THE EFFECT OF LEARNING MOTIVATION TOWARDS STUDENTS' MATHEMATICS
PROBLEM-SOLVING ABILITY: META-ANALYSIS CORRELATIONAL STUDY

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Abstrak: Studies emphasize that learning motivation is one of the primary elements that affect the achievement of learning objectives and at the same time, influences the skill of mathematical problem-solving. Research on the correlation between mathematical problem-solving and learning motivation despite numerous attempts at solutions, the correlation value is heterogeneous, making it inconsistent. This study aims to summarize the effect-size values obtained based on the main research through the correlation meta-analysis method. The literature data collection technique used the Google Scholar database which was selected using the inclusion criteria. Primary studies that fit the criteria consisted of 20 studies published in journals, proceedings, and theses from 2016 to 2022. Three steps of data analysis, including publication bias research, random or fixed effect models, and statistical hypothesis testing, were conducted using the Jeffreys Amazing Statistics Program (JASP) program. The results of the study show that there is a positive influence of learning motivation on students' mathematical problem-solving abilities at the elementary, middle, and high school levels in Indonesia in the moderate category \( r = 0.56; p < 0.01 \). The results of this study suggest educators to further optimize students' learning motivation because learning motivation influences the level of students' mathematical problem-solving ability.

Keywords: Learning motivation, mathematical problem-solving, problem-solving, meta-analysis

INTRODUCTION

Education is an important sector in creating quality human resources in facing future challenges. Future challenges include challenges to technological advances and currents of globalization so the ability to communicate, the ability to think clearly and critically are needed. The ability to think critically, logically, analytically, systematically, and creatively as well as the ability to collaborate can be obtained through learning mathematics so the curriculum in Indonesia regulates that mathematics is very necessary (Isro’il & Supriyanto, 2020). One of the mathematical abilities that is the goal of education based on the curriculum is the ability to solve problems.

Problem-solving ability is defined as a person's ability to carry out cognitive processing when solutions to problems are not readily available (Shute et al., 2016). The process of students working through
problems teaches them how to comprehend problems, design solutions and strategies, implement solutions, and verify the accuracy of the solutions and outcomes. Since solving problems is the main objective of all mathematics instruction and activities, problem-solving is at the core of mathematical learning.

Mathematical problem-solving, being a fairly intricate cognitive activity, demands the application of a diverse range of methods. Practicing mathematical problem-solving ability allows students to solve problems in their lives (Gede Gunantara et al., 2014). This is in line with a study conducted by (Triana et al., 2021) that Students can develop their analytical skills and apply them to various situations by solving problems. However, this expectation does not match the reality.

The facts found in learning activities are the mastery of students' problem-solving abilities is still in the low category. This is supported by studies conducted by Rini (2022) and Yarmayani (2016) which state that students still have difficulty solving problem-solving questions because they have not been able to understand the components of the questions given. The low problem-solving ability of students is in line with the results of the PISA survey of 15-year-old children which placed the ability of Indonesian students at 63rd place out of 72 countries (Yuliati, 2021). In light of these findings, it is important to take into account the variables that affect this capacity, such as student motivation.

Student motivation is a very dominant factor in determining the achievement of learning objectives (Ariany et al., 2023). Elevated levels of student motivation in learning correlate with improved learning outcomes (Nurrawi et al., 2023). Rini (2022) states that motivation to learn is an encouragement that comes from within or outside a person who is able to move the strength within a person to learn so as to achieve the goals to be achieved. Good intellectual ability as a basic capital to achieve learning objectives will be useless if individuals do not have the motivation to learn. The level to which a person is motivated will greatly influence the kind of conduct someone exhibits, both in the context of learning and in his professional and personal life (Firmansyah et al., 2020). Therefore, balancing intellectual intelligence and fostering strong learning motivation will actively influence the progression of mathematical skills, specifically in the realm of problem-solving abilities.

Mathematical problem-solving has an intrinsic motivation attached to it. Involving math problem-solving in schools can stimulate interest and enthusiasm from students. Thus, learning motivation greatly influences the optimal development of students' problem-solving abilities. In line with the results of research by Lestari et al., (2022) stating that students who have low learning motivation tend to have low learning outcomes which have an impact on students' mathematical problem-solving abilities. Numerous more pertinent studies have investigated the impact of learning motivation on mathematical problem-solving skills.

