personal problems with great potential to affect achievement in mathematics directly or indirectly include anxiety, mathematical connection ability, learning motivation, problem-solving ability, and students' perceptions of teachers competence. This analysis was based on the results from previous studies. Another study by Pantaleon et al. (2018) showed that learning anxiety can negatively affect student performance. Furthermore, it has been shown empirically that anxiety has a negative effect on mathematics learning achievement (Zakaria & Nordin, 2008; and Al Mutawah, 2015).

Apart from the learning anxiety factor, the effect of mathematical connection ability on mathematics learning achievement is also an important factor to be considered. National Council of Teachers of Mathematics (NCTM) (2000) stated that students' understanding tends to increase through connecting mathematical ideas. It has been shown empirically that this competency affects learning outcomes (see Ndiung & Nendi, 2018). Furthermore, according to Karakoç & Alacacı (2015), most students agreed that making real-world connections with mathematics helps in improving mathematical skills.

Learning motivation also has a significant effect on mathematics learning achievement. Several studies have shown that it has a positive and significant effect (Pantziara & Philippou, 2015; and Herges et al., 2017). Meanwhile, the problem-solving ability is an important competency that students need to have. It is one of the key processes in learning mathematics (Schunk, 2012). This indicates that it is an important factor in

student learning achievement. Furthermore, several studies have shown that problem-solving ability has a positive and significant effect on mathematics learning achievement (Bhat, 2011; Yurt & Sunbul, 2014; and Maheswari & Benjamin, 2015).

Students' perceptions of teachers also possibly affect their learning achievement. The teacher is a major component in creating quality education and developing students' potential and achievement in school. Students' performance on an assessment test is one of the important factors that can help understand the effectiveness of teacher performance (Ferguson, 2012). Empirically, it is known that students' perceptions of teacher competence affect their performance in mathematics (see Adediwura & Tayo, 2007; Aeni & Supadi, 2020; and Shin & Shim, 2021), including their attitudes towards the subject (Etuk et al., 2013).

These studies show that the five variables, including learning motivation, learning anxiety, mathematical connection ability, problem-solving ability, and students' perceptions of teacher competence, significantly affect mathematics learning achievement and are highly correlated. On the other hand, the five variables are also known to be significantly related to each other. For example, several studies found that learning anxiety negatively impacts learning motivation (Zakaria & Nordin, 2008; and James et al., 2013). Students' perceptions of teacher competence positively impact learning motivation and mathematics achievement (Shin & Shim, 2021). Furthermore, the mathematical connection ability may positively elevate learning motivation and problem-solving ability (Karakoç & Alacacı, 2015). Some studies show problem-solving ability is directly or indirectly influenced by learning motivation (see Pimta et al., 2009; and Özcan, 2016). These studies ascertain that there are six variables inherently related which can be structurally studied.

This study aims to determine the factors directly or indirectly influencing mathematics learning achievement among Indonesian students. There are six related variables, including mathematics anxiety, problem-solving ability, mathematics learning achievement, learning motivation, students' perceptions of teacher competence and mathematical connection ability. Previous studies only focused on the solo impact of each variable with none examining each variable the six variables simultaneously. On the other hand, looking at research trends in the field of mathematics education as conveyed by Kushwaha (2014), it is known that research related to the variables of students' perceptions of teacher competence and mathematical connection abilities is still rarely done. These two things make this research important to do. The two variables also propelled this study to provide comprehensive references that policymakers and education practitioners use to raise mathematics learning achievement in Indonesia.

Literature Review

Relationship between Anxiety and Learning Motivation

Zakaria & Nordin (2008) and James et al. (2013) stated that learning anxiety has a negative and significant effect on students' learning motivation. This was in line with the study carried out by Cordova et al. (2016), which stated that students manifest feelings of nervousness and confusion about mathematics therefore, they are not motivated to

take extra lessons. Anxiety tends to cause psychological and physiological reactions in students (Hunt et al., 2017). Furthermore, other studies also showed the relationship between anxiety levels and attitudes towards mathematics (Dagaylo-An & Tancinco, 2016). Some studies link mathematics anxiety to low learning motivation, affecting overall performance. These studies found that the anxiety causes dreadful feeling on the students' minds, hampering their ability to learn mathematics by reducing motivation. According to Majali (2020), student stricken by extreme mathematics anxiety have less enthusiasm. Based on the results from other studies, it was hypothesized that there is a significant negative relationship between anxiety and learning motivation.

Relationship between Anxiety and Mathematics Learning Achievement.

A study showed that low performance in mathematics learning is related to anxiety (Md. Yunus & Ali, 2009; Ramirez et al., 2016; and Juniati & Budayasa, 2020). It is also known to have a negative effect on the performance of students (Pantaleon et al., 2018) and mathematics learning achievement (Zakaria & Nordin, 2008; and Al Mutawah, 2015). Furthermore, it is a fear factor that leads to the poor performance of students in solving mathematical problems (Das & Das, 2013). As already discussed, extreme anxiety levels will hinder a student's full participation in mathematics class, thus limiting their motivation and ability to comprehend mathematical materials. Based on the results of these studies, it was assumed that anxiety has a negative effect on mathematics learning achievement.

