
Problem Based Learning (PBL) - Problem Solving Skills (PSS): Systematic Literature Review

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Abstract

At this time, education in Indonesia has entered the 21st century, which requires students to have 21st century skills, one of which is problem-solving skills (PSS). PSS is needed in life so that students can solve their problems appropriately, effectively, and efficiently. One way to increase students' PSS is to use varied and innovative learning models, such as problem-based learning (PBL). This research is an SLR study that aims to find out whether PBL can affect the increase in student PSS. The methodology in this study included identifying objectives by creating research questions, drafting implementation for the writing team, screening inclusion, searching for literature/ references, taking the essence of selected articles, screening exclusions, conducting synthesis, and writing studies. This study used one database, namely SCOPUS, with a total of 167 articles in the time period from 2013 – 2022. Then, these 167 articles were filtered by inclusion and exclusion so that 69 articles were obtained that were worthy of review. The results of the review of 69 articles can be presented as follows: (1) Indonesia is the country that has conducted the most research on the effect of PBL on PSS; (2) The fields of study involved in this research are very varied, but mathematics and health dominate the most; (3) The research objects involved also vary with the level of student education that dominates; (4) The general result of this study is that PBL can increase students' PSS, although there are several studies that contradict these results; (5) The learning model used is PBL, which has been combined with other learning models that are more innovative and creative. The conclusion of this study is that PBL can increase students' PSS..

Keywords: Systematic Literature Review; Problem Based Learning; Problem Solving Skills

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INTRODUCTION

The world of education has entered the 21st century, which requires students to have a range of competencies to be able to be problem solvers in a variety of contextual settings in the surrounding environment (Hughes, 2016). The competence of the 21st century that students should possess is the ability to think at a high level and sufficient knowledge in solving the challenges that will be faced (Amanda et al., 2022), capable of thinking critically, and able to learn independently in preparing for future life challenges, especially in the contextual Problem Solving Skill (PSS) (Klegeris et al., 2013; Martyn et al., 2014). Learning in the 21st century is designed to integrate pedagogical and technological aspects to enhance 21st-century competence (Ayu et al., 2021; Jude et al., 2014). If knowledge and technology were mastered by students, it would have many more advantages for student life than just learning through textbooks alone (Blackburn, 2017). The knowledge and competence that students now have will affect the technological progress of a country, the source of national wealth assets, and the increased development of the country (Argaw et al., 2017). Based on the exposure, the learning required in the 21st century is learning that connects knowledge and technology as well as presenting contextual problems that will later be solved by students using a variety of fields of science to be problem solvers of various problems (Merisa et al., 2020).

Problem solving skills are essential skills that students need in the 21st century (Egeci & Gencoz, 2011). This ability starts with identifying problems and using the knowledge you have to solve them until the process generates new knowledge from the problem solving that has been done (Martaningsih et al., 2022; Saengrith et al., 2022). The ability to solve problems not only focuses on environmental problems, but this ability is also needed when students work so that they are able to solve problems accurately, precisely, and quickly (Fang et al., 2016; Martyn et al., 2014). The role of PSS in this life is very important for all groups, even with the limitation of hearing ability, as in the study conducted on students who are Deaf and Hard of Hearing (DHH) (Marshall et al., 2016). This ability is also needed by DHH to solve their problems. This shows that PSS is very needed by every student, so it takes an effort to improve it, one of them by using the learning model that will be used in the classroom (Dewi et al., 2017).

