

Trends in Research on PBL-Based E-Worksheets to Enhance Students' Critical Thinking Skills: A Systematic Literature Review (2016–2025)

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Abstract: Critical thinking skills are essential competencies that students must possess in order to apply knowledge and skills acquired through learning to everyday situations and to face the challenges of an ever-evolving era. These skills can be facilitated through learning using the Problem-Based Learning (PBL) model. This study aims to identify and analyze research trends on PBL-based electronic student worksheets (E-LKPD) for enhancing students' critical thinking skills. The research employs a descriptive and analytical method. The data were obtained from documents indexed in Google Scholar from 2016 to 2025, using the tools Publish or Perish and Dimension.ai. The research procedure follows the PRISMA guidelines, focusing on the types of publications, sources of publications, and the most-cited research titles related to PBL-based E-LKPD. Data analysis was conducted using bibliometric analysis with the aid of VOSviewer software. The results indicate a trend in research on PBL-based E-LKPD for improving students' critical thinking skills from 2016 to 2025. There has been an increase in the number of publications from 2016 to 2023, although a decline was observed in 2024.

Keywords: Critical thinking; E-LKPD; Problem based learning

Introduction

Twenty-first-century technology continues to evolve dynamically, bringing significant changes and advancements in the field of education. One of the major changes and improvements in education is curriculum development. In Indonesia, curriculum development and implementation are based on current conditions and the numerous challenges that students, as the next generation, must face to remain competitive in the 21st century. It is not only the mastery and memorization of theoretical knowledge that students need to survive in this era, but also competencies that promote life skills and critical thinking (Susetyarini et al., 2020).

Students are expected to be active and independent in developing the 4C skills: creativity, critical thinking, collaboration, and communication (Doyan et al., 2023; Indarta et al., 2022; Muliyadi et al., 2023). Among these,

critical thinking is one of the essential demands of 21st-century learning. Critical thinking is the ability to analyze a case based on facts and evidence in order to reach a conclusion. According to Ennis (2018), critical thinking is reasonable and reflective thinking focused on deciding what to believe or do. Meanwhile, Agnafia (2019) defines critical thinking as the ability to connect current understanding with prior knowledge to reach a conclusion, solve problems, and form logical arguments.

When students possess strong critical thinking skills, they can provide logical arguments and explanations, make informed choices, and understand the relationships between systems. The lack of critical thinking skills among students is a reality observed both nationally and internationally (Saputri et al., 2019). These skills can be enhanced through the implementation of appropriate learning models and the use of relevant learning media. With strong critical

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thinking abilities, students are less likely to accept information passively; instead, they are able to justify their opinions with logical reasoning (Doyan et al., 2022; Firdaus et al., 2019; Kartini et al., 2019). Learning that requires students to identify problems, conduct objective investigations, analyze and think rationally about an idea, formulate questions, and draw conclusions is a form of instruction that promotes the development of critical thinking skills. Problem-Based Learning (PBL) can enhance theoretical knowledge and critical thinking skills, as it is a learning model in which students are confronted with real-life problems from their surrounding environment (Ejin, 2017). This is supported by Widayati et al. (2022) in their study on how PBL influences students' critical thinking skills in the topic of the excretory system, which revealed that PBL biology learning has a significant impact on students' critical thinking abilities. Their research showed that both students' mastery of biology concepts and their critical thinking skills improved significantly.

The PBL model is considered effective in developing students' critical thinking skills, especially in identifying and solving problems. It encourages students to engage with real-world issues relevant to daily life. By using this model, students are trained to sharpen their critical thinking skills while gaining a deeper understanding of the subject matter (Kusumawati et al., 2022). Therefore, PBL can be a powerful alternative to shift students from merely memorizing and retelling information toward active thinking and working (Dewi, 2020).

One type of instructional material that can support both students and teachers during the learning process—and that is well-suited for teaching critical thinking and problem-solving—is the student worksheet LKPD (Nurdin et al., 2018). With the advancement of technology, it is essential for teachers to adapt and integrate these developments into their teaching practices (Zahron & Yuliani, 2021). The electronic student worksheet (E-LKPD) is a digital version of the traditional LKPD that can be accessed anytime and anywhere using a laptop or smartphone (Apriliyani et al., 2021). Teachers can design and develop E-LKPD aligned with learning objectives and their own creativity. Lessons become more engaging and meaningful when conducted using E-LKPD, and such tools can also foster students' innovation and creativity (Lathifah et al., 2021).