Relationship between Students' Perceptions of Teacher Competence and Learning Motivation

Student assessment is an important instrument in determining the effectiveness of learning carried out by teachers (Ferguson, 2012). Studies have shown that students' perceptions of teacher competence can positively change their attitudes towards mathematics (Etuk et al., 2013). In general, students with a high perception of teacher competence tend to master mathematics faster as they are motivated to actively learn mathematics (Shin & Shim, 2021). This study demonstrates that the way students perceive their teacher's competence influences learning motivation, meaning that if their perception is positive, they will be more involved in learning mathematics. Students with a low and negative perceptions of the teacher's competence will adversely affect their willingness to participate in the lesson. Based on this analysis, it is then hypothesized that students' perceptions of teacher competence will have a positive and significant effect on learning motivation.

Relationship between Students' Perceptions of Teacher Competence and Problem Solving Ability

Adediwura & Tayo (2007) showed that students' perceptions of teacher competence affect their performance in mathematics. Based on this study, it is very possible that it will affect problem-solving ability, because this skill is needed in learning mathematics (Schunk, 2012). A positive perception of the teacher's competence of the subject of mathematics is important for motivating student (Shin & Shim, 2021) and helping them abide by the instruction given since they believe that the teacher is qualified. The positive perception will help the understand the material and improve their problem-

solving ability. Therefore, it provides a provisional assumption that students' perceptions have a positive and significant effect on problem-solving ability.

Relationship between Students' Perceptions of Teacher Competence and Learning Achievement

Based on Adediwura & Tayo (2007), it is known that the performance of students in mathematics is influenced by their perceptions of teacher competence. Some studies have also shown that students will attain higher learning achievement if they have positive perceptions of teacher competence (Aeni & Supadi, 2020; and Shin & Shim, 2021). An excellent perception supports students' involvements in learning mathematics because they are convinced that the teacher knows what they are doing. The more they participate in mathematics lessons, the more they enhance their problem-solving abilities and learning achievement. Based on some of these studies, it was hypothesized that students' perceptions of teacher competence significantly affect their learning achievement.

Relationship between Mathematical Connection Ability and Learning Motivation

Karakoç & Alacacı (2015) stated that the majority of students agree that making real-world connections with mathematics helps in increasing or developing their motivation and interest in the subject. Based on this study, it was seen that there is a relationship between mathematical connection ability and student learning motivation. Students with high mathematical connection ability can link everyday situations to mathematics concepts and solve problems that are not directly related to classwork. When a student makes this connection, they will be excited, hence motivated to take their study seriously. Therefore, it was assumed that mathematical connection ability and learning motivation are in direct proportion.

Relationship between Mathematical Connection Ability and Problem-Solving Ability

Karakoç & Alacacı (2015) also stated that most students agree that making real-world connections with mathematics helps them in mathematical process skills such as problem-solving. This empirical study assumed that mathematical connection ability has a positive and significant effect on problem-solving ability. This was supported by the NCTM (2000), which stated that the ability of students to connect mathematical ideas increase their level of understanding. This is because, with a good understanding, it is possible to help students solve mathematics problems.

Relationship between Mathematical Connection Ability and Learning Achievement

Ndiung & Nendi (2018) showed that the mathematical connection ability affects students learning outcomes. This was supported by the study carried out by Karakoç & Alacacı (2015), which stated that most students agree that making real-world connections helps improve their ability to generalize mathematical ideas. Furthermore, this connection ability increases their understanding and mastery of this material will not be easily forgotten (NCTM, 2000). The student's ability to connect various mathematical materials with topics inside and outside helps them understand the material studied more

easily. Therefore, the mathematics learning achievement is improved. Based on this analysis, it was hypothesized that the mathematical connection ability significantly affects learning achievement.

Relationship between Learning Motivation and Problem-Solving Ability

Özcan (2016) stated that students' mathematical problem-solving ability is explained by three sub-dimensions of independent learning model, namely internal motivation, willingness to carryout homework and metacognitive experiences. Meanwhile, Pimta et al. (2009), stated that problem solving ability is indirectly influenced by the motivation of students. Therefore, students' motivation in learning mathematics is one of the factors that help increase problem-solving ability. Students with high motivation tend to be more involved in learning mathematics and actively participate in solving problems, an important aspect of learning (Schunk, 2012). This analysis is in line with previous studies, which established that the higher the learning motivation, the higher the problem-solving ability.

Relationship between Learning Motivation and Learning Achievement

Several studies have shown that learning motivation has a positive and significant effect on mathematics learning achievement (Zakaria & Nordin, 2008; Pantziara & Philippou, 2015; Herges et al., 2017; and Arulmoly & Branavan, 2017). According to these studies, motivation has a real contribution to learning achievements. Students with high motivation may have more activities in studying mathematical materials, both independently and collectively. This may help them understand the various materials studied, increasing learning achievement. Therefore, it was hypothesized that learning motivation has a positive and significant effect on learning achievement.

Relationship between Problem Solving Ability and Learning Achievement

Problem-solving is a key process in learning mathematics (Schunk, 2012). This shows that in the mathematics learning process, good problem-solving abilities are needed. Several studies have shown that it has a positive and significant effect on mathematics learning achievement (For example Bhat, 2014; Yurt & Sünbül, 2014, and Maheswari & Benjamin, 2015). The results indicate that problem-solving ability significantly contributes to mathematics learning achievement. A good problem-solving ability help students solve math problems, both routine and non-routine. Based on these various studies, it was assumed that problem-solving ability significantly affects student learning achievement.