Learning in a classroom is very diverse in terms of context, teaching strategies and practices, and learning evaluation to increase student interest and motivation (Argaw et al., 2017). A variety of learning models are offered to improve student problem-solving capabilities, one of which is problem-based learning (PBL). PBL is a form of learning that focuses on students and trains them to find solutions to problems presented through open questions. It can be done in small learning groups to perform tasks presented related to real life (Martaningsih et al., 2022; Phungsuk et al., 2017; Prahani et al., 2022). Through PBL, someone who can communicate effectively and perform team collaboration compactly (Warnock & Mohammadi-Aragh, 2016). PBL is widely used in various countries as the basis of learning and curriculum because it is student-oriented (Hamdan et al., 2014; Prahani et al., 2022). In addition, the benefits of PBL can also improve critical thinking skills, self-control, the ability to communicate, and the ability to collaborate in the search for relevant information (Juandi & Tamur, 2021; Pilcher, 2014; Yeo & Tan, 2014). This learning process can position learners to solve real problems (Kladchuen & Srisomphan, 2021), so that students can use the knowledge they possess to think critically and collaborate in teams (Pilcher, 2014). The process of doing PBL gives students the ability to connect knowledge with its application in real life (Wright et al., 2014).

PBL-related research has been conducted extensively, for example, comparing PBL with other learning models such as Lecture-based Learning (LBL), which showed that PBL is more effective than LBL learning (Li et al., 2022)(Ma et al., 2016), the influence of self-learning, and PBL that can improve clinical practice capabilities (Najjar et al., 2021)(Fang et al., 2016). PBL is able to imply long-term knowledge gains (Rehmat & Hartley, 2020)(Carrió et al., 2016). PBL combined with Project-based Learning (POPBL) for transportation engineering education results in improved understanding (M. Li & Faghri, 2016), a comparison of PBL with traditional lecture-based learning (Solomon, 2020)(Carriger, 2016), and the influence of PBL on technical skills (Crespí et al., 2022)(Parno et al., 2019)(Warnock & Mohammadi-Aragh, 2016). Even SLR-related PBL research is widely done (Roslina et al., 2022), for example, comparing PBL to traditional learning models in self-control aspects (Günüs, 2014). However, SLR research that raises the theme of PBL as an attempt to enhance PSS is

still under-research. Thus, there needs to be research to study PBL related to PSS to get a trend of research influencing PBL against PSS. The aim of this research is to examine: (1) the countries conducting research related to PBL and PSS; (2) the fields of study frequently used as research; (3) the educational level of the research object; (4) the research results of the articles being studied; and (5) the updating of the learning models used in the research.

METHOD

The study of literature is one way of conducting basic scientific research. In the study of traditional literature, there are no systematic steps on how to conduct a good review. Along with the development of knowledge, a systematic literature review (SLR) was conducted (Xiao & Watson, 2019). SLR is a way to make a synthesis of an article that aims to answer certain questions in a transparent way and can be developed based on the articles that have been published by exploring the quality of the article (Lame, 2019; Okoli, 2015; Okoli & Schabram, 2010). There are eight steps in conducting SLR (Okoli, 2015), namely:

1. Identifying the purpose
The first step in the implementation of SLR was to clearly identify the purpose, objectives, and function for the reader (Cohen et al., 316 C.E.). The purpose of doing SLR on this article was to know the improvement of PSS in PBL, with some of the focuses described being country spread, field of study, spread of educational level, research results, and updating of the learning model used to improve PSS within PBL.
2. Drafting protocol and training the team/
drawing the draft execution and training team writers

The second step was to determine the procedures to be carried out and agree on them with the examining team before conducting the examination. The researchers determined the database that would be used. The database used in this article was SCOPUS. SCOPUS is one of the bases owned by the world's leading publisher, Elsevier. SCOPUS is also a trusted and internationally recognized reference source. The researchers searched the articles using keywords and wrote the date of data collection, which was on December 6, 2022, at 9.02 WIB. The selection of the articles based on the research objectives was then continued by reviewing the articles.

