



Systematic Literature Review: Implementation of Problem Based Learning (PBL) on Students' Mathematical Cognitive and Affective Aspects

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ABSTRACT

Problem Based Learning (PBL) is a learning model that is often used and is believed to be able to improve the skills needed by students in the 21st century. This study aims to determine and analyze the effect of PBL on Cognitive and Affective abilities in learning mathematics. This research is a Systematic Literature Review (SLR) study, in this study 19 relevant articles were selected from the 73 articles collected. The findings from the process of analyzing the article are that PBL can improve students' thinking skills, problem-solving abilities, and students' mathematical understanding which also results in a positive impact on student learning outcomes, these abilities are the cognitive aspects of students. PBL also has an influence on students' affective aspects, after getting PBL learning students have learning motivation, self-efficacy, and positive mathematical communication skills.

Keywords: affective skill; cognitive skill; mathematical learning; problem based learning

INTRODUCTION

Technological developments in the 21st century have a positive effect on life. In line with that, learning in the 21st century must also produce students who have comprehensive abilities to face problems and are globally competitive. In the current era, learning is starting to change from focusing on the teacher as the center of learning or teacher-centred to students being the focus or center of learning or what is usually called student-centred. In mathematics learning itself, the NCTM (National Council of Teachers of Mathematics) includes cognitive aspects, skills and the use of mathematics in everyday life as part of the objectives of mathematics learning. This goal also emphasizes the process of reasoning, communication, and solving problems then presenting students' ideas (NCTM, 2000). In accordance with the objectives of mathematics learning and the needs of the 21st century, PBL (problem based learning) is believed to be a learning model that can support all of this.

In the 1980s, the PBL approach began to be implemented in various higher education institutions throughout the world, including in the United States, Europe and Asia. Over time, PBL has become very popular in the world and is widely used throughout the world (Silva et al., 2018). In the 1980s, the PBL approach began to be applied in various higher education institutions throughout the world, including in the United States, Europe and Asia. Nowadays, PBL can be applied widely and at various levels of education, for example at elementary, middle and high school levels. Universities and Professional Education (Torp & Sage, 2002).

With the help of facilitated problem solving, students who learn through PBL will focus on learning with complex problems. To determine what students should do to solve a problem, students will work together in groups, students will participate in self-directed learning (SDL), then apply their newly acquired knowledge to their problem, and then record their progress and the success of their approaches. choose (Hmelo-Silver, 2004). PBL places learning in the context of real world problems and makes students responsible for their learning, PBL is a good learning model to help students become active learners. This places equal emphasis on assisting students in constructing knowledge and developing student learning strategies (Collins et al., 1989; Vanderbilt, 1997).

As a result, it is considered that implementing PBL into the learning process can help students become more adept at solving problems and working in groups. With that in mind, this research was conducted to systematically summarize the influence of problem-based learning (PBL) on mathematics learning. Mathematics learning consists of two aspects, namely cognitive and affective. Through a literature review, researchers understand the concept of PBL, choose appropriate research methodology, and evaluate the impact of PBL on students' cognitive and affective aspects. Literature study also helps identify challenges, success factors. This research relies on an in-depth understanding of the literature to form a solid basis for exploring the effectiveness of PBL in mathematics learning. In this research, the cognitive aspect is limited to the scope of several abilities, namely: critical thinking, achievement or learning outcomes, mathematical understanding. Meanwhile, affective abilities are limited to the scope of several abilities, namely: learning motivation and self-efficacy. So, we will discuss the impact of PBL on mathematics learning from cognitive and affective aspects?

RESEARCH METHODS

The method used in this scientific article is Systematic Literature Review (SLR), which aims to summarize the results of relevant research, to present the truth in a more complete and balanced manner (Rahmawati & Juandi, 2022). With this SLR research method, researchers review and identify related articles which are structured and systematic in accordance with established rules (Thovawira et al., 2021).

