Effect of problem-based learning on critical thinking skills

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Abstract. Students’ critical thinking skills cannot develop appropriately if in the learning process, the teacher is not active. Therefore, to improve students’ critical thinking skills, a teacher should choose and use strategies, approaches, and methods techniques that involve students actively in learning, both in manner mental, physical, and social. One alternative learning that provides opportunities for students to develop students’ critical thinking skills in problem solving is problem-based learning. This research was a research study literature examining related journal application of problem-based learning to improve critical thinking skills. The findings of this study included: (1) the implementation of PBL has the potential to help students motivate and provide learning experiences; and (2) PBL implementation is very useful in improving students' critical thinking skills, provided that teachers and students can apply each stage of PBL well.

1. Introduction

Education is a conscious effort related to how students can learn quickly of their own volition to solve problems, make decisions in their way that makes sense, and is responsible for the learning process. The successful implementation of the learning process is inseparable from the components. There are components that affect the course of a learning process. According to Ananda (2018), in teaching and learning activities several learning components are interrelated with one another, namely: 1) teachers, 2) students, 3) learning materials, 4) methods learning, 5) teaching media, 6) evaluation of learning [1]. The teacher has a crucial role in managing all teaching and learning activities. By using appropriate learning methods and media are expected to be able to improve students' abilities in critical thinking. One alternative learning that provides opportunities for students to develop students' necessary thinking skills is problem-based learning.

Problem-based learning is an innovation in learning because in learning, students' thinking abilities are truly optimized through a systematic group or teamwork process, so students can empower, hone, test, and develop the ability to think continuously [2]. According to Darling-Hammond et al. (2020),
problem-based learning emphasizes learning as a process that involves solving problems and critical thinking, learning real things widely, and highlighting communication, collaboration, and available resources to formulate ideas and develop reasoning skills [3].

2. Method
This research was a research study literature examining related journal application of problem-based learning to improve critical thinking skills [4]. This research was conducted by combining several journals to get comprehensive results. The steps taken include library data, reading, and comparing literature to be processed and produced [5]. Results from various studies of this literature will be used to describe education, technology, and vocational issues. This literature review will prove that the PBL method will stimulate teaching and learning. Problem is the main focus of teaching and learning that will happen through problem-solving activities [6]. Declarative knowledge and skills that are gained through critical thinking skills will be applied to solve a problem. This process is repeated, so the knowledge and skills will be easy to memorize, and it will be kept in long-term memory [7]. It will be easy to recall when it is needed, and it is an automatic process.

3. Findings and Discussions
3.1. Problem Based Learning Model
Problem-based learning models are those that require teachers to be able to direct students to solve problems that are authentic so that learning is more meaningful [8]. Problem-based learning has a concept where students are not only able to teach problem-solving but also can collaborate in groups [9]. Ünal & Çakir (2017) explains that problem-based learning is a useful model for the learning system. Through this model, students can exchange ideas, knowledge, and mutual respect when there are different views in the group [10]. Meanwhile, Arsana et al. (2019) revealed that the implementation of PBL prioritizes problem-solving, where the teacher's role is to provide a problem. Besides, teachers also need to facilitate investigations so that students are finally able to solve problems [11]. Referring to several opinions that have been put forward by previous researchers, it is concluded that the problem-based learning model is a model that emphasizes the activeness of students in finding solutions to problems or cases faced so that they can solve these problems.

The implementation of the PBL model in the learning process certainly has several advantages. According to Ariyanto et al. (2020), some of these advantages include (1) increasing students' critical thinking and problem-solving skills; (2) improve student collaboration skills; and (3) teach students to be able to take responsibility for their learning [12]. Alrahlah (2016) also stated several advantages of PBL such as (1) student-centered learning; (2) develop students' abilities according to the needs of the world of work; and (3) motivating students to be more dominant during the learning process. Besides, Alrahlah (2016) also pointed out the shortcomings of PBL, such as (1) students tend to get frustrated easily when carrying out the investigation process; (2) students' access to questions from the teacher is reduced, and (3) students become less confident when learning independently [13].

PBL has 5 phases in its implementation. The five phases include (1) students' orientation to the problem; (2) organizing students to learn; (3) guiding individual and group investigations; (4) develop and present the work; and (5) analyzing and evaluating the problem-solving process [8]. From the five phases, we can see that the role of students in this model is very dominant. All information related to problem-solving efforts is directed to be carried out both independently and in groups. The teacher's role, in this case, is just as a facilitator, provides feedback, and reinforces it when needed.