3. Applying practical screen/ inclusion filtering
The third step was inclusion filtering. In this step, the reviewers performed filtering aimed at determining which articles would be used and which would not be used. On unused articles, the reviewers must write down the reasons associated with the purpose or criteria of the article to be written. Inclusion filtering using the SCOPUS database, accessed on December 6, 2022, at 09:02. Meanwhile, the inclusion criteria used in this study included articles published in the last 10 years (2013–2022). The keywords used were "problem-based learning" AND "problematic solving skills." Thus, there were 167 SCOPUS-indexed articles with the distribution shown in Figure 1.
4. Searching for literature
The fourth step was the search for articles carried out by the the reviewers by writing the details of the articles that have been obtained and clearly explaining the comprehensiveness of the criteria of the articles to be written.

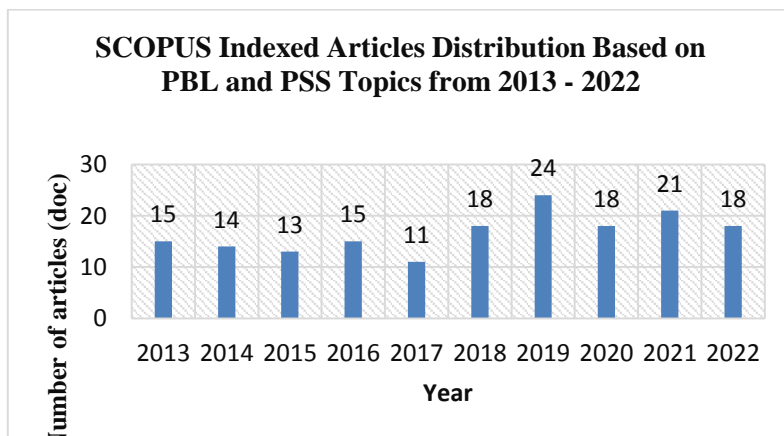


Figure 1. Graph of the Article Distribution from 2013 – 2022

5. Extracting data
After the fourth step was completed, the reviewers began a one-on-one review of the article that meets the criteria.
6. Appraising quality of the articles.
Then, the sixth step was exclusion filtration. In this filtering, the reviewers needed to explicitly outline the criteria to be used to assess which articles would be released due to inadequate quality. The results and exclusion filtering criteria can be seen in Table 1.

Table 1. Exclusivity Exclusion

No	Exclusivity	Number of Articles (documents)
1	Articles from SCOPUS	167
2	The paid article	31
3	Articles that do not match the topic	67

7. Synthesizing studies
The next step was to make a synthesis or analysis of the article to be used. This step combined the facts that have been analyzed using quantitative, qualitative, or both techniques.
8. Writing reviews
During the writing process of the review, the reviewers needed to report in detail, so that the reader can develop it independently.

RESULT AND DISCUSSION

Based on the results of the analysis of the 69 articles selected, the results are displayed as follows:

a) A Number of Countries

Research studies involving PBL learning models and efforts to improve student PSS have been studied in many countries. The detailed distribution of countries conducting the study is depicted in Figure 2.

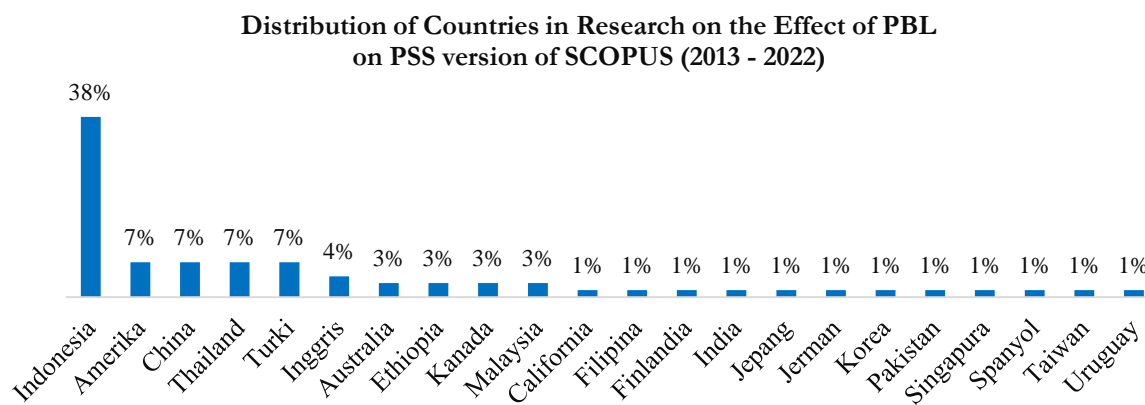


Figure 2. Distribution of Countries on the Effect of PBL on PSS version of SCOPUS