The results of related studies on the influence of two variables of learning motivation and problem-solving abilities provide various conclusions. According to certain findings, studying motivation improves Indonesian students' capacity for solving mathematical problems (Lestari et al., 2022; Nisrina, 2018; Rini, 2022; Zebua et al., 2022) with heterogeneous correlation values between one and another so they are not consistent. This is different from the results of a study by Nisa' et al., (2020) that learning motivation can or cannot affect students'
problem-solving abilities depending on the factors that influence it. Mulyana & Fitrianna (2019) found no significant correlation between learning motivation and problem-solving skills. Differences in the results of these studies will be confusing for educators and students, so it is very important to conduct further studies to obtain accurate conclusions. Students at school need to identify the exact size of the intended effect of learning motivation. Furthermore, this conclusion of the actual effect size is very necessary for teachers and students in schools as a consideration in optimizing mathematics learning activities (Sholehah et al., 2022). Thus, a follow-up analysis of the correlation of results is carried out, known as a meta-analysis correlational.

Meta-analysis is research that follows previously published studies that have been used by other researchers and are conducted objectively and methodically to draw reliable results (Retnawati et al., 2018). In a meta-analysis, researchers evaluate, summarize, and analyze data from several kinds of prior study findings, including the calculation of effect-size (Anugraheni, 2018). Effect-size statistical computations are used in meta-analyses because they can reduce the number of distinct ways that objective study findings might be interpreted. (Borenstein et al., 2009). Therefore, this study aims to comprehensively analyze the effect size of a primary study presenting statistical data on the influence of learning motivation on students' mathematical problem-solving abilities in Indonesia.

**METHOD**

This study was analyzed using a meta-analysis correlational method. Meta-analysis is a quantitative method that employs particular stages (such as calculating effect sizes) in order to show the strength of the variable correlations for each research study included in the analysis (Schwarzer et al., 2015). To overcome the variations in results between studies, meta-analysis is an accurate and impartial way of synthesizing study results. Retnawati et al., (2018) stated that by integrating research measured by its effect size, using pre-post contrast, comparison groups, and correlation studies, meta-analysis may be used to summarize primary research. This study attempts to calculate the effect size values between learning motivation and students' mathematical problem-solving skills based on correlation values from numerous pertinent primary studies. Effect-size provides a straightforward method for quantifying distinctions between two groups, offering numerous benefits in contrast to relying solely on statistical significance tests (Borenstein et al., 2009).

The primary data used in this study were gathered from publications and other sources that looked into the correlation between the ability of students to solve mathematical problems and their motivation to learn. The data were then processed using Microsoft Excel and Jeffreys Amazing Statistics Program (JASP) software after being selected based on the inclusion criteria, tested for publication bias, and processed.

**Inclusion Criteria**

The Google Scholar database is filtered using inclusion criteria for literature. The criteria for inclusion in the publication included (1) journal articles, proceedings, and theses, (2) research sites in the Indonesian region, (3) literature examining the impact of learning motivation on mathematical problem-solving skills, (4) research papers published between 2016 and 2022, and (5) correlation studies with at least one correlation value of r, t, or F. These requirements were established
by the researcher to guarantee the provision of responses to the research questions and the objectivity of the study. Publications that aren’t in the criteria won’t be included in the sample.

**Data Collection**

The Google search engine looked through the literature using the Google Scholar database. The phrases "learning motivation", "learning motivation", "mathematical problem-solving ability", "mathematical problem solving", "mathematics problem solving", and "problem-solving" are the keywords used to filter literature based on the inclusion criteria that have been described. The Google Scholar web database contains the chosen literature between the years 2016 and 2022. A total of twenty articles of literature were found that fit the sample requirements for this study based on the existing inclusion criteria.

**Data Analysis**

Publication data that fits the criteria is then entered into tables in Microsoft Excel according to the required categories such as research year, sample size (N), correlation value, and research sample grade. The selected publications will be tested for publication bias so that the data analyzed in the primary study is valid, accurate, and credible. This test used the funnel plot diagram and the safe N Rosenthal test. Data from correlational studies that have proven resistant to publication bias are then processed for correlation values.