Researchers conduct research in accordance with the steps set for conducting SLR, namely, formulating research questions, searching for relevant literature or articles, establishing inclusion criteria to help select articles, collecting data from articles for analysis, reporting research findings from articles (Thovawira et al., 2021). Access, completeness, uniqueness, and originality of content are the four criteria used to select articles for SLR (Maren, 1996). Therefore, in this study researchers reviewed data collected from articles contained in Google Scholar, Sinta, Semantic Scholar, Education Resources Information Center (ERIC) and Directory Open Access Journal (DOAJ). The selection of articles is based on appropriate research questions, with keywords in searching for articles namely "problem based learning, mathematics", "PBL in mathematics learning", "PBL on Mathematical abilities", "PBL on affective abilities". With the last 10 time periods when the research was used, namely 2013 to 2023, which have been selected and sorted according to the criteria. The articles used are then analyzed and tabulated in tables in the form of authors, journals

and research results. In this article, the results of several articles that have been reviewed and concluded will be discussed.

RESULTS AND DISCUSSION

Mathematics learning places great emphasis on problem solving, Munir, et al (2012) said that it is important in mathematics learning to build skills in understanding problems, making mathematical models, solving problems, and finding solutions. Problems that are relevant to the situation must be introduced to start learning mathematics (Contextual problem). Students are gradually directed to learn mathematical ideas by posing contextual challenges. PBL (Problem-Based Learning) is a teaching strategy that emphasizes problem solving in the context of actual cases or scenarios. Barrow (1996) claims that PBL helps children gain cognitive and non-cognitive abilities, including independence, cooperation, and critical thinking skills.

Several studies reveal the application of PBL in mathematics learning, the results of which show the influence of learning using PBL on students' cognitive and affective abilities. Some results of the application of PBL based on previous research are presented in Table 1. Based on studies using SLR in the application of PBL in mathematics learning, there are several results that show its influence on cognitive aspects such as learning outcomes, mathematical understanding, critical thinking abilities, and problem solving abilities. Not only that, there are several research results that state the influence of PBL on non-cognitive abilities or personality aspects or affective aspects, such as learning motivation, student self-efficacy, and communication skills.

Table 1. Selected Article

No	Author (Years)	Research Title	Ability Types
1	(Zetriuslita et al., 2017)	<i>Mathematical Critical Thinking and Curiosity Attitude in Problem Based Learning and Cognitive Conflict Strategy: A Study in Number Theory course</i>	Cognitive (Critical Thinking)
2	(Prihono & Khasanah, 2020)	Pengaruh Model <i>Problem Based Learning</i> Terhadap Kemampuan Berpikir Kritis Matematis Siswa Kelas VIII SMP	Cognitive (Critical Thinking)
3	(Asyari et al., 2015)	<i>Improving critical thinking skills through the integration of problem based learning and group investigation</i>	Cognitive (Critical Thinking)
4	(Widayanti & Dwi, 2020)	Penerapan Model Pembelajaran <i>Problem Based Learning</i> untuk Meningkatkan Prestasi Belajar Matematika dan Aktivitas Siswa	Cognitive (learning achievement/learning outcomes)
5	(Amiluddin & Sugiman, 2016)	Pengaruh Problem Posing dan PBL Terhadap Prestasi Belajar dan Motivasi Belajar Mahasiswa Pendidikan Matematika	Cognitive (learning achievement/learning outcomes) and affective (learning motivation)
6	(Fauzia, 2018)	Penerapan Model <i>Pembelajaran Problem Based Learning</i> Untuk Meningkatkan Hasil Belajar Matematika SD	Cognitive (learning outcomes/learning achievements)