3.2. The Impact of Problem-Based Learning Models on Critical Thinking Skills
As previously described, PBL is a learning model that can help students solve problems and improve their critical thinking skills. From the five phases of PBL learning that have been stated earlier, it can be seen that during the learning process, students are more dominant than teachers. The need for important information used as a basis for problem-solving tends to be directed to identification
independently or in groups. Thus, the teacher only acts as a facilitator who will provide feedback or reinforcement when needed [14]. The more intense the opportunity to discuss in the realm of problem-solving, of course, will also have a positive impact on the development of students' abilities. In this case, Wulandari & Shofiyah (2018) revealed that the intensity of the discussion has a positive impact on improving other students' abilities, one of which is the ability to think critically [15]. The term critical thinking itself is mostly used by people to solve problems, make decisions, and learn new concepts [16]. In PBL implementation, students began to show critical thinking skills when expressing opinions in discussion forums. The argumentation process based on concrete and valid evidence signifies that students have been able to activate their critical thinking skills.

Critical thinking has been considered one of the central goals at all levels of education and has produced a large literature. Theorists and educators in the field agree that the characteristics of critical thinking are defining problems, asking appropriate questions, analyzing assumptions, synthesizing information, evaluating results. According to Dima & Maassen (2018), critical thinking consists of three abilities; (1) the ability to collect data and use the correct senses to select related information, (2) the ability to analyze data and process data, classify, make conclusions, make predictions, validate and design hypotheses, and (3) the ability to take action on information and solve the problem [17]. Meanwhile, Innabi & Sheikh (2006) argue that there are two methods for teaching critical thinking. The two methods include (1) embedded systems, through this approach, critical thinking skills are taught indirectly without giving explanations to students, and (2) the infusion approach through this approach, critical thinking skills are taught to students in real terms using disciplinary content [18].

Ennis (1995) divides critical thinking skills into six indicators better known as Focus, Reason, Inference, Situation, Clarity, and Overview (FRISCO) [19]. The first indicator is the focus. This indicator emphasizes the students' ability to understand the topics, main points, and problems during the learning process [20]. The second indicator is the reason. This indicator focuses on the ability of students to express opinions rationally to make important decisions [21]. The third indicator is the inference. This indicator emphasizes the ability of students to provide an assessment of a conclusion. The fourth indicator is the situation. This indicator emphasizes the ability of students to make a final decision [22]. The fifth indicator is clarity. This indicator emphasizes the ability of students when giving explanations in discussion forums [23]. The sixth indicator is an overview. This indicator emphasizes the ability of students to be able to verify what to think [24].

If it is referred to be based on the six indicators that we have described one by one, we can draw a thought that shows that students who have critical thinking skills will not be arbitrary in providing information. Of course, the information that has been conveyed is based on a valid source of information based on authentic evidence. This thinking is in line with Mumtaz & Latiff's (2017) research, which analyzed students' ability to debate through the implementation of PBL. The results showed that the implementation of PBL was instrumental in improving student skills such as critical thinking and communication [25]. Similar results were also obtained by Asyari, Muhdhar, & Ibrohim (2016) where the implementation of a learning model that is identical to involving students actively tends to encourage students to improve their critical thinking skills. [26].

In line with other research results, Wulandari & Sakarji (2018) also showed that students' critical thinking skills continue to increase during the learning process. The reason is the high interest in student learning when allowed to convey ideas and express solutions to the problems given [7]. Then, Kamil, Velina, & Kamelia (2019) also proved that the implementation of PBL also positively affects the critical thinking skills of students, both public and Islamic school students [27]. Meanwhile, Hussin, Harun, & Shukor (2018) argued that the use of technology can be an alternative to PBL learning that can improve students' critical thinking skills. The hope is that both students and teachers can be more motivated in implementing PBL with a better concept according to their needs [28].

4. Conclusion
In this literature study, several conclusions were found, including: (1) the implementation of PBL has the potential to help students motivate and provide learning experiences; and (2) PBL implementation
is very useful in improving students' critical thinking skills, provided that teachers and students can apply each stage of PBL well.