Study question

According to the literature review, six variables significantly influence mathematics learning achievement, where some are interrelated. However, no study examined these six variables simultaneously by involving 19 structural relationships, either directly or indirectly. The questions formulated in this study include whether 1) learning anxiety, students' perceptions of teacher competence, and mathematical connection ability influence learning motivation, 2) students' perceptions of teacher competence, mathematical connection ability, and learning motivation influence problem-solving ability, 3) learning anxiety, students' perception of teacher competence, mathematical

connection ability, learning motivation, and problem-solving ability influence learning achievement, and 4) the extent of the direct and indirect influence between variables in the structure formulated model?

METHOD

Study Design

This was a quantitative study with a correlation design (Morrel & Carrol, 2013). This method was used to assess the relationship between several variables in one population group (Ary et al., 2010) and answer the associative hypothesis proposed. The number of variables used was six, namely, three exogenous and endogenous variables. The exogenous or endogenous variables are determined based on a literature review and analysis as described previously. The three exogenous variables include 1) mathematics anxiety (X1), 2) students' perceptions of teacher competence (X2), and 3) mathematical connection ability (X3). Meanwhile, the three endogenous variables included in the pathway model were 1) learning motivation (Y1), 2) problem-solving ability (Y2), and 3) mathematics learning achievement (Y3). The theoretical framework built in this study is presented in the following figure.

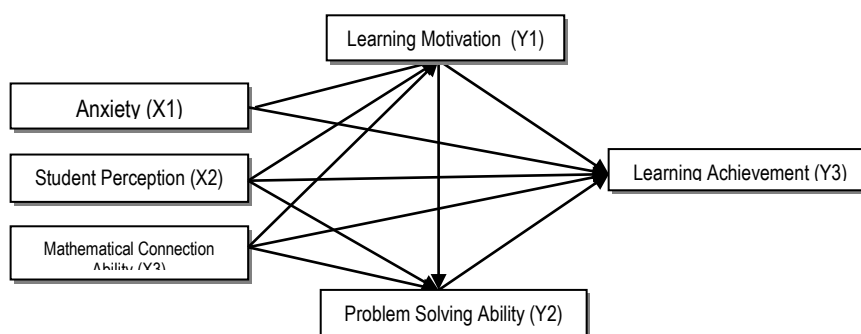


Figure 1
Theoretical framework of the relationship between variables

Sampling

The subjects in this study were all students of grade XI Senior High School in Purworejo Regency, Central Java, Indonesia. The sampling technique used was stratified cluster random. Stratification was used because the results of the National Examination showed that there is a fairly wide range of results among several schools. Cluster random sampling was used because the population in this study was quite large and spread geographically into 24 schools and 16 sub-districts. This means it would be difficult to use simple random sampling. In the first stage, school stratification was conducted based on the 2018/2019 National Examination Score (<https://hasilun.puspendik.kemdikbud.go.id>). Three schools were obtained from the school group in the high, medium, and low categories. Random clustering was carried out by taking two classes for each selected school. The sample consists of 6 classes, with 171 students, specifically 72 males and 99 females.

Data Collection

The number of instruments used in this study was six. Three instruments were in the form of a Likert scale, namely: 1) mathematics anxiety, 2) students perception, and 3) learning motivation. Meanwhile, the other instruments were in the form of essay tests, namely: 1) mathematical connection ability, 2) problem-solving ability and 3) mathematics learning achievement. The material topic tested was calculus which included limits and derivatives. The validity of these instruments was proven using content validity, while the reliability was estimated using the Cronbach Alpha formula. Content validity was used to obtain valuable input from experts regarding the quality of the instrument developed and to understand the validity of the items. However, the validity of the items based on the expert judgment was analyzed using Aiken's V formula. The items had high validity, with the criteria having an Aiken index above 0.80. The reliability criteria used referred to the study by Budiyo (2015), which stated that an instrument is reliable when it has a reliability coefficient of more than or equal to 0.70.

Meanwhile, the mathematics anxiety instrument used referred to the Mathematics Anxiety Rating Scale (MARS) developed by Suinn (2003). This variable was measured using a questionnaire in the form of a Likert scale. Furthermore, the number of items used in this study was 39. All the items have high validity with an Aiken index above 0.80. The instrument is also reliable, with a reliability coefficient of 0.82.

The students' perceptions of teacher competence instrument were developed with reference to aspects of teacher competence as stated in the Indonesian Government Regulation Number 74 of 2008 on Teachers (2008). This instrument also adapted that of students' perception, which was developed by Bhargava & Pathy (2011). The instrument used to measure this variable is a questionnaire in the form of a Likert scale. All the items used have high validity with an Aiken index above 0.80. The reliability coefficient obtained was 0.84, which indicated that it was reliable.

The mathematical connection ability instrument was developed by examining the indicators presented by NCTM (2000). The instrument used is a written test. A total of 5 essay topics were tested, and the material topic was Differential. All test questions used have high validity with an Aiken index above 0.80. The reliability of this instrument was estimated with a reliability coefficient of 0.87. Therefore, it was concluded that the mathematical connection ability instrument used in this study was reliable.

The learning motivation instrument was developed by adopting the instrument developed by Waage (2009) and Liu & Lin (2010). The instrument used is a questionnaire in the form of a Likert scale with a total of 30 items were used. These items have high validity with an Aiken index above 0.80. This instrument was reliable because it had a coefficient of 0.81.

