



Research trends and benefits of discovery learning and problem-based learning on critical thinking skills

Muhamad Kosim Gifari¹, Babang Robandi²

^{1,2}Universitas Pendidikan Indonesia, Bandung, Indonesia

mkgifari@upi.edu¹, brobandi@upi.edu²

ABSTRACT

This study uses the Systematic Review (SR) method to identify, evaluate, and synthesize evidence from literature relevant to the research topic about the influence of Discovery Learning (DL) and Problem-Based Learning (PBL) on critical thinking skills. The purpose of this study is to identify research trends and analyze selected literature. The software used in this study is Google Scholar, Harzing's Publish or Perish 8, Microsoft Excel, Mendeley Desktop, and VOSviewer. The bibliometric analysis identified seven interrelated clusters, including DL, PBL, and critical thinking skills. The results of the visualization highlight the importance of technology integration in education and the important role of teachers and teaching materials. SR analysis shows that PBL and DL journals make a major contribution to the development of research on critical thinking. The most cited articles show the dominance of research in this area, with experimental methods being the most common. The results of SR analysis show that the DL and PBL learning models can improve students' critical thinking skills, as seen from previous studies. The implication is that this learning approach has great potential to improve the quality of education by preparing students to think critically and analytically in facing future challenges.

ARTICLE INFO

Article History:

Received: 5 Jan 2024

Revised: 9 July 2024

Accepted: 14 Jul 2024

Available online: 21 Jul 2024

Publish: 30 Aug 2024

Keyword:

critical thinking; discovery learning; problem-based learning

Open access

Inovasi Kurikulum is a peer-reviewed open-access journal.

ABSTRAK

Penelitian ini menggunakan metode Systematic Review (SR) untuk mengidentifikasi, mengevaluasi, dan mensintesis bukti-bukti dari literatur yang relevan dengan topik penelitian tentang pengaruh Discovery Learning (DL) dan Problem-Based Learning (PBL) terhadap kemampuan berpikir kritis. Tujuan penelitian ini untuk mengidentifikasi tren penelitian dan menganalisis literatur terpilih. Software yang digunakan dalam penelitian ini yaitu Google Scholar, Harzing's Publish or Perish 8, Microsoft Excel, Mendeley Desktop, dan VOSviewer. Analisis bibliometrik mengidentifikasi tujuh cluster yang saling terkait, termasuk DL, PBL, dan kemampuan berpikir kritis. Hasil visualisasi menyoroti pentingnya integrasi teknologi dalam pendidikan dan peran penting guru serta bahan ajar. Analisis SR menunjukkan bahwa jurnal PBL dan DL memberikan kontribusi besar dalam pengembangan penelitian tentang berpikir kritis. Artikel yang paling banyak dikutip menunjukkan dominasi penelitian dalam bidang ini, dengan metode eksperimen menjadi yang paling umum. Hasil analisis SR menunjukkan bahwa model pembelajaran DL dan PBL dapat meningkatkan kemampuan berpikir kritis siswa, seperti yang terlihat dari penelitian-penelitian yang telah dilakukan sebelumnya. Implikasinya adalah bahwa pendekatan pembelajaran ini memiliki potensi besar dalam meningkatkan kualitas pendidikan dengan mempersiapkan siswa untuk berpikir secara kritis dan analitis dalam menghadapi tantangan masa depan.

Kata Kunci: Berpikir kritis, pembelajaran berbasis penemuan, pembelajaran berbasis masalah

How to cite (APA 7)

Gifari, M. K., & Robandi, B. (2024). Research trends and benefits of discovery learning and problem-based learning on critical thinking skills. *Inovasi Kurikulum*, 21(3), 1411-1422.

Peer review

This article has been peer-reviewed through the journal's standard double-blind peer review, where both the reviewers and authors are anonymised during review.

Copyright

2024, Muhamad Kosim Gifari, Babang Robandi. This an open-access is article distributed under the terms of the Creative Commons Attribution-ShareAlike 4.0 International (CC BY-SA 4.0) <https://creativecommons.org/licenses/by-sa/4.0/>, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author, and source are credited. *Corresponding author: mkgifari@upi.edu

INTRODUCTION

When a teacher only uses conventional models in every lesson, students will easily become apathetic towards the material introduced. Therefore, students lose the basic material as well as the essential material that they need to understand. One of which is to improve the quality of learning that can be achieved if teachers carry out innovative learning by placing students as the center of learning so students can interpret the meaning of learning (Devi & Bayu, 2020). Innovative learning makes students who are usually seen as objects in education become subjects who play an active role in the learning process. Meanwhile, teachers act as facilitators who work closely with students to discover and develop their capacity. Innovative learning aims to direct education to be able to prepare graduates who are independent and reliable both in terms of students and educators themselves (Rahmadani & Anugraheni, 2017).