The estimated values of r, t, and/or F are present in all of the correlational studies that were analyzed. These values can be converted to r by the formula:

\[ r = \frac{t}{\sqrt{t^2 + N - 2}} \]

where N denotes the total sample size. The data is arranged in Microsoft Excel for this task. With the exception of large samples, the sample's r distribution around the population is skewed; hence, the r value must first be transformed to Fisher's value (z), since the latter is symmetrical (Card, 2012). The following equation can be used to convert the value of r to z.

\[ z = 0.5 \times ln\left(\frac{1 + r}{1 - r}\right) \]

where the standard error (SEz) = \(\frac{1}{\sqrt{n - 3}}\). The conversion procedure makes use of Microsoft Excel. Because the meta-analysis of correlation employs the z-fisher value for computation, the acquired z-value must be translated back into a correlation value (r). The following formula can be used to modify the correlation value.

\[ r = \frac{\exp(2z) - 1}{\exp(2z) + 1} \]

The software Jeffrey's Amazing Statistics Program was used to examine this value.

In the final step, the value of the effect size obtained is interpreted according to the classification to describe the level of correlation strength between the independent and dependent variables. The effect size classification is presented in Table 1 below (Schober et al., 2018):

<table>
<thead>
<tr>
<th>Effect Size (ES)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00 – 0.10</td>
<td>Negligible correlation</td>
</tr>
<tr>
<td>0.10 – 0.39</td>
<td>Weak correlation</td>
</tr>
<tr>
<td>0.40 – 0.69</td>
<td>Moderate Correlation</td>
</tr>
<tr>
<td>0.70 – 0.89</td>
<td>Strong Correlation</td>
</tr>
<tr>
<td>0.9 – 1</td>
<td>Very strong correlation</td>
</tr>
</tbody>
</table>

In general, according to (DeCoster, 2009), formulating the issue, looking for relevant literature to use as a sample, determining the size of each study individually and collectively, examining the effects of moderating factors, and interpreting and
RESULTS AND DISCUSSION

The literature was searched on the Google Scholar database using the keywords and inclusion criteria that have been described resulting in a research sample. The literature that was filtered and sampled for the correlation meta-analysis research is shown in Table 2 by year, kind of publication, and Grade.