The main advantages of E-LKPD include their ability to reduce the limitations of time and space, thus making learning more effective. Moreover, E-LKPD can serve as engaging tools when students' motivation to learn declines (Syafitri et al., 2020). One effort to improve students' critical thinking skills is by implementing active learning models in the classroom, such as

designing a PBL E-LKPD. Therefore, this study aims to examine research trends related to PBL E-LKPD for enhancing students' critical thinking skills. It is expected that this research can serve as a reference for further studies on PBL E-LKPD development to support the improvement of students' critical thinking abilities.

Method

This research employs a descriptive-analytical method aimed at understanding and describing research trends on PBL-based E-LKPD in relation to students' critical thinking skills. The data used in this study were obtained from sources indexed in Google Scholar, using keywords related to research trends on PBL E-LKPD for enhancing students' critical thinking skills. The analysis in this study was conducted on 1,000 documents indexed in Google Scholar from 2016 to 2025.

Result and Discussion

This study aims to describe the research trend on the PBL model E-LKPD to improve students' critical thinking skills conducted from 2016 to 2025. The research document on the research trend of the E-LKPD PBL model to improve students' critical thinking skills is taken from the 2016 to 2025 document, the following is presented an image of the research trend of the E-LKPD PBL model to improve students' critical thinking skills.

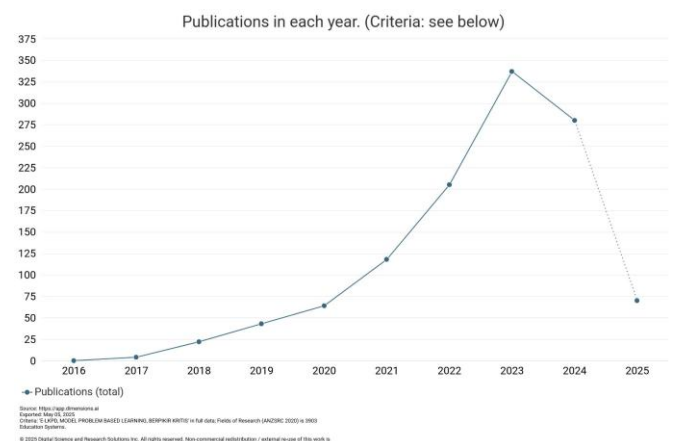


Figure 1. Research trends regarding E-LKPD based on the PBL Learning model to improve students' critical thinking skills

Figure 1 shows a graph of publication trends regarding E-LKPD based on the PBL Learning model to improve students' critical thinking skills from 2016 to 2025. In 2017, there were about 5 publications, showing the beginning of the introduction of E-LKPD in the context of PBL. The number of publications increased significantly in 2018, reaching about 25 articles, which

signifies the growing interest in this study. In 2019, there was an even bigger surge with nearly 45 publications, indicating that researchers are increasingly actively exploring and developing E-LKPD to support project-based learning. The years 2020 and 2021 recorded an ever-increasing number of publications, reaching around 63 and 120 articles, respectively, reflecting the growing popularity of the PBL model in education. The peak of publication occurred in 2023, with more than 340 articles published, signaling the most productive period in the study. However, after that peak, it began to see a sharp decline in 2024, with only about 280 publications. This may be due to a change in education policy, a reduction in funding for research, or a shift in research focus to other areas. The projections for 2025, shown by dotted lines, indicate the possibility of further decline with estimates of around 75 publications.

Table 1 presents information on publication trends related to E-LKPD (Student Worksheets) based on the PBL model to improve students' critical thinking skills, which are grouped by type of publication. The most common type of publication is articles, with a total of 1,084 publications. These figures indicate a high level of research activity in this field, reflecting the researchers' keen interest in exploring and developing effective learning methods. Furthermore, there are 44 publications in the proceeding category, which include

papers presented at conferences or seminars. This publication is important because it provides a platform for researchers to share the latest findings and discuss best practices. In addition, there are 18 publications in the form of edited books, showing the collaboration of researchers to collect various writings into one book, providing comprehensive guidance on E-LKPD and PBL. Finally, there are 13 publications in the form of chapters, which means that some researchers contributed by writing chapters in larger books, highlighting specific aspects of E-LKPD and PBL. Overall, this table illustrates that articles are the most dominant form of publication, while other types of publications also play an important role in disseminating knowledge and good practice in this field, enriching the literature and contributing to the improvement of the quality of learning.