It is seen in Figure 2, it shows that the spread of this PBL research studies are not only done in Asia but also in other continents that include America, Australia, and even Europe. Indonesia is the country that produces the most research on PBL learning. This shows that education in Indonesia has begun to focus on the analysis of contextual problems to improve the problem-solving abilities of its students. Teachers in Indonesia have the view that the PBL learning model, has many benefits for students, among which are improved problem-solving ability,

ability to communicate, literacy, critical thinking, creative thinking, the ability to write scientific work, metacognition, and collaborative ability (Ahdhianto et al., 2020; Amanda et al., 2022; A. Aslan, 2021; S. A. Aslan & Duruhan, 2021; Hendarwati et al., 2021; Juandi & Tamur, 2021; Kamid et al., 2021; Saengrith et al., 2022; Sari et al., 2021; Simanjuntak et al., 2021).

b) Distribution by Fields of Research

Problem-based Learning research studies are not merely applied to specific subjects. Uniquely, the field of research

involved in this study also varies, as can be seen in Figure 3.

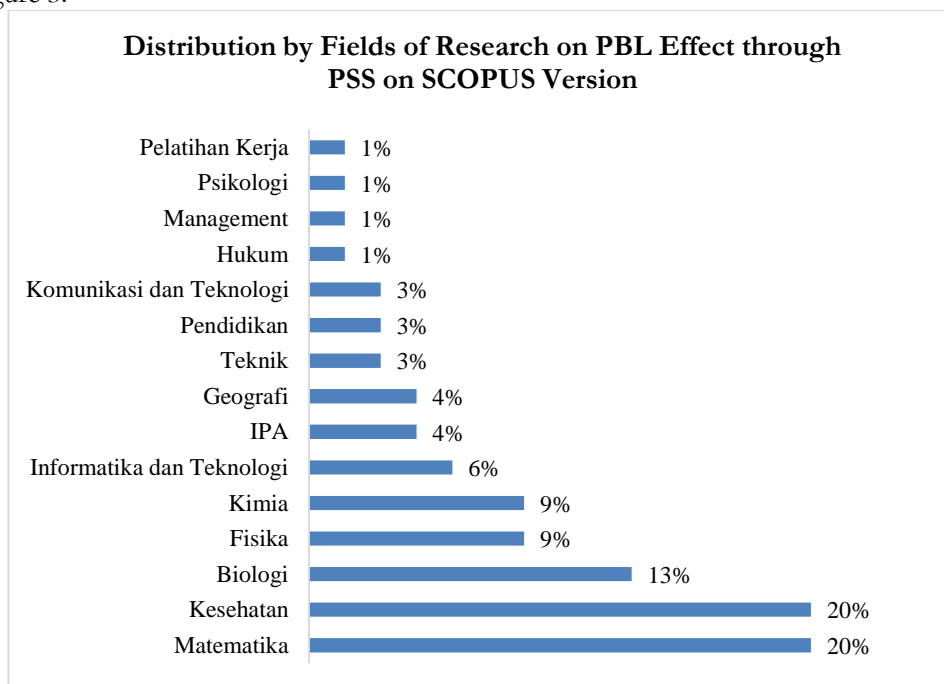


Figure 3. Graph of the Distribution by Fields of Research on SCOPUS Version

Graph 3 shows that Mathematics and Health are the most dominant fields of study among the 69 articles selected. The most common and commonly used process of learning mathematics is being able to solve problems, think logically to prove something, be able to communicate, orientate and perform representations (Marhaeni & Suparman, 2019).

c) Distribution of Educational Levels of the Research Objects

The research objects used in the 69 articles studied were students of different educational levels. The difference in educational level was used to determine the level of suitability of the learning strategy performed by the researchers for the object that has been studied so that it can be referenced. The distribution of the level of education used in this study can be seen in Figure 4.