The problem-solving ability instrument consisted of 5 questions. This variable was measured using a written test, though the indicator referred to Polya (1973). The five items used have high validity with an Aiken's V index of above 0.80. The reliability of this instrument had been analyzed with a reliability coefficient of 0.78. Therefore, it was concluded that the instrument was reliable.

The learning achievement instrument consisted of 5 essay questions. The instrument used to measure this variable was a written test. The indicators include 1) explaining the concept of limits and derivatives and 2) determining the value of limits and derivatives of functions. The instruments focused on solving routine problems related to limits and derivatives. The problem-solving indicators include understanding the problem, making plans, implementing solution strategies, and looking back at the solutions obtained (Polya, 1973). The questions given require knowledge of concepts outside the topic studied. These problems cannot be solved directly with routine procedures, distinguishing between learning achievement and problem-solving ability. The five essay questions used have high validity, with an index above 0.80. The reliability analysis results showed that this instrument was reliable with a coefficient of 0.86.

Data Analysis

The data analysis technique used was path analysis (Pedhazur, 1997). It was used to determine the relationship between the variables studied and the magnitude of direct and indirect effects for each given path. The linear structural relations (LISREL) software was used to assist data analysis, and the type used was LISREL 8.80.

FINDINGS

The first step before carrying out further analysis with LISREL was the model fit test. Referring to Pedhazur (1997) and Sharma (1996), the criteria for the fit model used was by examining the Chi-Square, Root Mean Square Error of Approximation (RMSEA), Goodness of Fit Index (GFI), Adjusted Goodness of Fit

Index (AGFI) and Standard Root mean square Residual (*SRMR*) values. The results of the model fit test for this study are presented in the following Table.

Table 1
Estimation result of model fit test

Fit index	Cut off	Estimation results	Fit level
χ^2	P-Value > 0,05	P-Value = 0,86	Good
Relative χ^2	$\chi^2 < 2df$	1,28 < 2 (4)	Good
RMSEA	$\leq 0,07$	0,00	Good
GFI	> 0,90	1,00	Good
AGFI	> 0,90	0,99	Good
SRMR	$\leq 0,08$	0,01	Good

From Table 1, it is seen that the chi-square value is 1.28 ($P = 0.86$), which is close to 0, while the p-value is more than 0.05, which is close to 1. Therefore, based on the Chi-Square value, the model was declared fit. Furthermore, RMR and SRMR values were also in the small category because they are close to 0 (less than 0.08); therefore, the model was also said to be fit. The RMSEA value of 0.00 was in the perfect fit category. The GFI and AGFI values were more than 0.90. Therefore, the model was in the fit category. Based on several criteria used, it was concluded that the causal model is in the fit category.

Following is a summary of the path coefficients and their t-values.

Table 2
Direct effect and significance test on the model

Causal Relationships	Path Coefficient	T-value	Conclusion
$X_1 \rightarrow Y_1$	-0,22	-4,67	Significant
$X_1 \rightarrow Y_2$	-0,04	-1,14	In-significant
$X_2 \rightarrow Y_1$	0,07	1,44	In-significant
$X_2 \rightarrow Y_2$	0,24	4,36	Significant
$X_2 \rightarrow Y_3$	0,09	2,26	Significant
$X_3 \rightarrow Y_1$	0,74	14,53	Significant
$X_3 \rightarrow Y_2$	0,36	4,56	Significant
$X_3 \rightarrow Y_3$	0,38	6,40	Significant
$Y_1 \rightarrow Y_2$	0,31	4,05	Significant
$Y_1 \rightarrow Y_3$	0,19	3,27	Significant
$Y_2 \rightarrow Y_3$	0,37	7,04	Significant

Table 2 shows a significant negative relationship between anxiety and learning motivation, though there is no significant effect on learning achievement. The insignificant effect also applies to the students' perceptions of teacher competence with learning motivation because it has the at-count value of less than 1.96. The variables, except anxiety, have a positive and significant effect on learning achievement. This is presented in the positive path coefficient with a t-count value of more than 1.96. The

structural equation for the path model is as follows: $Y_1 = -0,22X_1$, $Y_2 = -0,04X_1$,

$Y_1 = 0,07X_2$, $Y_2 = 0,24X_2$, $Y_3 = 0,09X_2$, $Y_1 = 0,74X_3$, $Y_2 = 0,36X_3$, $Y_3 = 0,38X_3$,

$Y_2 = 0,31Y_1$, $Y_3 = 0,19Y_1$, and $Y_3 = 0,36Y_2$. Therefore, learning anxiety has a greater effect on learning motivation than students' perceptions of teacher competence. Furthermore, mathematical connection ability has the greatest effect on problem-solving ability and learning achievement than other variables in the model structure.

The indirect effect on the model structure is presented in Table 3 below.