Table 1. Types of E-LKPD Trend Publications Based on the PBL Learning Model to Improve Students' Critical Thinking Skills Based on Publication

Publication Type	Publication
Article	1,084
Proceeding	44
Edited book	18
Chapter	13

Table 2. Top 5 Sources Trend Titles E-LKPD PBL Learning Model to Improve Students' Critical Thinking Skills in 2016-2025

Name	Publication	Quotation	Quotes Meaning
Journal of Science Education Research	307	795	2.59
Journal of Scholars Journal of Mathematics Education	103	390	3.79
Advances in Social Science, Education humanities Research	93	160	1.72
Basicedu Diary	92	676	7.35
Educational Journal of Education	82	248	3.02

This table presents information on the publication trend of E-LKPD (Student Worksheets) based on the Project-Based Learning (PBL) model to improve students' critical thinking skills between 2016 and 2019. The Journal of Science Education Research recorded the highest number of publications with 307 articles and a total of 795 citations, resulting in a citation-per-article ratio of 2.59, which shows a significant research influence. Furthermore, Jurnal Cendikia, which focuses on mathematics education, has 103 publications with 390 citations and a citation-per-article ratio of 3.79, signifying that its articles are getting good attention.

Advances in Social Science, Education and Humanities Research has 93 publications with 160 citations, recording a citation-per-article ratio of 1.72. Although the number of publications is not as large as that of other journals, its contribution is still important. Basicedu journal performed very well with 92

publications and 676 citations, resulting in a high citation-per-article ratio of 7.35, indicating that its articles are frequently referenced. Finally, Educative Journal of Education has 82 publications with 248 citations and a citation per article ratio of 3.02. Overall, this table shows that some journals have a significant influence in the field of PBL-based E-LKPD, with varying levels of citations reflecting the quality and relevance of published research.

The table 3 presents relevant quotes regarding the trend of E-LKPD in problem-based learning (PBL) models from 2016 to 2025. Nurjanah et al. (2022) discuss the development of problem-based E-LKPD. (Sanjaya et al. (2021) examine the profile and feasibility of problem-based learning theories to improve students' critical thinking skills. Munawarah et al. (2022) examined the use of Google Sites to support the critical thinking learning process. Munika et al. (2021) also discussed E-

LKPD based on problem-based learning and its importance in improving students' critical thinking skills in elementary school.

Table 3. Top 5 Quotes on E-LKPD Trends PBL Learning Model to Improve Students' Critical Thinking Skills in 2016-2025

Quotation	Year	Author	Heading
5.34	2022	Nofa Nurjanah, Guntur Trimulyono	Development of Problem-Based Learning E-LKPD to Practice Critical Thinking Skills in Human Heritage Materials
6.53	2021	Wulan Ega Sanjaya, Evie Ratnasari	Profile and Theoretical Feasibility of LKPD "Digestive System" based on Problem Based Learning to Train Critical Thinking Skills
8.55	2022	Nikmatul Munawaroh, Ni'matush Sholikhah	Development of LKPD Based on Problem Based Learning Through Interactive Videos Assisted by Google Site to Stimulate Critical Thinking Skills
3.44	2021	Risa Dewi Munika, Retno Marsitin, Nyamik Rahayu Sesanti	Problem-Based Learning Based E-LKPD Accompanied by Interactive Mathematics Quizzes to Improve Critical Thinking Skills
4.83	2023	A Letter to the Editor, A Letter to the Editor	Analisis Needs Development Needs of E-lkpd Based Hots Assisted Liveworksheet for Elementary School Participants

Table 4 Keywords on the E-LKPD Trend of PBL Learning Model To Improve Students' Critical Thinking Skills in 2016-2025

Conditions	Occurrence	Relevance
Influence of the PBL model	10	5.78
Development of LKPD	6	4.50
Application of the PBL model	5	2.23
Use of e-lkpd	7	1.34
Technology	6	0.52

Table 4 shows the keywords that often appear related to the E-LKPD Trend of the PBL Learning model to improve students' critical thinking skills in 2016-2025. First, the influence of the PBL (Problem-Based Learning) model recorded the highest number with a relevance value of 5.78, showing that the application of this model

has a great influence on student learning outcomes. Furthermore, the development of LKPD (Student Worksheet) obtained a score of 4.50, which also shows significant relevance in supporting the learning process.