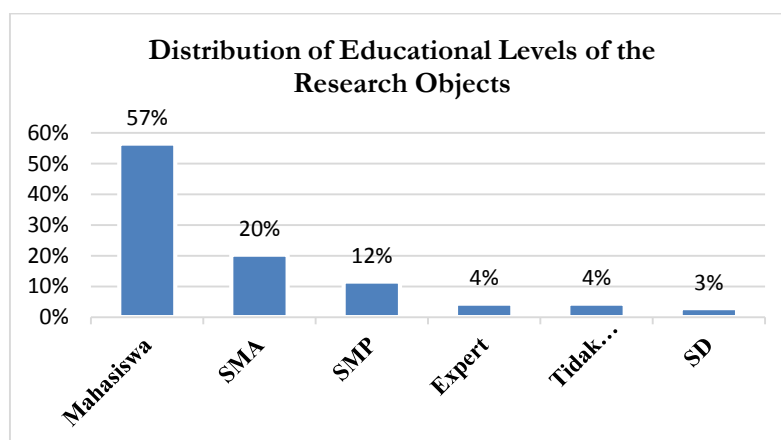


Figure 4. Graph of Distribution of Educational Levels of the Research Objects

The most widely used level of education for research objects is 57% for students, and the least is 3% for SD students. Research on students is most often done because the students have an urgent need to jump into the community, so it is necessary to do the right learning to improve their PSS. The problems presented in the PBL are contextual and require students to use various disciplines to obtain solutions (Amanda et al., 2022). The diversity of disciplines already mastered by this student, which is the foundation of PBL, is often applied to students.

Meanwhile, PBL research on elementary school students was conducted on Natural Science and Mathematics subjects. The main reason for the need to improve PSS through PBL in SD students is that PSS is a competence that students need to face challenges in the 21st century, needed from an early age to facilitate them in solving problems in everyday life, familiarize students with problems that are not

only relevant to learning in the classroom but also exist in daily life, accustom students to finding solutions to problems found, and familiarize students with how to collaborate and communicate (Ahdhianto et al., 2020; Martaningsih et al., 2022). In addition to using PBL learning, PSS can also be enhanced through modules integrated with STEM (Martaningsih et al., 2022).

d) Summary of research results on articles that have been reviewed

The research results are one of the goals of the researchers, who want to know the effectiveness of learning strategies in order to improve student PSS. Based on the 69 articles studied, a summary of the results of the study is obtained as in Figure 5. Results of research from selected articles reviewed by SCOPUS version (2013 - 2022).