Table 3
Indirect effect on the model

Causal Relationships	Indirect Effect
$X_1 \rightarrow Y_1 \rightarrow Y_2$	-0.042
$X_2 \rightarrow Y_1 \rightarrow Y_2$	0.013
$X_2 \rightarrow Y_1 \rightarrow Y_2$	0.140
$X_2 \rightarrow Y_2 \rightarrow Y_2$	0.088
$X_2 \rightarrow Y_2 \rightarrow Y_2$	0.133
$X_1 \rightarrow Y_1 \rightarrow Y_2 \rightarrow Y_2$	-0.025
$X_2 \rightarrow Y_1 \rightarrow Y_2 \rightarrow Y_2$	0.008
$X_2 \rightarrow Y_1 \rightarrow Y_2 \rightarrow Y_2$	0.084

Table 3 shows that the indirect effect of students' perceptions on learning achievement through learning motivation is 0.013, and 0.088 through problem solving. Therefore, the total effect of students' perceptions on mathematics learning achievement is 0.192. The indirect effect of mathematical connection ability on mathematics learning achievement through learning motivation is 0.140, while through problem-solving ability is 0.133. The total effect of mathematical connection ability on mathematics learning achievement is 0.654. The structural equations for this model are as follows:

$$Y_3 = -0.22X_1 + 0.19Y_1 \quad , \quad Y_3 = 0.07X_2 + 0.19Y_1 \quad , \quad Y_3 = 0.74X_3 + 0.19Y_1 \quad ,$$

$$Y_3 = 0.24X_2 + 0.37Y_2 \quad , \quad Y_3 = 0.36X_3 + 0.37Y_2 \quad , \quad Y_3 = -0.22X_1 + 0.31Y_1 + 0.37Y_2 \quad ,$$

$Y_3 = 0.07X_2 + 0.31Y_1 + 0.37Y_2$ dan $Y_3 = 0.74X_3 + 0.31Y_1 + 0.37Y_2$. According to this model, the mathematical connection ability indirectly has the greatest effect on learning achievement than other variables in the model structure.

DISCUSSION

Relationship between Anxiety and Learning Motivation

The first test discovered that anxiety had a negative and significant effect on learning motivation. It showed that they were indirectly proportional, which was in accordance with the hypothesis proposed. These results are in line with the previous studies, which stated that anxiety has negative implications for learning motivation (Zakaria & Nordin, 2008; James et al., 2013; and Majali, 2020). Also, the results are in line with the hypothesis proposed in this study. The direct effect of mathematics anxiety on learning motivation is -0.22, showing that the higher the anxiety, the lower the learning motivation.

Relationship between Anxiety and Mathematics Learning Achievement.

The second test result showed that anxiety had a negative but in-significant effect on learning achievement. This was not in accordance with the hypothesis proposed. These results also contravene previous studies, which stated that low learning achievement could be caused by mathematics anxiety (Md. Yunus & Ali, 2009; Al Mutawah, 2015; Ramirez et al., 2016; Pantaleon et al., 2018; and Juniati & Budayasa, 2020). The study indicates that anxiety does not contribute significantly to learning achievement. However, based on the Beta coefficient, a negative number was obtained. This implies that anxiety and learning motivation are indirectly proportional. Although the effect was not significant, teachers should keep students' anxiety levels low because the first results showed that anxiety significantly affects learning motivation.

Relationship between Students' Perceptions of Teacher Competence and Learning Motivation

The result of the third test was similar to that of the second. It showed that students' perception of teachers' competence had a positive but in-significant effect. This was not in accordance with the provisional assumptions proposed. These study results also contravene previous studies, which stated that students' perceptions of teacher competence affects students' attitudes (Etuk, Afangideh, Uya, 2013; and Gläser-Zikuda & Fuß, 2008) and learning motivation (Kunter et al., 2013). However, based on the Beta coefficient, a positive number was obtained. This implies that the competence of teachers and learning motivation are in direct proportion. Although, the effect was not significant, teachers should always try to keep students' perceptions of their competence positive. Also, it was discovered that learning motivation was not influenced by perceptions of teacher competence but other variables.

Relationship between Students' Perceptions of Teacher Competence and Problem Solving Ability

The fourth test result showed that students' perceptions of teacher competence had a positive and significant effect on problem-solving ability. Therefore, perception and problem-solving ability are direct and were also in accordance with the hypothesis proposed. This result supports Adediwura & Tayo (2007), which showed that students' perceptions have a significant and positive effect on their performance in mathematics. Furthermore, it was shown that the direct effect of students' perceptions on problem-solving ability was 0.24.

Relationship between Students' Perceptions of Teacher Competence and Learning Achievement

Students' perceptions of teacher competence are also known to have a significant effect on mathematics learning achievement. This was seen from the results of the fifth hypothesis test which showed that it had a positive and significant effect on mathematics learning achievement. Therefore, perception and learning achievement are in direct proportion. This was in accordance with the hypothesis proposed. The results of this study complement that from previous studies regarding the effect of students' perceptions on mathematics learning achievement (Aeni & Supadi, 2020; and Shin &

Shim, 2021). These form an important reference for mathematics teachers in managing learning. Teacher competence is based on the attention of students in learning. This study shows that student assessment of the teacher competence affects learning achievement. Therefore, teachers need to improve their competence and pay attention to their activities in the mathematics learning process.

Relationship between Mathematical Connection Ability and Learning Motivation

The sixth test results showed that mathematical connection ability had a positive and significant effect on learning motivation. This implies that they are in a direct proportion and were in accordance with the proposed hypothesis. These results were also supported by the study carried out by Karakoç & Alacacı (2015). Furthermore, it was shown that the direct effect of mathematical connection ability on learning motivation was 0.74. When viewed further, it was discovered that the mathematical connection ability had the greatest effect on students' learning motivation among the other two variables (mathematics anxiety and students' perceptions of teacher competence).