The essence of education is a conscious effort that human beings make continuously (throughout life) in their lives to be able to maintain their identity, existence, and survival (Rahmadani & Anugraheni, 2017). Education can also be referred to as the process of humanizing humans, where through education a person can maintain their quality and improve their existence towards the surrounding environment (Devi & Bayu, 2020). In the 21st century, maintaining identity, existence, and self-quality is very important given the rapid exchange of information. Critical thinking skills are indispensable to selecting and sorting out the various information obtained. As stated in previous research a person who thinks critically can ask questions appropriately, obtain relevant, effective, and creative information in sorting out information, logical reasons from information, and come to a credible and convincing conclusion about the world that makes it possible to live and do activities with success in it (Haeruman et al., 2017). Individuals who have good critical thinking skills can evaluate information and situations carefully, allowing them to identify and apply systematic methods of problem-solving. In contrast, according to Nasution in "The Importance of Critical Thinking Skills in Decision Making" individuals with low critical thinking skills often do not conduct in-depth analysis and tend to act on impulses or less valid information, resulting in less informed decisions and high-risk of making mistakes (Nasution, 2020). That way, the ability to think critically is not only a matter of intelligence but also about emotional problems of attitudes and behaviors. So the improvement of critical thinking skills in students needs to be considered in the educational process.

Given the importance of critical thinking skills for everyone, especially students who have to face challenges in the 21st century, various efforts must be made by every teacher to further develop the critical thinking skills of their students through innovative learning. Many studies have analyzed what learning models can improve students' critical thinking skills. Two of the learning models that can improve students' critical thinking skills are the Discovery Learning (DL) and Problem-Based Learning (PBL) learning models. Research related to PBL and DL related to critical thinking has been done quite a lot, including research that shows that the application of PBL significantly improves the understanding of concepts and critical thinking skills of high school students (Yulianti & Gunawan, 2019). Similar research found that students who learn with the DL model experience a higher increase in mathematical critical thinking skills compared to students who learn with the conventional model (Haeruman et al., 2017), and another one showed that PBL and DL have a significant influence on the critical thinking ability of grade V elementary school students (Prasetyo & Kristin, 2020).

In contrast to the previous study, this study examines the impact of DL and PBL on critical thinking skills by reviewing previous literature using *Systematic Review* (SR) analysis. Through SR, this research was conducted to identify, evaluate, and synthesize evidence from the literature relevant to the topic of the impact of DL and PBL on critical thinking skills. This method aims to produce a comprehensive understanding of the topic by analyzing and summarizing the findings from various relevant studies. In addition to identifying, evaluating, and synthesizing or analyzing the topic, this study also presents findings on research trends related to DL, PBL, and critical thinking by identifying research trends, leading authors,

the most cited journals, and so on. The findings of this research can make a positive contribution to further developing preparation and investigating the idea of learning in the classroom. Students who can think critically will provide an interactive learning atmosphere between students and students and teachers. In addition, this study can be a source of reference for researchers who want to identify research trends in the fields of DL, PBL, and critical thinking and want to know the results of the analysis of the impact of DL and PBL on critical thinking skills.

LITERATURE REVIEW

Critical Thinking

Critical thinking is the ability to answer questions that are not based on a routine process. Individuals who have this ability tend to draw conclusions based on a variety of evidence and comprehensive explanations. Critical thinking is also often associated with developing a person's cognitive strengths and attitudes aimed at the growth and improvement of students (Indrašienė et al., 2022). They do not immediately accept other people's differences of opinion, but first conduct an in-depth evaluation. Fisher in the book entitled "Critical Thinking: An Introduction" Only after evaluating the existing arguments do they conclude which is better and correct. Through critical reasoning, students can think about problems and respond to them comprehensively based on their thinking, using various arguments and evidence in a reflective, productive, and evaluative manner.

Critical thinking is a process that involves actively and skillfully evaluating the information received, to compare and contradict various ideas. This process includes refining and refining arguments, submitting questions, verifying information, screening and selecting relevant ideas, and supporting the ideas. Fisher emphasizes that critical thinking also involves making wise decisions and careful consideration, based on a strong and comprehensive understanding. Individuals who exhibit traits that are seen as critical thinkers can (1) identify key elements in a problem, especially related reasons, and conclusions; (2) identify and evaluate the assumptions underlying an argument; (3) clarify and interpret existing statements and ideas; (4) assessing the acceptability of an argument, especially in terms of credibility and claims presented; (5) evaluating different types of diverse arguments; (6) analyzing, evaluating, and producing comprehensive explanations; (7) conducting in-depth analysis to produce appropriate decisions; and (8) being able to draw valid inferences and produce coherent arguments (Paul & Elder, 2006; Ennis, 2011).

Discovery Learning

The discovery learning model is a learning that transforms students into learning experts. Students should be able to find the ideas they are investigating on their own. The DL learning model requires students to learn actively, where learning is not only assessed from the results but also from the learning process (Haeruman et al., 2017). Discovery learning focuses on self-exploration learning, and planning and learning strategies created by the teacher, so the teacher becomes a guide for the process of learning (Castronova, 2002; Simamora, 2019). So it can be said that DL is a learning method that encourages students to actively seek new knowledge through self-exploration and discovery. In this method, students are allowed to discover their concepts and principles through the process of exploration and inquiry. For example, DL involves the involvement of students in problem-solving activities where they must discover new facts, relationships, and understandings on their own (Alfieri et al., 2011).

