Meta-analysis Study: Effect of Problem Solving Learning Model on Problem Solving Ability in Students’ Science Learning SMP-SMA

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Abstract: In the era of the industrial revolution 4.0, the education system has used technology to assist the learning process. Technology-based learning makes it easy for students and teachers to carry out learning activities. However, teachers have not been able to optimally develop students' potential, low student learning outcomes and low problem-solving abilities in students. Problem solving ability is very important for a student in learning science. Problem-solving skills in science learning are the main key to training students' scientific thinking in solving phenomena in science. So, it is necessary for a teacher to improve the learning model for those who are able to develop students' problem solving abilities. Problem solving learning is a learning model based on problem solving. In addition, the problem solving learning model helps teachers to be more creative in carrying out the teaching and learning process. This study aims to analyze the effect of problem solving learning models on students' problem solving abilities in science learning. The data source for this research comes from an analysis of 30 national or international journals that have been published from 2010-2022. The search for data sources came from the Google Scholar, ScienceDirect, Emerald, Eric, Springer, Hindawi, ProQuest, Sage Journal, Wiley and Taylor of Francis databases. Sampling in this study was carried out by using purposive sampling technique. The data that can be used is related to the research variable. Furthermore, the research data search keywords are problem solving learning models, problem solving skills and science learning. Data analysis is a descriptive quantitative analysis technique with the help of the OpenMEE application. The results of the study concluded that the problem solving learning model had a significant influence on students' problem solving abilities in science learning with an effect size of 1.808, an average value of 83 and a standard deviation of 0.45

Keywords: Learning; Problem solving; Problem solving ability; Science

Introduction

The 21st century has had a huge influence on the progress of the world of education (Zorlu & Zorlu, 2021; Osman & Marimuthu, 2010; Güven & Alpaslan, 2022). Education has used technology as an aid to the learning process. In this 21st century learning, teachers must have hard skills and soft skills in developing students' potential (Semilarski et al., 2021). Furthermore, students are also trained to develop 21st century skills which consist of critical thinking, creative, collaborative and communication skills (Taar & Palojoki, 2022; Turhan & Demirci, 2021; Kara et al., 2022; Guo & Woulfin, 2016). These skills are needed by students in solving various phenomena that occur in life (Satria, 2018).

Teachers are educational staff who have a major role in training and developing students' knowledge in learning (Rizaldi et al., 2020). In the 2013 curriculum a teacher has applied 21st century learning. 21st century learning students must have the ability to think

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The ability to think scientifically functions to solve problems that occur in the learning process (Grushka et al., 2018; Hernández-Fernández, 2022; Ravinder et al., 2021). Science learning is one of the subjects that is still difficult for most students to understand in Indonesia (Matsun et al., 2021). In addition, students' problem-solving skills in science learning are low (Andika et al., 2020).

Science learning is a compulsory subject in schools that guides a student for scientific work (Lee et al., 2011; Ahmed, 2022). Furthermore, in learning science students must be able to apply the knowledge gained in everyday life (Hujatulatif et al., 2022). However, learning science is a subject that is still difficult for most students (Rahayu et al., 2012). Furthermore, Research by (Adiwiguna et al., 2019) states that 78% of students in Indonesia are only able to work on low category questions. Not only that, the results of the Indonesian PISA (Proram for International Student Assessment) study show that the level of learning science for Indonesian students is still relatively low with a score below 500 (Suhaimi et al., 2022; Ichsan et al., 2022). So, it is necessary to have a teacher's efforts to improve the quality of learning by improving the learning model (Santosa et al., 2021).

The problem solving learning model is a learning model that is able to increase the effectiveness of students in problem solving (Holder et al., 2017; Parwati et al., 2018; Kern, 2002). Student problem solving learning models can solve problems, discuss problems, and are able to provide solutions to any problems given by the teacher in the teaching and learning process (Hodiyanto, 2017). In addition, the problem solving learning model has five stages which consist of defining the problem, diagnosing the problem, formulating alternative strategies, determining and implementing the chosen strategy, and evaluating the problem (Turnip et al., 2016; Tampubolon & Sitindaon, 2013; Surya et al., 2017).