Relationship between Mathematical Connection Ability and Problem Solving Ability and Learning Achievement

Mathematical connection ability also had a positive and significant effect on problem-solving ability and mathematics learning achievement. These results support the study carried out by Ndiung & Nendi (2018) and Karakoç & Alacacı (2015). Furthermore, it was shown that the direct effect of mathematical connection ability on problem-solving ability and learning achievement was 0.36 and 0.38, respectively. Mathematical connection ability is known to contribute the most to learning achievement.

Relationship between Learning Motivation with Problem Solving Ability and Learning Achievement

Meanwhile, the ninth and tenth test results showed that learning motivation significantly affected problem-solving ability and mathematics learning achievement. This implies that learning motivation, problem-solving ability and learning achievement are in direct proportion. The effect of motivation on the cognitive abilities of students was previously assumed. Several previous studies also gave the same results (Zakaria & Nordin, 2008; Pantziara & Philippou, 2015; Herges et al., 2017; and Arulmoly & Branavan, 2017). Based on the Beta coefficient, the direct effect of learning motivation on problem-solving ability and learning achievement was 0.31 and 0.19, respectively.

Relationship between Problem Solving Ability and Learning Achievement

The final hypothesis test also showed that those results support the hypothesis proposed in this study. Furthermore, it was shown that problem-solving ability had a positive and significant effect on mathematics learning achievement. These results were similar to those from previous studies referred to in this study (Bhat, 2014; and Maheswari & Benjamin, 2015).

When examined further, the factor with the most significant effect on problem-solving ability and learning achievement was mathematical connection ability. These results provide an important reference that teachers should build students' mathematical

connection ability in classroom learning. The results of previous empirical tests also showed that this ability provides the greatest contribution to students' learning motivation. In addition, most students agreed that making real-world connections helps increase or develop their motivation, interest, and abilities in mathematics (see Karakoç & Alacacı, 2015). These results also support NCTM (2000), which stated that with the mathematical connection ability, the understanding level of students would increase and last longer. The study results indicated that making mathematical connections to other disciplines or the real world will have two advantages: 1) increasing learning motivation and 2) increasing their ability in mathematics.

This study provides an important reference for policymakers and practitioners of mathematics education in managing to learn. A mathematics teacher needs to develop various abilities that affect the achievement in the learning process. Mathematical connection ability has the greatest contribution to learning achievement. The ability of students to connect materials outside of mathematics helps them understand the problems. Teachers should not only focus on formal mathematical concepts. They need to discuss the relationship between mathematics and objects outside, both in other subjects and everyday life. Teachers also need to pay attention to student activities in learning and increase their competence. Students' perceptions of teacher competence also contribute positively to their learning achievement, although not as much as the mathematical connection ability.

These results also complement previous studies related to the factors affecting mathematics learning achievement. The existence of six variables studied simultaneously by involving 19 structural relationships between variables is expected to be adequate reference material for further academic study in the development of educational science, especially research.

CONCLUSION

This study has shown that learning anxiety has a negative and significant effect on learning motivation. However, it also has a negative and in-significant effect on learning achievement. Students' perceptions of teacher competence have a positive and in-significant effect on learning motivation. However, it has a positive and significant effect on problem-solving ability and learning achievement. Mathematical connection ability has a positive and significant effect on learning motivation, problem-solving ability, and learning achievement in mathematics. Furthermore, learning motivation has a positive and significant effect on problem-solving ability and mathematics learning achievement. The problem-solving ability has a positive and significant effect on learning achievement. Mathematical connection ability has the greatest effect, both direct and indirect.

This study only examined five variables affecting mathematics learning achievement. Many other variables affect mathematics learning achievement. There is a need to conduct more comprehensive studies to add information and references for mathematics teachers and improve the learning quality. Moreover, mathematics teachers need to pay attention to various aspects affecting student learning achievement. Implementing a new

learning environment needs to consider various factors affecting learning outcomes for the learning process and results to be more optimal.