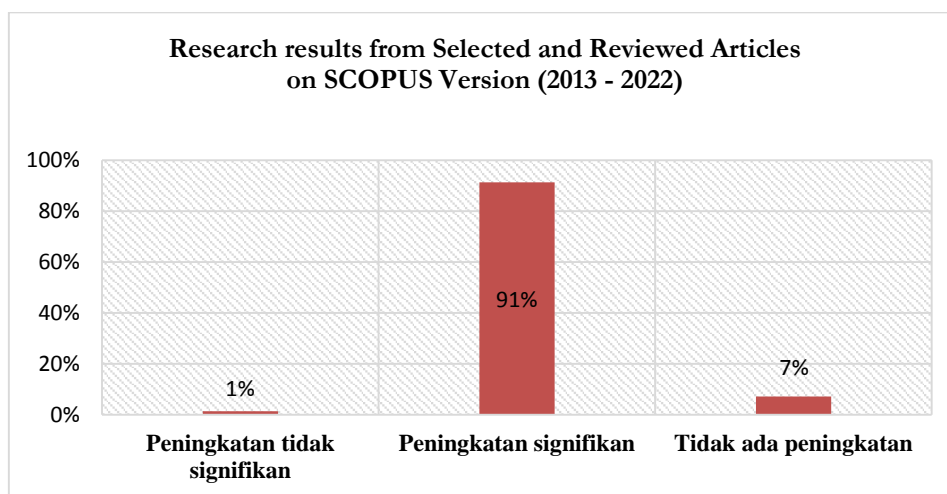


Figure 5. Graph of Research Results Summary from Selected and Reviewed Articles

In Figure 4, the results of the study showed that 91% of the studies were successful or PBL could significantly improve student PSS, 1% experienced insignificant PSS improvements, and 7% had no improvement in PSS at all. In the study that experienced an insignificant increase, the researchers performed bridge-in, objective, preassessment, participatory learning, post-assessment, and summary learning combined with CBL (case-based learning) on ophthalmology courses that only improved

student learning motivation. Some students acknowledge that the combination of these two models is only able to develop their PSS, not improve it. Students and lecturers think that more innovative learning models are needed to improve PSS on oftalmology courses (Chen et al., 2022).

Meanwhile, 7% of the research results showed no improvement, and the learning model used is generally PBL. Some students found it difficult to work with the LKPD given by the

teacher. In addition, students also lack understanding of the problems presented, have difficulties following PBL lectures due to being accustomed to traditional models, the learning devices used do not associate the learning material with student life, the LKPD used has not yet been applied to students, and there are still preliminary research studies (Carriger, 2016; Hidayati & Permana, 2019; Istriani & Suparman, 2019; Mabley et al., 2020; Permatasari et al., 2019). Based on such exposure, PBL has a great chance of increasing student PSS, although there are some difficulties students need to overcome before PBL can be implemented in a class.

e) Updating the learning model used in the articles that have been studied

Updating a learning model is needed to demonstrate innovation from a researcher seeking to improve student PSS. The updating of the learning model of the 69 articles that have been studied can be displayed in a graph as in Figure 5.

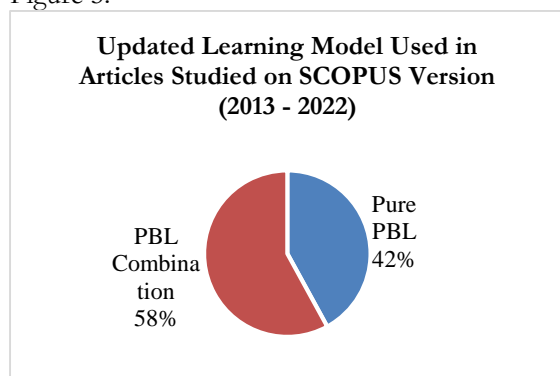


Figure 5. Graph of Updated Learning Model Used in Articles Studied on SCOPUS Version

The graph in Figure 5 shows that the research on the selected article used two variations of learning models, namely 42% of the total selected articles using pure PBL and 58% using PBL combined with other learning models or using current applicable technologies. Based on the research that have been studied, the learning using solely or pure PBL resulted in three types of research results namely PBL increases PSS significantly (Ahdhianto et al., 2020; Argaw et al., 2017; Asogwa et al., 2021; Chan, 2013; Günüs, 2014; Iwatsuki et al., 2021; Juandi & Tamur, 2021; Ma et al., 2016; Macho-Stadler & Jesús Elejalde-García, 2013; Marhaeni & Suparman, 2019; Martyn et al., 2014; Mughal &

Shaikh, 2018; Oktaviana & Suparman, 2020; Prasetyaningtyas & Suparman, 2019; Putra & Suparman, 2020; Saloranta et al., 2016; Sari et al., 2021; Shalini, 2021; Tosun & Taskesenligil, 2013; Valdez & Bungihan, 2019; Warnock & Mohammadi-Aragh, 2016; Wondie et al., 2020; Wright et al., 2014). PBL can increase PSS though it does not significantly increase (Chen et al., 2022). Also, PBL cannot increase students' PSS (Carriger, 2016; Hidayati & Permana, 2019; Istriani & Suparman, 2019; Mabley et al., 2020; Permatasari et al., 2019).