Research by Putri et al. (2018) stated that the problem-solving learning model was able to improve conceptual understanding and motivation to learn the rest in science learning. Research by Kopparla et al. (2019) states that the problem solving model can improve the solving abilities of elementary school students. Furthermore, research by Muhammad (2015) states that the problem solving learning model has a positive influence on students' problem solving abilities in students' mathematics learning. According to Gunawan et al. (2020) problem solving models are able to encourage students' critical thinking skills in science learning. Based on the problems above, this study aims to analyze the effect of problem solving learning models on problem solving abilities in science learning for junior high school students.

### Method

Research is a type of quantitative research with meta-analysis method. Meta-analysis research is a type of research that conducts a literature search that can be analyzed statistically (Santosa et al., 2021). The source of the data in this study came from an analysis of 30 national and international journals published in 2010-2022. The data search process was through Google Scholar, ScienceDirect, Emerald, Eric, Springer, Hindawi, ProQuest, Sage Journal, Wiley and Taylor of Francis. Data selection was carried out systematically and thoroughly. Data collection techniques in research are observation by observing the research components to be studied.

The sampling technique is a purposive sampling technique. The sample used for this research data must have a relationship with the research variable. The keywords used in the data search were problem solving learning models, problem solving abilities and science learning. The data analysis technique in this study is descriptive quantitative data analysis by calculating the Effect size, Mean and Standard Deviation values with the help of the OpenMEE application. The effect size criteria can be seen in table 1.

<table>
<thead>
<tr>
<th>Effect Size</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00 ≤ ES ≤ 0.20</td>
<td>Ignored</td>
</tr>
<tr>
<td>0.20 ≤ ES ≤ 0.50</td>
<td>Small</td>
</tr>
<tr>
<td>0.50 ≤ ES ≤ 0.80</td>
<td>Currently</td>
</tr>
<tr>
<td>0.80 ≤ ES ≤ 1.30</td>
<td>Tall</td>
</tr>
<tr>
<td>1.30 ≤ ES</td>
<td>Very High</td>
</tr>
</tbody>
</table>

Furthermore, statistical analysis in this study was carried out by calculating the effect size of each study and the combined effect size; Perform heterogeneity tests and choose an estimation model; carry out publication bias checks and calculate P values with the aim of testing the research hypotheses analyzed with the help of Comprehensive Meta-Analysis (CMA) 3.0 software.

### Result and Discussion

**Result**

Results should be clear and From the results of an analysis of 125 national and international journals about the influence of problem solving learning models on problem solving abilities in science learning for high school-junior high school students. However, the results of the study based on the criteria contained 27 articles analyzed can be seen in the table 2.
Based on table 2 explains the analysis of 27 national and international journals regarding the effect of problem solving models on problem solving abilities in science learning with an average effect size of 1,808 very high criteria. This shows that the problem solving learning model has a significant influence on problem solving abilities in science learning. Furthermore, a publication bias test was carried out which can be seen in Table 3.