REFERENCES

- Adediwura, A. A., & Tayo, B. (2007). Perception of teachers' knowledge, attitude and teaching skills as predictor of academic performance in Nigerian secondary schools. *Educational Research and Reviews*, 2(7), 165–171.
- Aeni, N., & Supadi, S. (2020). The effects of student's perception on teacher performance and learning motivation towards student's English achievement. *INFERENCE: Journal of English Language Teaching*, 3(2), 146. <https://doi.org/10.30998/inference.v3i2.6018>.
- Al Mutawah, M. A. (2015). The influence of mathematics anxiety in middle and high school students math achievement. *International Education Studies*, 8(11), 239. <https://doi.org/10.5539/ies.v8n11p239>.
- Arulmoly, C., & Branavan, A. (2017). The impact of academic motivation on student's academic achievement and learning outcomes in mathematics among secondary school students in paddiruppu educational zone in the Batticaloa district, Sri Lanka. *International Journal of Scientific and Research Publications*, 7(5), 115–126.
- Ary, D., Jacobs, L., Razavieh, A., & Sorensen, C. (2010). *Introduction to research in education*. California: Wadsworth Cengage Learning.
- Bhargava, A., & Pathy, M. (2011). Perception of student teachers about teaching competencies. *American International Journal of Contemporary Research*, 1(1), 77–81. http://aijcrnet.com/journals/Vol._1_No.1_July_2011/10.pdf.
- Bhat, A. M. (2014). Effect of problem solving ability on the achievement in mathematics of high school students. *Indian Journal of Applied Research*, 4(8), 685–688. <https://doi.org/10.15373/2249555x/august2014/195>.
- Brezavšček, A., Jerebic, J., Rus, G., & Žnidaršič, A. (2020). Factors influencing mathematics achievement of university students of social sciences. *Mathematics*, 8(12), 1–24. <https://doi.org/10.3390/math8122134>.
- Budiyono. (2015). *Assessment of learning outcomes*. Surakarta: UNS Press.
- Cordova, A., Chavez, M. E. E., & Gasca, S. B. (2016). Mathematics really generates anxiety? Empirical study in middle school students. *International Electronic Journal of Mathematics Education*, 12(1), 88–97.
- Dagaylo-An, M. B., & Tancinco, N. P. (2016). Mathematics anxiety and the academic performance of the freshman college students of the naval state university. *International Journal of Engineering Sciences & Research Technology*, 5(7). <https://doi.org/10.5281/zenodo.58530>.
- Das, R., & Das, G. C. (2013). Math Anxiety: The Poor Problem-Solving Factor in School Mathematics. *International Journal of Scientific and Research Publications*, 3(4), 1–4.
- Etuk, E. N., Afangideh, M. E., & Uya, A. O. (2013). Students' perception of teachers'

characteristics and their attitude towards mathematics in oron education zone, Nigeria. *International Education Studies*, 6(2), 197–204. <https://doi.org/10.5539/ies.v6n2p197>.

Ferguson, R. F. (2012). Can student surveys measure teaching quality? *Phi Delta Kappan*, 94(3), 24–28. <https://doi.org/10.1177/003172171209400306>.

Ganal, N. N., & Guiab, M. R. (2014). Problems and difficulties encountered by students towards mastering learning competencies in Mathematics. -*Journal of Arts, Science & Commerce*, 5(4), 25–37.

Gläser-Zikuda, M., & Fuß, S. (2008). Impact of teacher competencies on student emotions: A multi-method approach. *International Journal of Educational Research*, 47(2), 136–147. <https://doi.org/10.1016/j.ijer.2007.11.013>.

Government Regulation of Indonesia Number 74 of 2008 concerning Teachers. (2008).

Hadi, S., Retnawati, H., Munadi, S., Apino, E., & Wulandari, N. F. (2018). The difficulties of high school students in solving higher-order thinking skills problems. *Problems of Education in the 21st Century*, 76(4), 520–532.

Herges, R., Duffield, S., Martin, W., & Wageman, J. (2017). Motivation and achievement of middle school mathematics students. *Mathematics Educator*, 26(1), 83–106.

Hunt, T. E., Bhardwa, J., & Sheffield, D. (2017). Mental arithmetic performance, physiological reactivity and mathematics anxiety amongst U.K. primary school children. *Learning and Individual Differences*, 57, 129–132. <https://doi.org/10.1016/j.lindif.2017.03.016>.

James, A. O., Tunde, B. F., Ademuyiwa, A. C., & Bolanle, A. O. (2013). Effects of gender, mathematics anxiety and achievement motivation on college students' achievement in mathematics. *International Journal of Education and Literacy Studies*, 1(1), 15–22. <https://doi.org/10.7575/aiac.ijels.v.1n.1p.15>.

Juniati, D., & Budayasa, I. K. (2020). Working memory capacity and mathematics anxiety of mathematics undergraduate students and its effect on mathematics achievement. *Journal for the Education of Gifted Young Scientists*, 8(1), 279–291. <https://doi.org/10.17478/jegys.653518>.

Jupri, A., Drijvers, P., & Van den Heuvel-Panhuizen, M. (2014). Student difficulties in solving equations from an operational and a structural perspective. *International Electronic Journal of Mathematics Education*, 9(1–2), 39–55.

Karakoç, G., & Alacacı, C. (2015). Real-World Connections in high school mathematics curriculum and teaching. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, 6(1), 31. <https://doi.org/10.16949/turcomat.76099>.

Kunter, M., Klusmann, U., Baumert, J., Richter, D., Voss, T., & Hachfeld, A. (2013). Professional competence of teachers: Effects on instructional quality and student development. *Journal of Educational Psychology*, 105(3), 805–820. <https://doi.org/10.1037/a0032583>.

Kushwaha, S. S. (2014). Trend in researches on mathematics achievement. *IOSR*

Journal of Research & Method in Education (IOSRJRME), 4(6), 53–62. <https://doi.org/10.9790/7388-04625362>.

Lee, I. (2010). The Effect of learning motivation , total quality teaching and peer-assisted learning on study achievement : Empirical analysis from vocational universities or colleges ' students in Taiwan. *Adult Learning*, 6(December), 56–74.

Liu, E. Z. F., & Lin, C. H. (2010). The survey study of mathematics motivated strategies for learning questionnaire (MMSLQ) for grade 10-12 Taiwanese students. *Turkish Online Journal of Educational Technology*, 9(2), 221–233.

Maheswari D, V., & Benjamin, A. E. W. (2015). Problem solving ability and academic achievement in mathematics of vii standard students in Madurai district. *Indian Journal of Applied Research*, 5(2), 166–168.