7	(Fachri & Paloloang, 2014)	Penerapan Model <i>Problem Based Learning</i> (PBL) untuk Meningkatkan Hasil Belajar Siswa Pada Mateteri Panjang Garis Singgung Persekutuan Dua Lingkaran di Kelas VIII SMP Negeri 19 Palu	Cognitive (learning outcomes/learning achievements)
8	(Eviliasani et al., 2022)	<i>Problem-Based Learning Assisted by GeoGebra to Improve Students' Mathematical Understanding</i>	Cognitive (mathematical understanding)
9	(Astuty & Ansari, 2022)	<i>Improvement of student's mathematical understanding ability through problem based learning</i>	Cognitive (mathematical understanding)
10	(Tyata et al., 2021)	<i>Exploring Project-Based Teaching for Engaging Students' Mathematical Learning</i>	Cognitive (mathematical understanding)
11	(Masitoh & Fitriyani, 2018)	<i>Improving Students' Mathematics Self-Efficacy through Problem Based Learning</i>	Affective (Self-efficacy)
12	(Chrsitianti Ginting et al., 2023)	<i>Development of Learning Materials through PBL with Karo Culture Context to Improve Students' Problem Solving Ability and Self-Efficacy</i>	Cognitive and Affective (problem solving and self-efficacy)
13	(Ratnaningsih, 2017)	<i>The Analysis Of Mathematical Creative Thinking Skills And Self efficacy Of High Students Built Through Implementation Of Problem Based Learning And Discovery Learning.</i>	Affective (Self-efficacy)
14	(Rianti Rahmalia et al., 2020)	Meningkatan Kemampuan Komunikasi Matematis dan Disposisi Matematis Siswa SMP Melalui Model <i>Problem Based Learning</i>	Affective (Mathematical Communication)
15	(Ningrum, 2016)	Meningkatkan Kemampuan Komunikasi Matematis Siswa Menggunakan <i>Problem Based Learning</i> berbasis <i>Flexible Mathematical Thinking</i>	Affective (Mathematical Communication)
16	(Harapit, 2018)	Peranan <i>Problem Based Learning</i> (PBL) Terhadap Kemampuan Pemecahan Masalah Dan Motivasi Belajar Peserta Didik	Cognitive and Affective (Problem Solving and Learning Motivation)
17	(Nurjanah et al., 2022)	Penerapan Model <i>Problem Based Learning</i> terhadap Kemampuan Pemecahan Masalah Matematis Ditinjau dari Gaya Belajar Siswa SMP	Cognitive (Problem Solving)
18	(Septian & Komala, 2019a)	Kemampuan Koneksi Matematik Dan Motivasi Belajar Siswa Dengan Menggunakan Model <i>Problem-Based Learning</i> (PBL) Berbantuan Geogebra Di SMP	Affective (Learning Motivation)

19	(Aang & Muhaemin, 2020)	Peningkatan Hasil Belajar Matematika Siswa melalui Model Problem Based Learning	Cognitive (Learning Outcomes)
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The Effect of PBL on Cognitive Abilities

Aspects of cognitive abilities, the application of the PBL learning model in the classroom can improve mathematics learning outcomes, critical mathematical thinking abilities, and can also improve the ability to solve problems. There are a total of 5 articles that discuss the influence of PBL on student learning outcomes/achievement, 3 articles discuss its influence on critical thinking abilities, 3 articles discuss the influence on mathematical understanding, and 3 articles discuss the influence of PBL on problem solving abilities.

A total of 19 articles were selected, there were 5 articles that discussed the influence of PBL on learning outcomes or achievement. In this case, each article represents each level of education. In Fauzia's research (2018) it was said that PBL can improve student learning outcomes by up to 40%. At the junior high school level, the PBL learning model has a good effect and is concluded to improve the learning outcomes of junior high school students (Fauzia, 2018). In their research, Aang & Muhaemin (2020) stated that the application of the PBL learning model can improve the learning outcomes or achievements of high school students. Amiluddin & Sugiman (2016) in their research stated that PBL has a positive influence on student learning outcomes. Fachri & Paloloang (2014) in their research carried out learning using PBL learning steps, where the teacher orients students towards problems, organizes students to learn, guides problem solving, presents results, and also evaluates the results, from the learning process the results obtained are improvements learning outcomes. This shows that PBL can be an alternative for conducting classroom learning as an effort to improve student learning outcomes.

The application of the PBL learning model also influences students' critical thinking abilities. PBL is noted to be able to improve students' critical thinking abilities (Zetriuslita et al., 2017). The application of PBL encourages students to think critically through planning, arguing, stating questions and problems, as well as analyzing and providing solutions to environmental problems (Asyari et al., 2015). PBL can be an alternative learning model for teachers to use in the classroom to help students improve their critical thinking skills (Prihono & Khasanah, 2020).