Meanwhile, PBL combination is a PBL learning model that is combined with technology or using software that aims to facilitate students in solving problems. The variations used in this study are highly varied and creative, among other things: PBL is combined with gamification (Kladchuen & Srisomphan, 2021; Poonsawad et al., 2022); PBL is combined with online systems or online learning (Amin et al., 2021; Aslan, 2021; Aslan & Duruhan, 2021; Blackburn, 2017; Carrió et al., 2016; Kim & Kee, 2013; Lian & He, 2013; Phungsuk et al., 2017; Prahani et al., 2022; Saengrith et al., 2022); PBL is combined with STEM (Marshall et al., 2016; Martaningsih et al., 2022; Othman, 2022; Su et al., 2022), PBL is combined with software and technology (Adanali & Alim, 2019; Karantzas et al., 2013; Nugraha et al., 2019; Simanjuntak et al., 2021; Yerizon et al., 2022).

In this present study, some previous researchers also combined PBL with other learning models, including complexity science, flipped PARSEr, the AMES test, TPACK, collaborative learning, small groups, role play, SMART, POE, character emphasis, contextual learning, local tribal traditions (handep), PjBL, and independent learning (Amanda et al., 2022; Blanco et al., 2021; Chamidy et al., 2020; Demitra & Sarjoko, 2018; Fang et al., 2016; Fitriani et al., 2020; Hamdan et al., 2014; Hendarwati et al., 2021; Kamid et al., 2021; Klegeris et al., 2013; Klegeris, 2021; Kusmiyati et al., 2018; M. Li & Faghri, 2016; Nantha et al., 2022; Pilcher, 2014; Suhirman et al., 2019; Utami et al., 2020; Yeo & Tan, 2014; Yuberti et al., 2019). The results of the research studies showed that the use of PBL in combination is able to improve students' PSS. The combination of PBL with learning models, technologies, and other learning approaches has proven to attract the interest, motivation, and ability of 21st century students to solve the given problems (Ferreira & Trudel, 2012; Hamdan et al., 2014; Klegeris et al., 2013).

CONCLUSION

Based on the results of the review of selected SCOPUS versions of articles during the 2013–2022 period, it can be concluded that (1) Indonesia is the country that has conducted the most research on the effect of PBL on increasing PSS, with publications of 38% of the 69 selected articles, (2) fields of the study involved in this study varied, with the most dominating percentages being mathematics and health, namely 20%, followed by Biology at 13%, Physics at 9% and Chemistry at 9%, (3) the research object also used various levels of education, with the highest percentage being college students at 57%, (4) the results of the study as a whole are that there is an effect of the PBL learning model on increasing PSS, however, there are 7% of studies that produce no increase at all, and 1% of articles inform that there is an increase even though it is not significant, (5) meanwhile, the novelty of learning models also varied; around 58% of research carried out innovations in PBL learning models, and 42% did sole PBL learning models (without any combination with other learning models). The use of PBL has been shown to increase PSS. The contextual problem presentation syntax in PBL helps students to be able to see problems from a real-life perspective, so that their PSS can be trained optimally. In its application, PBL can be combined with various learning strategies, media, and technology. The use of technology and instructional media as a form of PBL integration can help students to deepen the problem and look for various alternative solutions to existing contextual problems, so that students' PSS can be more implicated.

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