Majali, S. Al. (2020). Positive anxiety and its role in motivation and achievements among university students. *International Journal of Instruction*, 13(4), 975–986. <https://doi.org/DOI:10.29333/iji.2020.13459a>.

Md. Yunus, A. S., & Ali, W. Z. W. (2009). Motivation in the learning of mathematics. *European Journal of Social Sciences*, 7(4), 93–101.

Morrel, P. D., & Carrol, J. B. (2013). *Conducting educational research*. Rotterdam: Sense Publishers.

NCTM. (2000). *Principles and standards for school mathematics*. United States of America : The National Council of Teachers of Mathematics, Inc.

Ndiung, S., & Nendi, F. (2018). Mathematics connection ability and students mathematics learning achievement at elementary school. *SHS Web of Conferences*, 42, 00009. <https://doi.org/10.1051/shsconf/20184200009>

OECD. (2019). *PISA 2018 Results (Volume I): What Students know and can do*, PISA, OECD Publishing, Paris. <https://doi.org/10.1787/5f07c754-en>.

Özcan, Z. Ç. (2016). The relationship between mathematical problem-solving skills and self-regulated learning through homework behaviours, motivation, and metacognition. *International Journal of Mathematical Education in Science and Technology*, 47(3), 408–420. <https://doi.org/10.1080/0020739X.2015.1080313>.

Pantaleon, K. V., Juniati, D., & Lukito, A. (2018). The proving skill profile of prospective math teacher with high math ability and high math anxiety. *Journal of Physics: Conference Series*, 1097(1). <https://doi.org/10.1088/1742-6596/1097/1/012154>

Pantziara, M., & Philippou, G. N. (2015). Students' motivation in the mathematics classroom. revealing causes and consequences. *International Journal of Science and Mathematics Education*, 13, 385–411. <https://doi.org/10.1007/s10763-013-9502-0>.

Pedhazur, E. J. (1997). *Multiple regression in behavioral research*. Singapore: Thomson Learning.

Pimta, S., Tayruakham, S., & Nuangchale, P. (2009). Factors influencing mathematics problem-solving ability of sixth grade students. *Journal of Social Sciences*, 5(4), 381–385. <https://doi.org/10.3844/jssp.2009.381.385>.

Pipere, A., & Mierîna, I. (2017). Exploring non-cognitive predictors of mathematics achievement among 9th grade students. *Learning and Individual Differences, 59*, 65–77. <https://doi.org/10.1016/j.lindif.2017.09.005>.

Polya, G. (1973). *How to Solve It*. Princeton: University Press.

Ramirez, G., Chang, H., Maloney, E. A., Levine, S. C., & Beilock, S. L. (2016). On the relationship between math anxiety and math achievement in early elementary school: The role of problem solving strategies. *Journal of Experimental Child Psychology, 141*, 83–100. <https://doi.org/10.1016/j.jecp.2015.07.014>.

Retnawati, H., Kartowagiran, B., Arlinwibowo, J., & Sulistyarningsih, E. (2017). Why are the mathematics national examination items difficult and what is teachers' strategy to overcome it? *International Journal of Instruction, 10*(3), 257–276. <https://doi.org/10.12973/iji.2017.10317a>

Schunk, D. H. (2012). *Learning theories*. New Jersey: Printice Hall Inc.

Sharma, S. (1996). *Applied multivariate techniques*. New York: John Wiley & Sons, inc.

Shin, D., & Shim, J. (2021). Students' perceived mathematics teacher competence: longitudinal associations with learning outcomes and choice of college major. *Education Sciences, 11*(1), 1–14. <https://doi.org/10.3390/educsci11010018>.

Suinn, R. M. (2003). The mathematics anxiety rating scale, a brief version: psychometric data. *Psychological Reports, 92*(1), 167. <https://doi.org/10.2466/pr0.92.1.167-173>.

Sumaji, Sa'Dijah, C., Susiswo, & Sisworo. (2019). Students' problem in communicating mathematical problem solving of Geometry. *IOP Conference Series: Earth and Environmental Science, 243*(1). <https://doi.org/10.1088/1755-1315/243/1/012128>.

Tambychik, T., & Meerah, T. S. M. (2010). Students' difficulties in mathematics problem-solving: What do they say? *Procedia - Social and Behavioral Sciences, 8*, 142–151. <https://doi.org/10.1016/j.sbspro.2010.12.020>.

Toraman, Ç., Özdemir, H. F., Aytug Kosan, A. M., & Orakci, S. (2020). Relationships between cognitive flexibility, perceived quality of faculty life, learning approaches, and academic achievement. *International Journal of Instruction, 13*(1), 85–100. <https://doi.org/10.29333/iji.2020.1316a>.

Waage, K. (2009). Motivation for learning mathematics in terms of needs and goals. *Proceedings of CERME, 84–93*.

Yurt, E., & Sünbül, A. M. (2014). A structural equation model explaining 8th grade students' mathematics achievements. *Educational Sciences: Theory & Practice, 4*(1), 2193. <https://doi.org/10.12738/estp.2014.4.2193>.

Zakaria, E., & Nordin, N. M. (2008). The Effects of mathematics anxiety on matriculation students as related to motivation and achievement. *Eurasia Journal of Mathematics, Science & Technology Education, 4*(1), 27–30. <https://doi.org/10.12973/ejmste/75303>.