Research shows that DL can improve students' conceptual understanding, critical thinking skills, and learning motivation. For example, DL has a significant positive influence on student learning outcomes when compared to traditional expository teaching methods (Alfieri et al., 2011). This is reinforced by previous research that showed that students involved in DL showed improved critical thinking and problem-

solving skills (Syarifudin et al., 2019). Through this learning process, students can find new things that have never been encountered before. These new things are problems that need to be solved, where ultimately students can discover and gain new knowledge through the process of "experimentation". Therefore, discovery learning is learning that involves students in the process of mental learning activities, which can be done through exchanging opinions, discussions, independent reading, and independent tests, so that children can learn on their own (Minarni, 2019). This can certainly improve students' independent learning skills. Students identify what they want to know, search for information, and synthesize it into the final result. In this stage, a teacher must master the context that will be conveyed to students. Although this learning is student-centered, the presence of a teacher is needed as an evaluator and reflection so that the findings produced by students are not misinterpreted. Without adequate guidance, DL can cause misconceptions and confusion among students, especially when dealing with complex subjects (Hmelo-Silver et al., 2007).

Problem-Based Learning (PBL)

The PBL model prepares learners to think critically and analytically and to find and use appropriate learning resources (Yulianti & Gunawan, 2019). According to previous research, PBL involves students working in small groups to solve complex real-world problems, thus developing their problem-solving and critical thinking skills (Schmidt et al., 2015). This puts the concentration of the learning model in creating critical thinking skills. Students who play a role as subjects in the educational process can train their ability to solve a problem because they are used to developing critical thinking skills through the PBL model.

PBL has various benefits in education. First, PBL helps students develop critical thinking and analytical skills. PBL improves students' critical thinking and problem-solving skills through involvement in complex tasks. Second, PBL promotes deeper learning and a better understanding of concepts (Hung, 2016). Another research showed that students involved in PBL have better long-term knowledge retention and are better able to apply their learning in different contexts (Strobel & Barneveld, 2018). In addition, previous research found that the PBL model has the following advantages: (1) Problem-solving in PBL is good enough to understand the content of the lesson; (2) Problem-solving takes place during the learning process, challenges students' abilities and provides satisfaction to students; (3) PBL can increase learning activities; (4) Assisting in the transfer process of students to understand problems in daily life; (5) Helping students develop their knowledge and helping students to take responsibility for their learning; (6) Helping students to understand the essence of learning as a way of thinking, not just understanding learning by teachers based on textbooks; (7) PBL creates a fun learning environment that students like; (8) Enabling real-world applications; and (9) Stimulating students to learn continuously (Yulianti & Gunawan, 2019).

To implement PBL successfully, several steps must be followed. First, relevant and challenging problems must be designed. Effective PBL issues must be relevant, challenging, and encourage investigation. Second, facilitators must guide students through the learning process without providing direct solutions (Dolmans et al., 2016). The role of tutors in PBL is to facilitate student learning by guiding and supporting the learning process (Schmidt et al., 2015).

METHODS

This study uses the *Systematic Review* (SR) method. The systematic review method differs from a literature review by a well-managed and highly organized qualitative surveillance process in which researchers tend to cover less material from a smaller number of databases to write their literature reviews (Kowalczyk & Truluck, 2013; Robinson & Lowe, 2015; Tinmaz et al., 2022). SR examined the findings of previous research for the identification of consistent and repeating themes (Uman, 2011). In this study, SR is used to identify, evaluate, and synthesize or analyze evidence from literature relevant to research

topics on DL and PBL on critical thinking skills and to identify research trends, leading authors, and the most cited journals. *Google Scholar* is used as a database with a large number of data sets, which can be used as a reference source for conducting comprehensive SR. A systematic review of the library began with the help of *Harzing's Publish or Perish 8*, *Microsoft Excel*, *Mendeley Desktop* version 1.19.8.0, and *VOSviewer* version 1.6.20. The software simulates csv., ris., and txt., formats from *Google Scholar* to be converted into the desired form network visualization by using *VOSviewer*.

The menus used in the search on *Harzing's Publish or Perish 8* are (**Table 1**): (1) *Google Scholar* search; (2) Year (2015-2024); (3) Keywords (*critical thinking, discovery learning, problem-based learning*); and (4) Maximum results on the most results (1000). The results of the search using *Harzing's Publish or Perish* software showed 991 articles that appeared that contained the keywords *critical thinking, discovery learning, and problem-based learning*. The articles were screened on *Microsoft Excel* software so that 513 journals were obtained that research related to the benefits/impacts/influences/effectiveness of DL and/or PBL on critical thinking skills. Then the 513 articles were analyzed related to DL and PBL research trends on students' critical thinking skills as well as analysis to provide an in-depth understanding of literature relevant to the research topic. In-depth analysis is not carried out on all existing articles but is screened with a focus on DL and PBL articles that affect students' critical thinking skills with a large number of citations.