Mathematical understanding is also one of the abilities that can be improved through the PBL learning approach. PBL is noted to be able to improve mathematical understanding abilities better than conventional learning (Astuty & Ansari, 2022). In their research Eviliasani, et al. (2022) stated that there was an increase in mathematical understanding ability through PBL model learning with the help of Geogebra learning media. The results of responses to online learning using Problem Based Learning approach teaching materials supported by GeoGebra were obtained from student and teacher response questionnaires as well as interview results. From these data, it can be concluded that overall, students' responses to PBL approach teaching materials supported by software GeoGebra is positive and shows a correlation between students' level of mathematical understanding and responsiveness to teaching materials (Eviliasani et al., 2022). The higher the students'

mathematical abilities, the more responsive they are to the PBL approach supported by GeoGebra software. Findings show that PBL is very helpful in involving students through questions, pair/group discussions, discovery learning, and concept mapping so that mathematical understanding abilities are formed (Tyata et al., 2021).

Furthermore, the PBL learning model also has a good effect on problem-solving abilities (Chrsitianti Ginting et al., 2023; Harapit, 2018). Nurjanah et al., (2022) in their research stated that the PBL learning model can improve problem solving abilities and have a significant effect on the learning process.

The Effect of PBL on Affective Ability

In the aspect of affective abilities, the application of the PBL learning model can increase students' learning motivation, self-efficacy, and mathematical communication skills. There are a total of 3 articles that discuss the influence of PBL on student learning motivation, 3 articles discuss its effect on self-efficacy, 2 articles discuss mathematical communication skills.

Of the total of 19 articles that have been selected, there are 3 articles that discuss the influence of PBL on students' learning motivation. PBL is considered to be able to increase students' learning motivation (Harapit, 2018; Septian & Komala, 2019a). In research conducted on mathematics education students, the PBL approach had a positive effect on student learning motivation, and PBL had a better effect on learning motivation compared to Problem Posing (Amiluddin & Sugiman, 2016). Learning with a PBL approach provides learning motivation which provides encouragement for students to actively participate in carrying out the learning process (Septian & Komala, 2019).

Self-efficacy is a person's belief in his or her abilities. In one study, the PBL learning model was revealed to be able to increase students' mathematics self-efficacy. At the end of cycle I, students' mathematics self-efficacy was still in the medium category and increased at the end of cycle II, students' mathematics self-efficacy was in the high category (Masitoh & Fitriyani, 2018). PBL can also be combined with local wisdom, one of which is KCC (Karo Culture Context), in this research PBL-KCC meets the effectiveness criteria and can increase students' self-efficacy (Chrsitianti Ginting et al., 2023).

Learning using PBL requires cooperation between students, to carry out cooperation students need to have good mathematical communication skills. In its application, PBL influences the improvement of students' mathematical communication skills better than increasing the communication skills of students who receive conventional learning (Rianti Rahmalia et al., 2020). PBL combined with Flexible Mathematical Thinking can also be a means of improving students' communication skills, because in learning it prioritizes the activity of discussing students' learning results, then presenting them, this makes PBL a bridge for students to master mathematical communication, both verbally and writing.

CONCLUSION

This research is a Systematic Literature Review (SLR) research. In this research, 19 relevant articles were selected from the 73 articles collected. The findings from the article analysis process are that PBL can improve students' critical thinking skills, problem solving abilities, and students' mathematical understanding which also results in a positive impact

on student learning outcomes, these various abilities are the cognitive aspects of students. PBL also has an influence on students' affective aspects. After receiving PBL learning, students have positive learning motivation, self-efficacy and mathematical communication skills. Overall, the influence of PBL on mathematics learning is good not only on cognitive aspects but also on affective abilities. Therefore, teachers can use PBL as an option in conducting learning, especially in mathematics learning to improve cognitive abilities and affective abilities.

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