META-ANALYSIS OF THE EFFECT OF THE APPLICATION OF THE PROBLEM-BASED LEARNING MODEL ON THE MATHEMATICAL PROBLEMSOLVING ABILITY OF STUDENTS IN MATHEMATICS LEARNING

Chintya Novelia, Ali Asmar, Edwin Musdi, Armiati
Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Negeri Padang, Indonesia
Email: chintyanovelia2511@gmail.com

Abstract

Students' problemsolving abilities can be improved in one way, namely by choosing the right mathematics learning model. One learning model that can be used is the problembased learning model. The aim of this research is to re-analyze the influence of the problembased learning model on students' mathematical problemsolving abilities by reviewing, summarizing data and analyzing several research results that have been published on Google Scholar as many as 14 articles using statistical methods. The type of research in this article is meta-analysis research. The research steps include data collection, coding, calculating the increase in problem solving abilities and effect size, and drawing conclusions. Based on the research results, the average effect size is 2.02 in the very large category. Based on the average effect size, it can be concluded that the problembased learning model influences students' mathematical problemsolving abilities.

Keywords: problem solving ability; meta analysis; problem based learning

INTRODUCTION

Mathematics is one branch of science that has an important role in the development of science and technology. Mathematics is a compulsory subject for students from elementary school to university. Success in mathematics will help learners take good decisions and prepare them to compete in economics and technology (Siregar et al., 2020). The five basic standards of learning mathematics include mathematical communication, mathematical reasoning, mathematical problem solving, mathematical connections, and a positive attitude towards mathematics (Aini & Mukhlis, 2020). Problem-solving skills are an important part of learning maths (Umrana et al., 2019). Even problem-solving skills are considered important in math learning (Argarini, 2018).

The ability to solve problems is a step to find solutions to problems that arise in everyday life. According to (Umrana et al., 2019). Problem solving is the process followed by students to solve a problem they face until it is no longer a problem. According to Polya in Rusmana, (2020) states that there are four stages of problemsolving steps, namely understanding the problem, planning the solution, solving the problem and re-examining the resolution. One way to improve students' problem-solving skills is to choose the appropriate mathematical learning model. One of the learning models that can be used is the problem-based learning model.

Problem-based learning is an innovative learning model that teaches many important strategies to meet the skills needs of the 21st century (Surur & Tartilla, 2019). Problem-based learning is a problem-based learning model that can help students understand learning material, which in turn can develop their thinking skills (Kodariyati & Astuti, 2016). Problem-based learning can train and develop the ability of students to solve problems related to real problems in everyday life (Oktaviani et al., 2018). The syntax of the problem-based learning model according to Arends in Oktaviani et al., (2018) that is (1) Provide problem orientation to students, (2) organizing learners to research, (3) assist in investigating both independently and in groups, (4) develop and subsequently present the work of students, (5) analyze and evaluate the process in solving existing problems (Dutertre, 2015).

This study aims to quantitatively analyze the influence of problem-based learning models on the ability to solve students' mathematical problems in mathematics learning.

RESEARCH METHOD

This research is a type of quantitative research that uses data analysis techniques, especially meta-analysis. Meta-analysis is a technique used to summarize the results of two or more studies with the aim of combining, reviewing, and summarizing previous studies. In addition, using meta-analyses, many different questions can be investigated based on data from previously published research findings. According to Card in Utami, (2017) states that the meta-analysis is a synthesis of several studies that focus on the results obtained in the study. According Saputri & Wardani, (2021) states that meta-analysis is research conducted by reviewing, summarizing data, and analyzing many existing research results using statistics. While according to Soetjipto, (1995) Meta-analysis is an attempt to summarize various research findings quantitatively. One of the conditions needed to conduct a meta-analysis is the examination of the results of similar studies. The population used in this study is 14 articles which are educational journal articles and thesis research and dissertations in national journals published within the last 10 years about the influence of *problem-based* learning models on students' problem-solving abilities in mathematics learning. The research steps used in this article include:

Data collection

The first step in this research is to collect articles found on *Google Scholar*. Criteria used to collect articles according to Saputri & Wardani, (2021) as follows:
1. The selected article is a published article
2. The selected articles are articles published in the last 10 years.
3. The selected article uses a *problem-based learning model* as an independent variable.
4. The selected article uses mathematical problem-solving capabilities as a dependent variable.
a. The samples used in the article range from elementary to tertiary level.
   Based on these criteria, 14 relevant articles were selected to be analyzed.