Table 1. Stages of analyzing SR related to DL and PBL on critical thinking skills

No.	Description	Conditions/Results
1	Object	Analyze research trends through and analyze the benefits of DL and PBL on students' critical thinking skills through the SR method
2	Data source	Basis data <i>Google Scholar</i>
3	Coverage	Critical thinking, DL, and PBL
4	Field	Education
5	Year of publication	2015-2024
6	Selected documents	991
7	Documents are filtered	513 (for research trend analysis), and 7 out of 513 (for benefit analysis)
8	Documents analyzed	Selected databases from <i>Harzing's Publish or Perish 8</i> were then analyzed with the help of <i>Microsoft Excel</i> and <i>VOSviewer</i>

Source: Research 2024

RESULTS AND DISCUSSION

Research Trend on PBL and DL

Based on the data of DL articles, PBL, and critical thinking skills obtained, then analysis was carried out to consider several factors, especially the article being studied, keyword analysis, authorship, and citation analysis. The majority of findings are reported as percentages and frequencies. *VOSviewer* software is used to map the co-occurrence of author keywords and analyze citations. These articles are reviewed based on the number of documents produced per year using software, namely *Harzing's Publish or Perish* and *Microsoft Excel*. The review of the document based on the year of publication will help to review and observe the pattern of the selected regions ([Ahmi & Mohamad, 2019](#)). **Table 2** below summarizes the details of publication data statistics from 513 articles published from 2015 to 2024.

Table 2. Articles published from 2015-2024 on *Google Scholar Search*

No.	Year	Frequency	Percentage (%)	Cumulative Frequency	Cumulative Percentage (%)
1	2015	14	3	14	3
2	2016	18	4	32	6
3	2017	15	3	47	9
4	2018	28	5	75	15
5	2019	53	10	128	25
6	2020	77	15	205	40
7	2021	72	14	277	54
8	2022	82	16	359	70
9	2023	128	25	487	95
10	2024	26	5	513	100
Total		513	100		

Source: Research 2024

The identification of research trends regarding DL, PBL, and critical thinking skills in this article begins with the appearance of keywords in the title and abstract. The author visualized the database obtained from Harzing's Publish or Perish 8 software using VOSviewer software. With a minimum number of occurrences of 5 times per item, 53 items were PBL and DL is the largest item in network visualization.

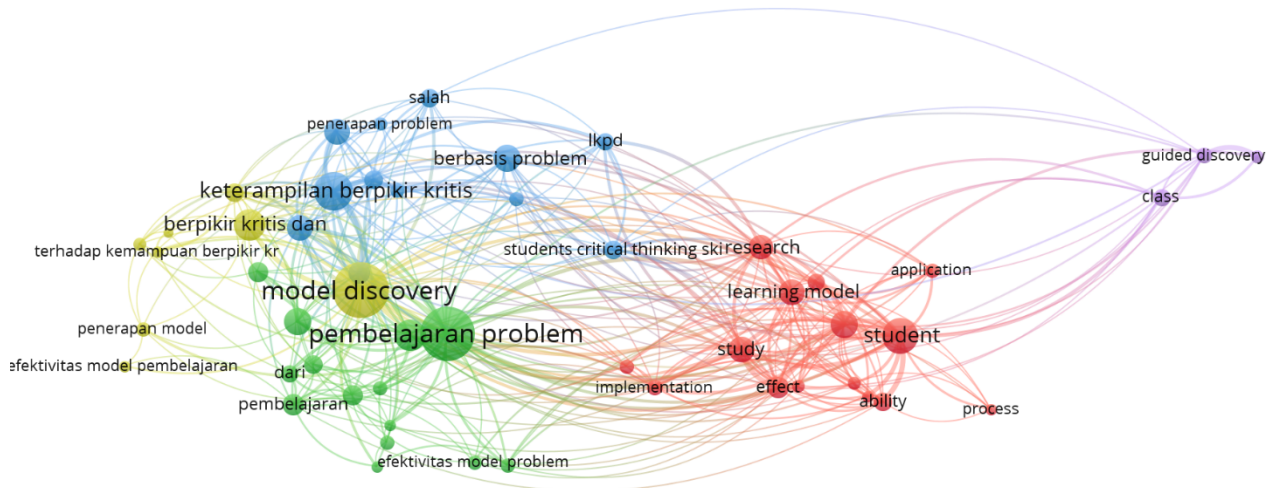


Figure 1. Visualization of 513 article metadata on *Google Scholar*
 Sources: Data Processed 2024

The identification of research trends regarding DL, PBL, and critical thinking skills in this article begins with the appearance of keywords in the title and abstract. The author visualized the database obtained from *Harzing's Publish or Perish 8* software using VOSviewer software. With a minimum number of occurrences of 5 times per item, 53 items were PBL and DL are the largest item in network visualization and also an item that often appears and is discussed in selected literature. The analysis of co-words based on the results of the analysis of *the VOSviewer* application shows (see **Figure 1**) that the PBL and DL models are the largest, most frequently appearing, and are widely discussed concerning critical thinking skills/abilities. This is because PBL and DL are effective in improving students' critical thinking skills. PBL has effectiveness on critical thinking skills (Ariani, 2020; Devi & Bayu, 2020; Prasetyo & Kristin, 2020; Putri et al., 2020; Yulianti & Gunawan, 2019) and DL is an effective learning method in improving students' critical thinking skills (Ambarwati, 2017; Farib et al., 2019; Haeruman et al., 2017).