<table>
<thead>
<tr>
<th>Author</th>
<th>Hedge’s</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Sari et al., 2021)</td>
<td>0.325</td>
<td>Low</td>
</tr>
<tr>
<td>(Huang et al., 2020)</td>
<td>1.430</td>
<td>Very High</td>
</tr>
<tr>
<td>(Cooper et al., 2008)</td>
<td>0.781</td>
<td>Medium</td>
</tr>
<tr>
<td>(Khoiriyah &amp; Husamah, 2018)</td>
<td>2.140</td>
<td>Very High</td>
</tr>
<tr>
<td>(Alfin et al., 2019)</td>
<td>-0.302</td>
<td>ignored</td>
</tr>
<tr>
<td>(Sarican &amp; Akgunduz, 2018)</td>
<td>0.457</td>
<td>Low</td>
</tr>
<tr>
<td>(Fuad et al., 2019)</td>
<td>0.892</td>
<td>High</td>
</tr>
<tr>
<td>(Argaw et al., 2017)</td>
<td>3.210</td>
<td>Very High</td>
</tr>
<tr>
<td>(Kınaı̇ &amp; Bagceci, 2016)</td>
<td>-0.180</td>
<td>ignored</td>
</tr>
<tr>
<td>(Frerjean et al., 2018)</td>
<td>0.741</td>
<td>Medium</td>
</tr>
<tr>
<td>(Musna et al., 2021)</td>
<td>1.20</td>
<td>High</td>
</tr>
<tr>
<td>(Urene et al., 2012)</td>
<td>2.051</td>
<td>Very High</td>
</tr>
<tr>
<td>(Hong &amp; Diamond, 2012)</td>
<td>-0.285</td>
<td>ignored</td>
</tr>
<tr>
<td>(Klegeris &amp; Hurren, 2011)</td>
<td>2.654</td>
<td>Very High</td>
</tr>
<tr>
<td>(Senar, 2014)</td>
<td>2.780</td>
<td>Very High</td>
</tr>
<tr>
<td>(Subali et al., 2017)</td>
<td>0.451</td>
<td>Low</td>
</tr>
<tr>
<td>(Purwaningsih et al., 2020)</td>
<td>1.320</td>
<td>Very High</td>
</tr>
<tr>
<td>(Ahtokhi et al., 2021)</td>
<td>0.910</td>
<td>High</td>
</tr>
<tr>
<td>(Ahgar, 2012)</td>
<td>-0.650</td>
<td>ignored</td>
</tr>
<tr>
<td>(Batlolona et al., 2018)</td>
<td>1.070</td>
<td>High</td>
</tr>
<tr>
<td>(Haenilah et al., 2021)</td>
<td>0.651</td>
<td>Medium</td>
</tr>
<tr>
<td>(Yuberti et al., 2019)</td>
<td>3.150</td>
<td>Very High</td>
</tr>
<tr>
<td>(Yuberti et al., 2019)</td>
<td>0.120</td>
<td>Ignored</td>
</tr>
<tr>
<td>(Lin et al., 2021)</td>
<td>1.421</td>
<td>Very High</td>
</tr>
<tr>
<td>(Binar et al., 2020)</td>
<td>0.912</td>
<td>High</td>
</tr>
<tr>
<td>(Serin et al., 2009)</td>
<td>-0.631</td>
<td>ignored</td>
</tr>
<tr>
<td>(Cavallo, 2011)</td>
<td>0.450</td>
<td>Low</td>
</tr>
<tr>
<td>Average Effect Size</td>
<td>1.808</td>
<td>Very high</td>
</tr>
</tbody>
</table>

Based on table 3, it shows the results of the publication bias test, the effect size observed value is 0.674 and the adjusted value is 0.561. Furthermore, the heterogeneity test of the effect size distribution was carried out. The results of the heterogeneity test can be seen in table 4.

<table>
<thead>
<tr>
<th>Q-Value</th>
<th>df (Q)</th>
<th>P-value</th>
<th>I-squared</th>
<th>Q-Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.00</td>
<td>19</td>
<td>0.000</td>
<td>87.087</td>
<td>22.10</td>
</tr>
</tbody>
</table>

Based on table 4, the results of the heterogeneity test for the influence of the effect size of the problem solving learning model on problem solving abilities in science learning is 22.10. This explains that the heterogeneity of the effect size distribution influences the problem solving model used in this study, which is the random effect model. Furthermore, to see the effectiveness of the problem solving learning model on problem solving abilities in science learning, the N-Gain test was carried out. The results of the N-Gain test can be seen in table 5.