In addition, the application of the PBL model has re-emerged with a relevance value of 2.23, which indicates that although previously mentioned, there are certain aspects of this model that still need further research. The use of e-LKPD (electronic Learner Worksheets) had a lower relevance, which was 1.34, which shows that despite the use of technology, its impact on learning outcomes still needs to be improved. Finally, the technology aspect itself was recorded to have the lowest relevance, which was 0.52, indicating that although important, technology has not been fully optimized in the current learning context.

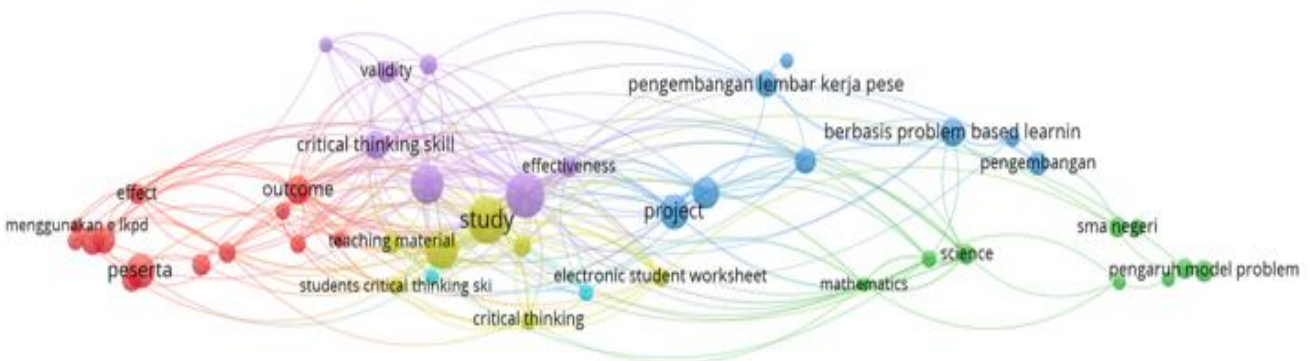


Figure 2. Results of bibliometric keyword mapping on research trends in the Problem Based Learning (PBL)-based E-LKPD model to improve critical thinking skills in science learning

The following is a visualization achieved by creating a landscape map, which offers a visual representation of the subject related to the scientific study. The results of bibliometric mapping for the shared word network in articles related to the topic of

research trends on the Problem Based Learning (PBL)-based E-LKPD model to improve critical thinking skills in science learning in Figure 2.

Figure 2 shows the results of bibliometric keyword mapping on research trends in the Problem Based

Learning (PBL)-based E-LKPD model to improve critical thinking skills in science learning. There are 45 keyword items that are frequently used in science generic skills research from 2016 to 2025. This image also contains seven clusters: the first cluster is red consisting of 10 keyword items such as "LKPD-assisted," "effect," "implementation," and "PBL model implementation." The second cluster in green consists of 10 keyword items, including "mathematics," "project," and "science." The third cluster in blue includes 8 keyword items such as "Development," and "PBL model" The fourth cluster in yellow consists of 7 keyword items, including "Critical thinking skill," and "student." The fifth cluster is purple

consisting of 6 keywords "project-based" and "development". The sixth cluster is blue consisting of 4 keyword items, namely "critical thinking" and "study". The network visualization in Figure 2 shows the relationships between the visualized terms. The keywords classified in the six clusters are arranged in a color chart that shows the interconnected divisions. The results of this analysis can be used to determine keyword research trends in the past year. This analysis shows some keywords that are often used in research on PBL models to improve critical thinking skills in science learning.