<table>
<thead>
<tr>
<th>No</th>
<th>Year</th>
<th>Author(s)</th>
<th>Publication</th>
<th>n</th>
<th>(r_{xy})</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2016</td>
<td>Muhammad Ihsan</td>
<td>Journal</td>
<td>179</td>
<td>0.221</td>
<td>Junior High School</td>
</tr>
<tr>
<td>2</td>
<td>2017</td>
<td>Hakasina wati dkk</td>
<td>Journal</td>
<td>80</td>
<td>0.459</td>
<td>Islamic Senior High School</td>
</tr>
<tr>
<td>3</td>
<td>2018</td>
<td>Arfatin Nurrahmah &amp; Nur Alamsyah</td>
<td>Proceeding</td>
<td>60</td>
<td>0.611</td>
<td>Junior High School</td>
</tr>
<tr>
<td>4</td>
<td>2018</td>
<td>Ismayani Safitri</td>
<td>Journal</td>
<td>84</td>
<td>0.315</td>
<td>Islamic Junior High School</td>
</tr>
<tr>
<td>5</td>
<td>2018</td>
<td>Nada Nisrina</td>
<td>Journal</td>
<td>92</td>
<td>0.875</td>
<td>Senior High School</td>
</tr>
<tr>
<td>6</td>
<td>2018</td>
<td>Fatimah et al.</td>
<td>Proceeding</td>
<td>44</td>
<td>0.516</td>
<td>Junior High School</td>
</tr>
<tr>
<td>7</td>
<td>2019</td>
<td>Anna Jayanti &amp; Anggi Ajeng Widyaninggar</td>
<td>Journal</td>
<td>42</td>
<td>0.35</td>
<td>Vocational School</td>
</tr>
<tr>
<td>8</td>
<td>2019</td>
<td>Usep Rahayu Mulyana &amp; Aflich Yusnita Fitrianna</td>
<td>Journal</td>
<td>32</td>
<td>0.349</td>
<td>Junior High School</td>
</tr>
<tr>
<td>9</td>
<td>2019</td>
<td>Yuni Supriyatin</td>
<td>Journal</td>
<td>91</td>
<td>0.814</td>
<td>Vocational School</td>
</tr>
<tr>
<td>10</td>
<td>2020</td>
<td>Azizah Tri Rahmah &amp; Aniswita</td>
<td>Journal</td>
<td>34</td>
<td>0.69</td>
<td>Islamic Junior High School</td>
</tr>
<tr>
<td>11</td>
<td>2020</td>
<td>Irhamna et al.</td>
<td>Journal</td>
<td>235</td>
<td>0.398</td>
<td>Junior High School</td>
</tr>
<tr>
<td>12</td>
<td>2020</td>
<td>Muhammad Sapi'I</td>
<td>Undergraduate Thesis</td>
<td>101</td>
<td>0.468</td>
<td>Islamic Senior High School</td>
</tr>
<tr>
<td>13</td>
<td>2021</td>
<td>Irham Habibi Harahap</td>
<td>Journal</td>
<td>73</td>
<td>0.529</td>
<td>Islamic Junior High School</td>
</tr>
<tr>
<td>14</td>
<td>2021</td>
<td>Ikha Yullati</td>
<td>Journal</td>
<td>79</td>
<td>0.65</td>
<td>Islamic Junior High School</td>
</tr>
<tr>
<td>15</td>
<td>2021</td>
<td>Siti Kharimatul Khotimah</td>
<td>Undergraduate Thesis</td>
<td>36</td>
<td>0.59</td>
<td>Senior High School</td>
</tr>
<tr>
<td>16</td>
<td>2022</td>
<td>Farida Susantina</td>
<td>Journal</td>
<td>90</td>
<td>0.27</td>
<td>Junior High School</td>
</tr>
<tr>
<td>17</td>
<td>2022</td>
<td>Dian Endang Lestari et al.</td>
<td>Journal</td>
<td>67</td>
<td>0.397</td>
<td>Senior High School</td>
</tr>
<tr>
<td>18</td>
<td>2022</td>
<td>Sri Hastuti Noer</td>
<td>Journal</td>
<td>36</td>
<td>0.588</td>
<td>Senior High School</td>
</tr>
<tr>
<td>19</td>
<td>2022</td>
<td>Arisman Zeuba et al.</td>
<td>Journal</td>
<td>15</td>
<td>0.282</td>
<td>Senior High School</td>
</tr>
<tr>
<td>20</td>
<td>2022</td>
<td>Endah Sethiya Rini</td>
<td>Undergraduate Thesis</td>
<td>28</td>
<td>0.918</td>
<td>Elementary School</td>
</tr>
</tbody>
</table>
Based on Table 2, there are 20 studies that investigate the correlation between learning motivation and mathematical problem-solving skills in Indonesia. Of the 20 studies, 13 studies calculated and reported the correlation value (r) in published articles while the others only wrote down the t or F values so that they were converted to r values using the formula previously described.

When all the r values have been obtained, it is clear that the correlation values are extremely varied, ranging between 0.221 and 0.918. Learning motivation has a big impact on mathematical problem-solving skills, as shown by the positive sign in the r-value of all studies. Diversity also occurs in the many samples used in the articles which are in the range of 15 to 235 so that the total sample is 1498 students who are at the elementary, middle/MTs, SMA/MA/SMK levels.

The next step in the meta-analysis is to test publication bias with a funnel plot diagram and use Fail-safe N Rosenthal.

Figure 1 shows the funnel diagram’s effect size or correlation (r) distribution spreads symmetrically on the left and on the right, indicating that the publications under observation are not susceptible to publication bias. To strengthen this opinion, the Fail-safe N test is used in Table 3. Based on Table 3, the N value is 3845. Through manual calculations, N/(5k+10) = 3485/ 5(20) + 10 = 31.68. Since the results obtained were 31.68>1, this finding means that all primary studies included in the meta-analysis process are resistant to publication bias. In the table, the p-value < 0.001 indicates that the pooled effect sizes of each of the primary studies are not susceptible to publication bias. So that in general the studies analyzed are resistant to publications so there is no need to add or subtract the observed publication samples. The selection of a suitable model for carrying out the next test is through the Q-value shown in Table 4.
The summary of the heterogeneity test results based on effect size values is shown in Table 4. The model chosen for the following analysis is based on the table. The Q-value in the table presents the heterogeneity test and also indicates that not all distributions of correlation values are equal. This implies that each correlation study contributes to a statistically significant measure. The residual heterogeneity estimates in Table 5, which show an $I^2$ value of 88% and are extremely close to 100%, further support this. This indicates that a random effects model should be utilized. The next stage is to put the research hypothesis to the test, utilizing the following test hypothesis:

$H_0$: there is no significant influence between learning motivation and students' mathematical problem-solving abilities in Indonesia

$H_1$: there is a significant influence between learning motivation and students' mathematical problem-solving abilities in Indonesia

The decision of making criterion is rejecting $H_0$ if the $p$-value $\leq 0.05$.

Based on Table 6, it can be seen that the value of $z=7.851$ with $p$-value $< \alpha=0.05$. This shows that there is not enough evidence to accept $H_0$. So it can be inferred that there is a significant correlation between learning motivation and the problem-solving ability of students in Indonesia. More research is required to determine the strength of the correlation, which may be determined by computing the size aggregate effect value or the correlation summary value using the forest plot shown in Figure 2.
The summary effects of all the studies examined in this analysis are within their respective ranges, as shown in Figure 2. The random effect model's summary effect value, with a range of 0.22 to 1.58, is $z=0.63$. As previously mentioned, the correlation meta-analysis employs the z-fisher value in its calculation, therefore this number must be translated back into a correlation value ($r$). The total effect size of all the examined studies, as determined by manual computations, is 0.56, with a correlation value range of 0.21 to 0.92. The correlation value is in the category of moderate (Schober et al., 2018). The summary effect-size value that has been obtained based on data from the inconsistent correlation values of 20 literature give accurate, valid, and credible results.

The study's findings show that there is a positive correlation between students' propensity for problem-solving and learning motivation, with a summary effect size value of 0.56. This is supported by several findings (Hutajulu et al., 2019; Nisrina, 2018; Rahmah et al., 2020) that there is a significant influence between students' learning motivation and problem-solving abilities. This result was supported by the findings of a study by Zebua et al. (2022), which showed that student's willingness to learn is correlated with their propensity to solve mathematical problems. In other words, learning motivation affects how well students can solve mathematical problems.

Learning motivation is the main factor in motivating students to be motivated in learning mathematics and resulting in better student problem-solving abilities (Rahmah et al., 2020). (Hakasinawati et al., 2017) stated that solving math problems necessitates students' internal motivation, which transforms their energy into a source of
strength for task completion, ultimately leading to the optimal achievement of goals. This is because students who have high motivation tend to have a high desire to succeed and a strong need for learning so they are more enthusiastic in the learning process and solve problems.

Problem-solving abilities contribute a major role in learning mathematics and solving mathematical problems is the main goal that must be mastered by students in learning mathematics. According to Nada Nisrina (2018), problem-solving is a way of finding solutions to new situations. According to (Surya et al., 2016) study, students' logical, critical, analytical, creative, and systematic thinking skills will grow as they become more adept at solving mathematical problems. As a result, students' progress in learning will be influenced by their ability to solve mathematical issues.

CONCLUSION

According to the study's results and discussion, there is a significant positive correlation between learning motivation and students' mathematics problem-solving skills at the elementary, middle, and high school levels in Indonesia. Each study's effect size value differs significantly from the others, satisfying the heterogeneity presumption. A random effects model is used in further analysis as a consequence. Because the research under consideration is not subject to publication bias, the publications under consideration represent the population. Thus, the model's calculated summary effect value through random effects is 0.56, which is at a moderate level and ranges from 0.21 to 0.92. With a coefficient of determination ($R^2$) of 0.31, it means that learning motivation contributes 31% to influencing mathematical problem-solving abilities. The findings of this study are anticipated to offer teachers and students crucial information on the need to maximize learning motivation in order to raise students' problem-solving skills and meet learning objectives. Other researchers can also replicate this study with more databases or a wider area coverage so that it involves a larger population and sample.

REFERENCES