Based on the co-word review, research trends related to PBL and DL show several key directions that stand out. Some research trends related to PBL and DL are (1) Research that focuses on improving students' critical thinking skills through PBL and DL; (2) Research that focuses on how PBL and DL methods encourage student interaction and active participation in the learning process; (3) Research that examines the effectiveness of these two methods in various educational contexts; (4) Research that highlights the importance of scaffolding and guidance in the implementation of PBL and DL; and (5) Research that examines the application of PBL and DL in various disciplines and educational contexts. Overall, research trends related to PBL and DL focus on improving students' critical thinking skills, interaction, and active participation, the effectiveness of learning methods, the importance of scaffolding and guidance, and application in various disciplines and contexts. These studies support and strengthen the position of PBL and DL as effective approaches to improving the quality of education.

Systematic Review of Benefit of PBL and DL on Critical Thinking

These journals are located closer together and are highly cited. **Table 3** shows the 7 most cited articles, having the highest index value among other articles, as well as authors who are prolific in researching PBL, DL, and critical thinking skills. The article by Yulianti and Gunawan (2019) became the most cited article by researchers with a total of 357 citations or an average of around 71 citations per year.

Table 3. Articles about DL or PBL related to critical thinking skills are often cited

No.	Title	Author	Year of Publication	Journal	Index	Number of Citations
1	Model Pembelajaran Problem Based Learning (PBL): Efeknya Terhadap Pemahaman Konsep dan Berpikir Kritis	E. Yulianti, I. Gunawan	2019	Indonesian Journal of Science and Mathematics Education	Sinta 2	357
2	Pengaruh Model Discovery Learning Terhadap Peningkatan Kemampuan Berpikir Kritis Matematis dan Self-Confidence Ditinjau dari Kemampuan Awal Matematis Siswa SMA di Bogor Timur	L. D. Haeruman, W. Rahayu, dan L. Ambarwati	2017	Jurnal Penelitian dan Pembelajaran IPA	Sinta 2	215
3	Berpikir Kritis dan Hasil Belajar IPA Melalui Pembelajaran Problem Based Learning Berbantuan Media Visual	P. S. Devi dan G. W. Bayu	2020	Mimbar PGSD Undiksha	Sinta 2	129

No.	Title	Author	Year of Publication	Journal	Index	Number of Citations
4	Pengaruh Model Pembelajaran Problem Based Learning dan Model Pembelajaran Discovery Learning terhadap Kemampuan Berpikir Kritis Siswa Kelas 5 SD	F. Prasetyo dan F. Kristin	2020	Didaktika Tauhidi: Jurnal Pendidikan Guru Sekolah Dasar	Sinta 3	125
5	Pengaruh Model Pembelajaran Problem Based Learning Terhadap Kemampuan Berpikir Kritis Siswa SD pada Muatan IPA	R. F. Ariani	2020	Jurnal Ilmiah Pendidikan dan Pembelajaran	Sinta 3	115
6	Problem Based Learning Terintegrasi STEM di Era Pandemi Covid-19 untuk Meningkatkan Keterampilan Berpikir Kritis Siswa	C. D. Putri, I. D. Pursitasari, dan B. Rubini	2020	JUPI (Jurnal IPA dan Pembelajaran IPA)	Sinta 3	104
7	Proses Berpikir Kritis Matematis Siswa Sekolah Menengah Pertama Melalui Discovery Learning	P. M. Farib, M. Ikhsan, dan M. Subianto	2019	Jurnal Riset Pendidikan Matematika	Sinta 2	77

Source: Research 2024

Based on the table above, the journals that have been widely cited are journals that have been indexed by Sinta. Sinta 2 and Sinta 3 dominated the journals that were widely cited in research on DL and PBL on critical thinking skills. The methodology that is widely carried out in researching DL and PBL on critical thinking skills is experimental methods, both pseudo-experiments and quasi-experiments. The articles that are briefly analyzed in this paper are articles with publications indexed in Sinta 2 and Sinta 3.