<table>
<thead>
<tr>
<th>Class</th>
<th>Pretest</th>
<th>Postest</th>
<th>Mean</th>
<th>SD</th>
<th>N-gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>60</td>
<td>50</td>
<td>30</td>
<td>90</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Based on table 5, the results of the N-gain test of the problem solving model on problem solving abilities are 0.72. Not only that, the problem solving model was able to increase student learning outcomes by 83. This shows that the problem solving learning model is effective in encouraging problem solving skills in science learning for junior high school students. So, a teacher must apply the problem solving learning model in carrying out the teaching and learning process, especially in science subjects.

**Discussion**

The problem solving learning model is a learning model that can improve problem solving abilities in science learning for junior high school students. This can be seen from the results of the effect size of 1,808 very high criteria. So, the problem solving model has a significant influence on the problem solving abilities of students in junior and senior high schools. This is in line with research by Fülopp (2021) stated that the problem solving model had an influence on students' ability to solve a problem in the learning process. In addition, the problem solving model can increase the effectiveness of students in learning and assist students in analyzing problems that occur (Sudarsono et al., 2022; Hobri et al., 2020). Menurut Zulkarnain et al. (2020) stated that the problem solving model was able to foster students' critical and creative thinking skills in learning science for junior and senior high school students.

Furthermore, based on the results of the N-gain test of 0.72, the problem solving model is effective in helping students solve various problems that occur in learning science. Ridwan et al. (2021) stated that the problem
solving learning model was able to encourage critical thinking skills and problem solving for students. However, a teacher’s problem solving model must have better teaching skills. In learning science, junior and senior high school students have applied a way of thinking in solving problems. Therefore, the problem solving model is a solution for teachers to develop students’ competence in learning science (Sudarsana et al., 2019). Besides that, Susanti et al. (2021) problem solving models make it easier for students to master learning concepts.

Applying the right learning model will make it easier for students to understand the lessons conveyed by the teacher (Yapatang & Polyiem, 2022; Suharyat et al., 2022; Santosa & Yulianti, 2020). Teachers who have the ability to apply problem solving models will make students have competitiveness in facing the 21st century (Ichsan et al., 2022). In this 21st century learning, students must be able to solve various science problems that occur in everyday life. According to Parwati et al. (2018) states that the problem solving model is a very appropriate learning model to train students to solve problems in the learning process. Research by Surur et al. (2020) the problem solving model has a positive effect on improving students' cognitive skills in learning science. So, the problem solving learning model is a model that needs to be applied to junior and senior high school students in improving problem solving abilities (Ismail, 2020; Yunus et al., 2021).

Science learning is a learning that requires high critical thinking skills in solving scientific phenomena (Razak et al., 2021). Science learning at the present time is a subject that must be mastered by junior and senior high school students. Research by Suharyat et al. (2022) Science learning is a subject that requires students to think scientifically and be able to solve science problems quickly and precisely in life. Not only that, the problem solving model used by the teacher in the teaching and learning process will make it easier for students to think scientifically and critically in learning science (Satria & Sopandi, 2019).

Conclusion

From the research that has been done, it is concluded that the problem solving learning model has a significant influence on students' problem solving abilities in science learning with an effect size of 1.808, an average value of 83 and a standard deviation of 0.45. The problem solving model gives positive results in encouraging ability solving student problems in learning science in junior and senior high schools. In addition, the problem solving model is able to improve student learning outcomes in learning.

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Author Contributions

This research involved five researchers who had their respective roles. Yayat Suharyat: collecting and formulating research data; Linda Winiasri and Tomi Apra Santosa: conducting data selection process and statistical analysis; Abdul Rahman and Kartini Marzuki: Analyzed and interpreted the data.

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Conflicts of interest

Authors declare no conflict of interest.

References


students. JPB (Jurnal Pendidikan Biologi Indonesia), 4(2), 151–160. https://doi.org/10.22219/jpbj.v4i2.5804


Tampubolon, T., & Sitinda, S. F. (2013). Pengaruh Model Pembelajaran Problem Solving Terhadap...
https://doi.org/10.24114/inpafi.v1i3.1915

https://doi.org/10.1021/ed1011844


https://doi.org/10.29333/IJI.2021.14128A