Coding

Coding is an important requirement to facilitate data collection and analysis. Therefore, the meta-analysis tool is carried out using coding tables (Boisandi & Darmawan, 2017). The variables used to encode and produce the necessary information are the name of the researcher, year of study, title of study, level of education, and research data. Each article is coded from A1 to A14 according to predefined variables. The following examples of meta-analysis coding results are presented in Table 1:

Table 2. *Meta-Analysis* **Coding Examples**

No	Kode	Heading Research	Name Researchers	Year	Ladder Education	Average Pretes	Postest
1	A1	The effectiveness of *the Problem Based Learning* Model is seen from the Mathematical Problem Solving Ability	Nurma Angkotasan	2014	SMA	70,28	82,95
2	A2	Improving Students' Mathematical Problem Solving Ability through Problem-Based Learning	Tina Sri Sumartini	2016	SMK	44,03	71,81
3	A3	The Effect of Problem-Based Learning on the Mathematical Problem Solving Ability of High School Students	Ibnu Imam Al Ayubi, Erwanudin, Martin Bernard	2018	SMA	69,42	89,62

Calculation of the increase in problem-solving ability (N-gain) and *effect size of* each article

To determine the increase in problem-solving ability in this study, the N-gain test was used. Meanwhile, to find *the effect size of* each item, Cohen's formula is used in (Ambarika & Wardani, 2021;

Meta-Analysis of the Effect of the Application of the Problem-Based Learning Model on the Mathematical Problemsolving Ability of Students in Mathematics Learning

e-ISSN 2774-5155
p-ISSN 2774-5147

Saputri & Wardani, 2021) as follows.

$$Effect\ size = \frac{Posttest\ average\ score - Pretest\ average\ score}{Standart\ deviation}$$

Tabel 2. Kriteria Penilaian *Effect size*

Effect size	Interpretasi
0 < d < 0,2	Kecil
0,21 < d ≤ 0,50	Sedang
0,51 < d ≤ 1,00	Besar
d > 1,00	Sangat Besar

RESULT AND DISCUSSION

Based on the data collection steps carried out by searching for articles on Google Scholar, 14 articles will be analyzed. The following are the results of grouping articles based on education level, independent variables and dependent variables.

Table 3. Grouping of Article Analysis Results Data

Types of analysis	Hasil analisis	Jumlah analisis
Education Level	SD/MI	6
	SMP	2
	SMA/SMK	5
	Perguruan Tinggi	1
Variabel Terikat	Kemampuan pemecahan masalah matematis	14
Variabel Bebas	Model Problem Based Learning	14

Based on Table 3, it is known that there are 6 articles with research subjects at the elementary level, 2 articles at the junior high school level, 5 articles at the high school / vocational level and 1 article at the university level. The bound variable included in each item is mathematical problem-solving ability. While the free variable is the problem-based learning model.

Calculation of the increase in problem-solving ability (N-gain) and effect size of each article

Table 4. Analysis Results of Improved Problem Solving Ability Based on Gain Test

No	Kode Artikel	Rata-rata pretest	Rata-rata postest	Gain	Keterangan
1	A1	67,32	74,75	0.23	Low
2	A2	70,28	82,95	0.43	Intermediate
3	A3	69,43	81,50	0.39	Keep
4	A4	60,25	68,61	0.21	Low
5	A5	44,03	71,81	0.50	Intermediate
6	A6	69,42	89,62	0.66	Intermediate
7	A7	41,33	61,77	0.35	Intermediate
8	A8	9,24	42,91	0.37	Intermediate
9	A9	32,34	76,71	0.66	Intermediate
10	A10	49,78	75,66	0.52	Intermediate
11	A11	60,83	84,17	0.60	Intermediate
12	A12	44,04	74,67	0.55	Intermediate
13	A13	71,19	95,61	0.85	Higt
14	A14	11,01	84,12	0.82	Higt

Based on Table 4, it is known that there are 10 items of problem solving skill improvement with medium category, 2 items with low category, and 2 items with high category.

Table 5. Effect Size Article

No	Kode Artikel	Effect Size	Keterangan
1	A1	0.58	Big
2	A2	0.98	Big
3	A3	0.94	Big
4	A4	0.65	Big
5	A5	2.16	Very big
6	A6	1.57	Very big
7	A7	1.59	Very big
8	A8	2.62	Very big
9	A9	3.45	Very big
10	A10	2.01	Very big
11	A11	1.81	Very big
12	A12	2.38	Very big
13	A13	1.90	Very big
14	A14	5.68	Very big
Rata-rata Effect Size		2,02	Very big

Based on Table 5, it is known that there are 4 articles with large category effect sizes and 10 articles with very large category effect sizes.

Tabel 6. Effect size Artkel Berdasarkan Jenjang Pendidikan

No	Jenjang Pendidikan	Jumlah artikel	Rata-rata Effect size	Keterangan
1	SD/MI	6	1.97	Sangat Besar
2	SMP	2	1.83	Sangat Besar
3	SMA/SMK	5	3.80	Sangat Besar
4	Perguruan Tinggi	1	1.90	Sangat Besar

From Table 6, it can be seen that the level of influence of the application of problem-based learning models on problem-solving abilities at each level of education is in a very broad category. The effect size for the elementary / MI level is 1.97, the junior high school level is 1.83, the high school / vocational level is 3.80, and the higher education level is 1.90.