PBL has effectiveness on critical thinking skills (Ariani, 2020; Devi & Bayu, 2020; Prasetyo & Kristin, 2020; Putri et al., 2020; Yulianti & Gunawan, 2019). In addition to the PBL model, DL is also an effective learning model in improving students' critical thinking skills. Discovery Learning is an effective learning method for improving students' critical thinking skills (Ambarwati, 2017; Farib et al., 2019; Haeruman et al., 2017). The influence of PBL and DL on the critical thinking ability of grade V elementary school students. The results showed that these two learning models had a significant influence on students' critical thinking skills, with a significance value of 0.033 from the independent sample t-test (Prasetyo & Kristin, 2020). Although this study does not state which is more effective between the two, these results suggest that PBL can significantly improve students' critical thinking skills, especially when compared to conventional learning methods.

The concept of implementing PBL in improving the quality of critical thinking is also a topic that is often the focus of academics. The implementation of PBL significantly improves the concept understanding and critical thinking skills of high school students (Yulianti & Gunawan, 2019). The critical thinking gain value of the experimental class was 0.58 compared to the control class of 0.31, with an effect size value of 0.66 and the ANOVA test results showed a significance of < 0.005, indicating that PBL had a positive influence on students' critical thinking skills. This research shows that PBL creates an active learning environment, where students are more involved in solving real problems that encourage them to think critically and analytically. The results follow the explanation (Dakabesi & Luoise, 2019) that the students who studied in the experiment class (in this case using the PBL model) had different critical thinking skills better than the students who studied using the conventional model. The subsequent research also supports the results of the research (Yulianti & Gunawan, 2019). PBL is effective in improving the critical thinking skills of the students based on the result of the mean analysis, standard deviation, and t-test. They recommend that

problem-based learning may improve the level of critical thinking skills of the students and improve the teaching-learning process (Lapuz & Fulgencio, 2020). Previous research found that: (1) there is a significant difference in students' critical thinking skills between the group taught using problem-based learning and the group taught using expository learning, with a p-value of 0.004, and (2) the implementation of problem-based learning positively and significantly influences students' critical thinking skills, with a significance value of 0.005 (Darmawati & Mustadi, 2023). The findings of previous research are also one of those that are often used as a reference in other research, especially in PBL (Yulianti & Gunawan, 2019).

Several learning media can influence PBL learning according to research. One research highlighted the influence of PBL assisted by visual media on the critical thinking ability of elementary school students in science lessons (Devi & Bayu, 2020). The significance value of the t-test for equality of means of 0.001 shows that the use of visual media in PBL increases the effectiveness of learning in developing critical thinking skills. The addition of visual media helps in making it easier to understand complex concepts, making the learning process more interesting and increasing student engagement. PBL is effective in improving the critical thinking skills of elementary school students in science lessons (Ariani, 2020). PBL assists students in solving problems, organizing tasks, and gathering information for experiments, thereby increasing student motivation and engagement in learning. This shows that PBL not only improves critical thinking skills but also encourages student engagement and motivation.

Likewise, Discovery learning which also emphasizes learning focused on finding a solution to a problem. The influence of the Discovery Learning (DL) learning model on mathematical critical thinking skills and self-confidence of high school students (Haeruman et al., 2017). This study found that students who studied with the DL model experienced a higher increase in mathematical critical thinking skills compared to students who learned with the conventional model. Data analysis showed that the N-gain of mathematical critical thinking in the group that used DL was higher, indicating the superiority of DL in improving students' critical thinking skills. This shows that the DL method, which requires students to find solutions on their own through the process of discovery, is very effective in stimulating their critical thinking skills. Critical Thinking Process of Junior High School Students through the Application of the DL Model. This study emphasizes that the stages in DL directly involve the process of critical thinking, encouraging students to think deeply and analytically (Farib et al., 2019). Students are invited to identify problems, propose hypotheses, conduct experiments, and draw conclusions, all of these processes require strong critical thinking skills. These findings provide practical guidance for teachers in designing effective mathematics learning to train students' critical thinking skills. DL encourages students to be actively involved in the learning process through independent exploration and discovery, which significantly improves their critical thinking skills (Palinussa et al., 2023). Students learn to think deeply and analytically through the process of problem identification, hypothesis submission, experimentation, and conclusions drawn. These studies show that DL is not only effective in improving conceptual understanding but also in developing critical thinking skills. By giving students the freedom to explore and find solutions on their own, DL creates a learning environment that encourages critical and creative thinking. It is important to apply it in a variety of subjects, especially mathematics, to ensure students are prepared for the more complex challenges of the future.

Based on the analysis of existing research trends, several research opportunities with novelty can be identified for further research. One of them is the integration of technology in the discovery and problem-based learning models. This research can explore how digital technologies such as interactive learning applications, virtual reality (VR), and augmented reality (AR) can improve students' critical thinking skills. In addition, there is an opportunity to examine the socio-cultural influence on the application and effectiveness of this learning model in different regions or countries, which can provide new insights into the adaptation of learning models in different contexts.