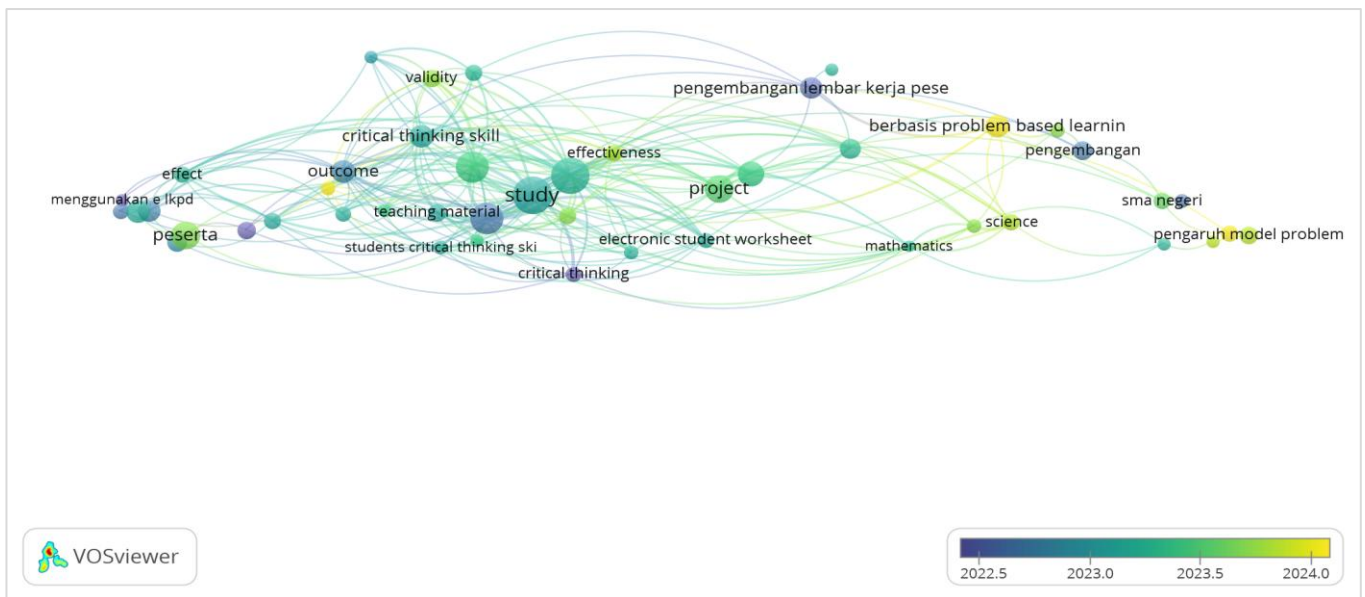


Figure 3. The research trend on the Problem Based Learning (PBL)-based E-LKPD model to improve critical thinking skills in science learning in Google Scholar-indexed journals from 2016 to 2025

Figure 3 shows the research trend on the Problem Based Learning (PBL)-based E-LKPD model to improve critical thinking skills in science learning in Google Scholar-indexed journals from 2016 to 2025. The trend of article writing themes related to the Problem Based Learning model to improve critical thinking skills in science learning from the longest to the latest year is characterized by the theme of purple, blue, turquoise, dark green, light green and yellow. The image above shows that these keywords are widely used by researchers in 2022. In 2022, the keywords that often appear are study, project, participants, critical thinking, and others.

Figure 4 shows a density visualization. The density of the research theme is shown in bright yellow. The brighter the color of a theme, the more research is done. The fading of the color means that the theme is rarely researched. Themes that are faded in color such as design, results, skills, objects are keywords that are

dimly colored. This shows that these keywords can be used as a reference for further research. The yellow color indicates keywords that are current and frequently used in research. Overall, research on the Problem Based Learning model to improve critical thinking skills in science learning is important because it makes a significant contribution to the development of science in the 21st century. 21st century education and the PBL model are learning models that are able to facilitate critical thinking skills. Critical thinking skills are essential so that students are able to process information to solve problems both in learning and in real life. The research trend of the Problem Based Learning model to improve critical thinking skills in science learning is expected to continue to grow in the next few years. This can be done by developing a new combination of PBL models with technology or other things to facilitate students' critical thinking skills, especially in science subjects.