The results of the meta-analysis of the effect of problem-based learning on the ability to solve mathematical problems in mathematics learning were seen in the improvement before and after the test, most of which were in the moderate category. There are 10 items in the medium category, 2 items in the low category, and 2 items in the high category. Problem solving skills increase because the learning process follows a problem-based learning model, students understand the problem given faster because right at the beginning of the learning activity, the teacher has provided the delivery material (Susilowati, 2020).

CONCUSSION

The problem-based learning model affects the ability of students to solve mathematical problems, this is shown from the results of the effect size test. Based on effect size, there was an increase in problem solving before and after treatment with the problem-based learning model, with an average effect size of 2.02 at a very large level. Recommendations for future research include the use of more articles and a more careful selection of articles used in meta-analysis studies.

REFERENCESS

Aini, N. N., & Mukhlis, M. (2020). Analisis Kemampuan Pemecahan Masalah Pada Soal Cerita Matematika Berdasarkan Teori Polya Ditinjau Dari Adversity Quotient. Alifmatika: Jurnal Pendidikan Dan Pembelajaran Matematika, 2(1), 105–128.

Ambarika, R., & Wardani, L. K. (2021). Analisis Hubungan Perilaku Caring Dengan Tingkat Kepuasan

Meta-Analysis of the Effect of the Application of the Problem-Based Learning Model on the Mathematical Problemsolving Ability of Students in Mathematics Learning

e-ISSN 2774-5155
p-ISSN 2774-5147

Pelayanan Kesehatan. The Indonesian Journal Of Health Science, 13(1), 53–60.

Argarini, D. F. (2018). Analisis Pemecahan Masalah Berbasis Polya Pada Materi Perkalian Vektor Ditinjau Dari Gaya Belajar. Matematika Dan Pembelajaran, 6(1), 91–100.

Boisandi, B., & Darmawan, H. (2017). Meta Analisis Pengaruh Penerapan Pembelajaran Berbasis Konstruktivisme Pada Materi Fisika Di Kalimantan Barat. Jurnal Ilmiah Pendidikan Fisika Al-Biruni, 6(2).

Dutertre, B. (2015). Solving Exists/Forall Problems With Yices. Workshop On Satisfiability Modulo Theories.

Kodariyati, L., & Astuti, B. (2016). Pengaruh Model PBL Terhadap Kemampuan Komunikasi Dan Pemecahan Masalah Matematika Siswa Kelas V SD. Jurnal Prima Edukasia, 4(1), 93–106.

Oktaviani, B. A. Y., Mawardi, M., & Astuti, S. (2018). Perbedaan Model Problem Based Learning Dan Discovery Learning Ditinjau Dari Hasil Belajar Matematika Siswa Kelas 4 SD. Scholaria: Jurnal Pendidikan Dan Kebudayaan, 8(2), 132–141.

Rusmana, I. M. (2020). Pembelajaran Matematika Menyenangkan Dengan Aplikasi Kuis Online Quizizz. Prosiding Sesiomadika, 2(1a).

Saputri, Y., & Wardani, K. W. (2021). Meta Analisis: Efektivitas Model Pembelajaran Problem Solving Dan Problem Based Learning Ditinjau Dari Kemampuan Pemecahan Masalah Matematika SD. Jurnal Cendekia: Jurnal Pendidikan Matematika, 5(2), 935–948.

Siregar, N., Fauzi, K. A., & Hasratuddin, H. (2020). Pengembangan Bahan Ajar Berbasis Pembelajaran Matematika Realistik Untuk Meningkatkan Kemampuan Komunikasi Matematis Siswa. Jurnal Pendidikan Matematika (JPM), 6(2), 70–77.

Soetjipto, H. P. (1995). Aplikasi Meta-Analisis Dalam Pengujian Validitas Aitem. Buletin Psikologi, 3(2), 20–28.

Surur, M., & Tartilla, T. (2019). Pengaruh Problem Based Learning Dan Motivasi Berprestasi Terhadap Kemampuan Pemecahan Masalah. Indonesian Journal Of Learning Education And Counseling, 1(2), 169–176.

Susilowati, R. D. (2020). Efektivitas Model Pembelajaran Inquiry Dan Problem Based Learning Terhadap Kemampuan Pemecahan Masalah Pada Mata Pelajaran Matematika Kelas IV SD. JEMS: Jurnal Edukasi Matematika Dan Sains, 8(1), 49–59.

Umrana, U., Cahyono, E., & Sudia, M. (2019). Analisis Kemampuan Pemecahan Masalah Matematis Ditinjau Dari Gaya Belajar Siswa. Jurnal Pembelajaran Berpikir Matematika, 4(1), 67–76.

Utami, C. T. (2017). Self-Efficacy Dan Resiliensi: Sebuah Tinjauan Meta-Analisis. Buletin Psikologi, 25(1), 54–65.