A multidisciplinary approach to learning is also a promising area, with research focusing on the integration of different disciplines (such as STEM) in discovery and problem-based learning approaches to provide students with a more comprehensive understanding. Longitudinal studies that evaluate the long-term impact of the use of this learning model on students' critical thinking abilities in school contexts and daily life are also significant research opportunities. Another research showed that the integration of PBL with STEM (Science, Technology, Engineering, and Mathematics) provides more significant results in improving critical thinking skills compared to ordinary PBL (Putri et al., 2020). The gain value in PBL-STEM reached 0.72, higher than PBL which was only 0.43. This integration offers a more comprehensive and effective approach to developing students' critical thinking skills, especially in the context of learning in the pandemic era. This approach shows that the combination of PBL with STEM elements can expand the scope and effectiveness of PBL in developing critical thinking skills.

In addition, the adaptation of learning models for students with special needs, such as learning or physical disabilities, is also an important area of research. This research can develop inclusive learning strategies and assess their effectiveness. Finally, the development of more sophisticated assessment instruments to measure students' critical thinking skills in the context of this learning model is another research opportunity that can make a significant contribution to the field of education. These opportunities not only offer new contributions but also help address today's educational challenges as well as prepare students for the future with better critical thinking skills.

Overall, these seven studies provide strong evidence that PBL and DL learning models can significantly improve students' critical thinking skills at various levels of education. PBL is more effective in the context of problem-solving and practical applications, while DL excels in facilitating analytical and mathematical thinking. The use of visual media and STEM integration further enhances the effectiveness of PBL, providing a more comprehensive approach to the development of students' critical thinking skills. These studies emphasize the importance of innovation in learning methods to improve important competencies in the 21st century.

CONCLUSION

Based on data tracing from several articles that have been described, in general, the DL and PBL models can foster students' critical thinking skills. This is by considering the results of data testing from several studies conducted by previous researchers taken by experts. Studies that include learning models such as Problem-Based Learning (PBL) and Discovery Learning (DL) provide a deep understanding of their influence on students' critical thinking skills. The results of bibliometric analysis show that research in the field of education focuses on the development of critical and creative thinking skills through innovative learning approaches such as PBL and DL. There is significant attention to the integration of technology in education, the importance of the role of teachers and teaching materials, and the relevance of research to the educational context in Indonesia. These findings provide insight into key trends and focuses in education research, and underscore the importance of these approaches in advancing the quality of education.

DL and PBL learning models have proven to be effective in improving students' critical thinking skills at various levels of education. PBL and DL can improve conceptual understanding and critical thinking skills through a variety of approaches, including the use of visual media and STEM integration. These findings emphasize the great potential of these two models in advancing the quality of education and preparing students for future challenges so that it can be used as a solution for educators to develop students' critical thinking skills. If students can answer a problem on an event well, useful, and evaluative, then they can think fundamentally. A person who thinks at the most basic level has key competencies such as quick understanding, judgment, evaluation, certainty, clarification, and restraint. This is important to have in the 21st century where there are many problems in daily life. A person who cannot think fundamentally tends

to be more easily influenced by bad currents. Therefore, the use of DL and PBL models is very important to be applied today because it is feasible to be applied to 21st-century education.

AUTHOR'S NOTE

The publication of this article does not contain elements of conflict of interest. The data and content of the article have been tested for plagiarism. Alhamdulillah, the author would like to express his gratitude to all the researchers who were used as references in this study. The author also expressed his gratitude to the Ministry of Religion (Kementerian Agama) together with the Education Fund Management Institution (LPDP) of the Ministry of Finance (Kementerian Keuangan) where the writer is a student who obtained the Indonesia Bangkit Scholarship (BIB) initiated by the two ministries.

REFERENCES

- Ahmi, A., & Mohamad, R. (2019). Bibliometric analysis of global scientific literature on web accessibility. *International Journal of Recent Technology and Engineering*, 7(6), 250-258.
- Alfieri, L., Brooks, P. J., Aldrich, N. J., & Tenenbaum, H. R. (2011). Does discovery-based instruction enhance learning?. *Journal of Educational Psychology*, 103(1), 1-18.
- Ariani, R. F. (2020). Pengaruh model pembelajaran problem based learning terhadap kemampuan berpikir kritis siswa SD pada muatan IPA. *Jurnal Ilmiah Pendidikan dan Pembelajaran*, 4(3), 422-432.
- Castronova, J. A. (2002). Discovery learning for the 21st century: What is it and how does it compare to traditional learning in effectiveness in the 21st century. *Action research exchange*, 1(1), 1-12.
- Dakabesi, D. & Luiso, I. S. Y. (2019). The effect of problem based learning model on critical thinking skills in the context of chemical reaction rate. *Journal of Education and Learning (EduLearn)*, 13(3), 395-401.
- Darmawati, Y., & Mustadi, A. (2023). The effect of problem-based learning on the critical thinking skills of elementary school students. *Jurnal Prima Edukasia*, 11(2), 142-151.
- Devi, P. S., & Bayu, G. W. (2020). Berpikir kritis dan hasil belajar ipa melalui pembelajaran problem based learning berbantuan media visual. *Mimbar PGSD Undiksha*, 8(2), 238-252.
- Dolmans, D. H., Loyens, S. M., Marcq, H., & Gijbels, D. (2016). Deep and surface learning in problem-based learning: A review of the literature. *Advances in Health Sciences Education*, 21(5), 1087-1112.
- Ennis, R. (2011). Critical thinking: reflection and perspective part I. *Inquiry: Critical Thinking Across the Disciplines*, 26(1), 4-18.
- Farib, P. M., Ikhsan, M., & Subianto, M. (2019). Proses berpikir kritis matematis siswa sekolah menengah pertama melalui discovery learning. *Jurnal Riset Pendidikan Matematika*, 6(1), 99-117.
- Haeruman, L. D., Rahayu, W., & Ambarwati, L. (2017). Pengaruh model discovery learning terhadap peningkatan kemampuan berpikir kritis matematis dan self-confidence ditinjau dari kemampuan awal matematis siswa sma di Bogor Timur. *Jurnal Penelitian dan Pembelajaran IPA*, 10(2), 157-168.
- Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: a response to kirschner, sweller, and clark (2006). *Educational Psychologist*, 42(2), 99-107.
- Hung, W. (2016). All PBL starts here: The problem. *Interdisciplinary Journal of Problem-Based Learning*, 10(2), 1-10.