References

[1] Ananda R 2018 The Effectiveness of the Implementation of the Case Methods in the Learning Evaluation Course at State Islamic University of North Sumatera J. Ilm. Peuradeun 6 103
[2] Eggen P and Kauchak D 2012 Strategies and models for teachers: teaching content and thinking skills (Boston: Pearson Education, Inc)
[3] Darling-Hammond L et al 2020 Implications for educational practice of the science of learning and development Appl. Dev. Sci. 24 97–140
[4] Rasmitadila R et al 2020 The Perceptions of Primary School Teachers of Online Learning during the COVID-19 Pandemic Period: A Case Study in Indonesia J. Ethn. Cult. Stud. 7 90
[5] Ariyanto S R et al 2019 Collaborative Problem-Based Learning Models Implementation in Vocational High Schools Proceedings of the 1st Vocational Education International Conference (VEIC 2019) (Paris, France: Atlantis Press)
[6] Yew E H J and Goh K 2016 Problem-Based Learning: An Overview of its Process and Impact on Learning Heal. Prof. Educ. 2 75–9
[7] Narmaditya B S, Wulandari D, and Sakarji S R B 2018 Does Problem-Based Learning Improve Critical Thinking Skill? J. Cakrawala Pendidik. 37
[8] Arends R I 2012 Learning to teach (Dubuque, Iowa: McGraw-Hill)
[9] Belland R B, Glazewski D K, and Richardson J 2010 Problem-based learning and argumentation: Testing a scaffolding framework to support middle school students’ creation of evidence-based arguments Instr. Sci. 39 667–94
[10] Ünal E and Çakir H 2017 Students’ views about the problem based collaborative learning environment supported by dynamic web technologies Malaysian Online J. Educ. Technol. 5 1–19
[11] Innabi H and Sheikh O El 2006 The Change in Mathematics Teachers’ Perceptions of Critical Thinking after 15 Years of Educational Reform in Jordan Educ. Stud. Math. 64 45–68
[12] Ennis R H 1995 A logical Basis for Measuring Critical Thinking Educ. Leadersh. 4 44–54
[13] Alrahlah A 2016 How effective the problem-based learning (PBL) in dental education. A critical review Saudi Dent. J. 28 155–61
[14] Ali 2011 Problem Based Learning dan Argumentation Sebagai Solusi dalam Meningkatkan Kemampuan Berpikir Kritis Siswa SMK J. Kependidikan J. Has. Penelit. dan Kaji. Kepustakaan di Bid. Pendidikan, Pengajaran dan Pemelajaran 6 197
[15] Alrahlah A 2016 How effective the problem-based learning (PBL) in dental education. A critical review Saudi Dent. J. 28 155–61
[16] Innabi H and Sheikh O El 2006 The Change in Mathematics Teachers’ Perceptions of Critical Thinking after 15 Years of Educational Reform in Jordan Educ. Stud. Math. 64 45–68
[17] Ennis R H 1995 A logical Basis for Measuring Critical Thinking Educ. Leadersh. 4 44–54
[18] Alexandra G and Ratu N 2018 Profil Kemampuan Berpikir Kritis Matematis Siswa SMP dengan Graded Response Models Mosharafa J. Pendidik. Mat. 7 103–12
[19] Aminudin M and Basir M 2019 Kemampuan Berpikir Kritis Mahasiswa Calon Guru Matematika dalam Menilai Kebenaran Pernyataan Matematis UNION J. Pendidik. Mat. 7 369–82
[22] Muthma’innah M, Dahlan J A and Suhendra S 2019 Ability of mathematical critical thinking what about Learning Cycle 7E model? J. Phys. Conf. Ser. 1157 032129

[23] Cahyono B et al 2019 Analysis critical thinking skills in solving problems algebra in terms of cognitive style and gender J. Phys. Conf. Ser. 1321 022115

[24] Kusuma E D, Gunarhadi G, and Riyadi R 2018 The Strategies to Improve Critical Thinking Skills through Problem-Based Quantum Learning Model at Primary School Int. J. Multicult. Multireligious Underst. 5 123

[25] Muntaz S and Latif R 2017 Learning through debate during problem-based learning: an active learning strategy Adv. Physiol. Educ. 41 390–4

[26] Asyari M, Muhdhar M H I A, and Ibrom H S 2016 Improving critical thinking skills through the integration of problem based learning and group investigation Int. J. Lesson Learn. Stud. 5 36–44

[27] Kamil B, Velina Y, and Kamelia M 2019 Students’ Critical Thinking Skills in Islamic Schools: The Effect of Problem-Based Learning (PBL) Model Tadris J. Kegur. dan Ilmu Tarb. 4 77 85

[28] Hussin W N T W, Harun J, and Shukor N A 2018 Problem Based Learning to Enhance Students Critical Thinking Skill via Online Tools Asian Soc. Sci. 15 14