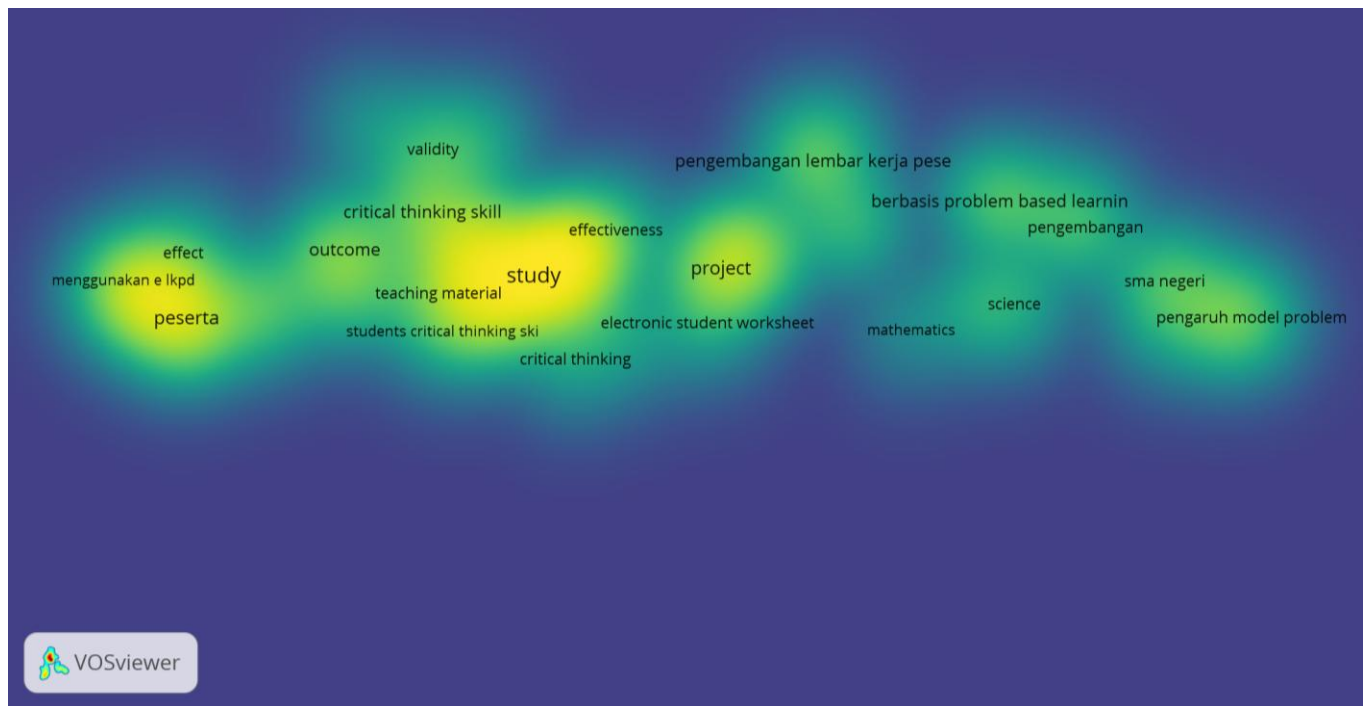


Figure 4. Density visualization

Conclusion

The development of 21st century technology has brought significant changes in education, especially through the development of curricula that support life skills and critical thinking. Critical thinking skills are one of the main demands in 21st century learning, which needs to be improved through the right learning model, such as Problem Based Learning (PBL). PBL not only helps students in dealing with real problems, but also improves their analytical and comprehension skills. This study shows that the PBL model E-LKPD can be an effective tool in supporting the teaching of critical thinking skills. By utilizing technology, teachers can design E-LKPD that is in accordance with learning outcomes and creativity, so that learning becomes more interactive and innovative. The analytical descriptive research method used in this study successfully identified trends in the use of PBL model E-LKPD from 2016 to 2025, in the hope of providing insights for further research. Overall, improving students' critical thinking skills through the PBL and E-LKPD models is expected to prepare the younger generation to face challenges in the global era. This research emphasizes the importance of developing a new combination of PBL models with technology to continue to improve the quality of learning, especially in science subjects.

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