- Indrašienė, V., Jegelevičienė, V., Merfeldaitė, O., Penkauskienė, D., Pivorienė, J., Railienė, A., ... & Valavičienė, N. (2019). What critical thinking and for what?. *Social Welfare: Interdisciplinary Approach*, 9(1), 24-38.
- Kowalczyk, N., & Truluck, C. (2013). Literature reviews and systematic reviews: What is the difference?. *Radiologic Technology*, 85(2), 219-222.
- Lapuz, A. M. E., & Fulgencio, M. N. (2020). Improving the critical thinking skills of secondary school students using problem-based learning. *International Journal of Academic Multidisciplinary Research (IJAMR)*, 4(1), 1-7.
- Minarni, A. (2019). Developing learning devices based on geogebra assisted discovery learning with savi approach to improve motivation and mathematical communication of senior high school students MTs Aisyiyah. *American Journal of Educational Research*, 7(12), 893-900.
- Palinussa, A. L., Lakusa, J. S., & Moma, L. (2023). Comparison of problem-based learning and discovery learning to improve students' mathematical critical thinking skills. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, 13(1), 109-122.
- Paul, R., & Elder, L. (2006). Critical thinking: the nature of critical and creative thought. *Journal of Developmental Education*, 30(2), 34-35.
- Prasetyo, F. & Kristin, F. (2020). Pengaruh model pembelajaran problem based learning dan model pembelajaran discovery learning terhadap kemampuan berpikir kritis siswa kelas 5 SD. *Didaktika Tauhidi: Jurnal Pendidikan Guru Sekolah Dasar*, 7(1), 13-27.
- Putri, C. D., Pusitasari, I. D., & Rubini, B. (2020). Problem based learning terintegrasi stem di era pandemi covid-19 untuk meningkatkan keterampilan berpikir kritis siswa. *Jurnal IPA dan Pembelajaran IPA*, 4(2), 193-204.
- Rahmadani, N. N. & Anugraheni, I. (2017). Peningkatan aktivitas belajar matematika melalui pendekatan problem based learning bagi siswa kelas 4 SD. *Scholaria: Jurnal Pendidikan dan Kebudayaan*, 7(3), 241-250.
- Robinson, P., & Lowe, J. (2015). Literature reviews vs systematic reviews. *Australian and New Zealand Journal of Public Health*, 39(2), 103.
- Schmidt, H. G., Rotgans, J. I., & Yew, E. H. J. (2015). The process of problem-based learning: what works and why. *Medical Education*, 49(8), 792-806.
- Simamora, R. E., & Saragih, S. (2019). Improving students' mathematical problem solving ability and self-efficacy through guided discovery learning in local culture context. *International Electronic Journal of Mathematics Education*, 14(1), 61-72.
- Strobel, J., & Barneveld, A. (2018). When is PBL more effective? A meta-synthesis of meta-analyses comparing pbl to conventional classrooms. *Interdisciplinary Journal of Problem-Based Learning*, 13(1), 44-58.
- Syarifudin, S., Ahmad, I., & Halim, L. (2019). The effect of discovery learning on students' critical thinking and problem-solving skills. *Journal of Education and Learning*, 8(4), 107-115.
- Tinmaz, H., Lee, Y.T., & Fanea-Ivanovici, M. (2022). A systematic review on digital literacy. *Smart Learning Environments*, 9(21), 1-18.
- Uman, L. S. (2011). Systematic reviews and meta-analyses. *Journal of the Canadian Academy of Child and Adolescent Psychiatry*, 20(1), 57-59.
- Yulianti, E., & Gunawan, I. (2019). Model pembelajaran problem based learning (PBL): Efeknya terhadap pemahaman konsep dan berpikir kritis. *Indonesian Journal of Science and Mathematics Education*, 2(3), 399-408.