## Research Trends in Problem Based Learning in Middle School (1998-2023): A Bibliometric Review

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### Abstract

Problem-based learning is a learning model that uses real-life problems that require authentic investigations to construct knowledge actively and collaboratively. The aim of this study was to capture the research landscape related to problem-based learning applied to students at the middle school level from 1998 to 2023. A descriptive bibliometric analysis method was used in this study. The data obtained was taken from the Scopus database. The results of the study show that publications related to problem-based learning, especially in middle schools, go up and down every year. Publications in 2003 have been cited more than any other year. The United States of America is the most influential country in this field. publications in journals related to problem-based learning research applied to middle school students are mostly at the Q1 rank, namely 45 journals. The research focus is divided into 3 namely, 1) knowledge, skills and development; 2) effect, self-efficacy, achievement and effectiveness; 3) middle school students, environment and abilities. These three research focuses can be used as a reference for future researchers to determine the focus of their research related to problem-based learning.

**Keywords:** Problem-Based Learning; Bibliometrik; Middle School

### Introduction

Problem-based learning is an instructional design approach for promoting student learning in context-rich settings (Lawless et al., 2018). Problem-based learning researchers have illustrated for decades that using interdisciplinary contexts, like social studies, as a context to engage in real-world problem solving can have a profound and positive impact on learning by deepening students' understanding and yielding flexibility in application and transfer of knowledge/skills (Lawless et al., 2018). Problem-based learning is a learning model that is based on problems that require authentic investigation, namely investigations that require real solutions to real problems (Belland et al., 2019). Problem-based learning is learning that is used to stimulate students' higher-order thinking in situations that are oriented to real-world problems (Sutama et al., 2022). Problem-based learning is learning that starts from solving a problem and to solve this problem students need new knowledge to be able to solve it (Nowak, 2007; Wirkala & Kuhn, 2011). Based on the opinions of the experts above, it can be concluded that problem-based learning is a learning model that uses real-life problems that require authentic investigations to construct knowledge actively and collaboratively.

A successful teaching and learning process may make the classroom a joyful place to learn. An effective teaching strategy is one of the elements that has a significant impact on students' learning accomplishment, according to previous studies (Marchy et al., 2022; Mayani et al., 2022; Muhammad, Elmawati, et al., 2023; Ramadhaniyati et al., 2023; Sanusi et al., 2023). A problem-based learning environment provides learners with instructional mechanisms that can increase their higher-order thinking skills while they are exploring authentic and ill-structured problems, participating in social interactions, and receiving coaching from peers and teachers

(Lawless et al., 2018). However, problem-based learning involves many cognitive challenges. Learners are challenged to understand a problem situation, clarify the causes of the problem, decide on important facts to be investigated, and generate hypotheses for a solution (Song et al., 2006). Problem-based learning is a process of learning where a case problem is presented to students who are asked to apply reasoning, questioning, researching, and critical thinking to find a solution to the problem (Cerezo, 2004). Problem-based learning aims at promoting student-centered learning and enhancing the development of students' higher-order thinking and fostering students' social skills (Azer, 2009; Samosir et al., 2020).

Problem-based learning has been systematized for more than decades. Problem-based learning is a learning model that continues to grow, making it popular today. Studies reveal that there is a positive effect from problem-based learning on student skills. Highlighted among the benefits of applying Problem-Based Learning are the increase in the student's ability to conduct research, integrate theory and practice, communicate, conduct group work, apply knowledge and skills to develop a viable solution to a problem and develop self-directed studies (de Pinho et al., 2015).

Through a variety of research on the learning process in schools, educators have responded to the significance of children developing higher-order thinking abilities and skills. Implementing a problem-based learning model (PBL) is one action that has been taken frequently. Problem-Based Learning model strives to encourage students to learn actively by providing questions that push them to explore their curiosity, develop higher-order thinking skills, and make hypotheses and find solutions (Samosir et al., 2020). Results from multiple primary research studies, especially when compared to traditional learning, demonstrate the effectiveness of Problem-Based Learning model in enhancing critical and creative thinking abilities. Therefore the research interest related to problem-based learning is very large. Research conducted by (Juandi, 2021) shows that most research related to Problem-Based Learning model is carried out in middle schools. For that we need a method that can be used in analyzing the results of these studies especially in middle school.

In research, an analysis is needed, one of which is bibliometric analysis. Bibliometrics is a method used to introduce scientific publications related to scientific citations used in the field of librarianship or other fields. Bibliometric analysis was carried out to classify authors, their institutions, core journals published in the indexing system, search strategies through automated machines, control of bibliographies, and prepare retrospective bibliographic and library management (rahayu & sensusiyati, 2021). The bibliometric map used to visualize on a computer program is the VOS Viewer application. Bibliometrics is a research field with a long history, many bibliometric studies have been conducted and several bibliometric studies have investigated a topic or field based on documents indexed in Scopus or the Web of Science (Amiri et al., 2023). There have been many studies using bibliometric analysis such as research by (Muhammad, Himmawan, et al., 2023; Muhammad, Marchy, et al., 2022, 2023; Muhammad, Mukhibin, et al., 2022). Researchers use the Scopus database to find the necessary data. According to (Alviz-Meza et al., 2022) scopus is the most widely used database for publishing articles.

**Literature Review**

To synthesize the results of previous research related to problem-based learning in secondary schools, several researchers like (Anadiroh, 2019; Handayani Anik, 2021; Juandi, 2021; Paloloang et al., 2020; Wilder, 2015; Zakaria et al., 2019) who have conducted research using meta-analysis methods and systematic literature review related to problem-based learning. Research result (Anadiroh, 2019) is that the Problem-Based Learning model is influential and effective in terms of region, educational level, and application of learning to improve critical thinking skills, metacognitive, problem solving skills, science process skills, and scientific literacy skills. Research conducted by (Paloloang et al., 2020) who also conducted a meta-analysis at

various levels of education found that the Problem-Based Learning model was more effectively applied at middle school of education. Likewise research conducted by (Handayani Anik, 2021) explained that the Problem-Based Learning model can improve students' creative thinking skills.

Research conducted by (Zakaria et al., 2019) entitled "A Systematic Review of Problem Based Learning in Education" explained that Mathematics Education is the discipline that uses Problem-Based Learning model the most and 95% of its users believe that Problem-Based Learning model has positive impacts towards education and can be used as an alternative method at any level of education. Research result (Wilder, 2015) a systematic review entitled "Impact of Problem-Based Learning on Academic Achievement" showed that Problem-Based Learning model fosters not only development of content knowledge, but also a wide range of skills, such as communication and collaboration skills, decision-making, problem-solving, critical-thinking, and self-directed learning. Research result (Juandi, 2021) found that the study on the influence of Problem-Based Learning model on enhancing mathematical abilities has gotten a lot of attention, especially in terms of increasing comprehension and solving mathematical problems, but there hasn't been much published on creative thinking skills and mathematical literacy.

## Research purposes

The purpose of this research is to capture the research landscape related to problem-based learning that is applied to students at the middle school level from 1998 to 2023. The research questions are as follows.

1. What are the publication trends related to problem-based learning applied to middle school students?
2. What are the citation trends related to problem-based learning applied to middle school students?
3. What is the geographical distribution of publications and patterns of cooperation between countries in research related to problem-based learning applied to middle school students?
4. How is the distribution of journal rankings based on quartile scores related to problem-based learning applied to middle school students?
5. What is the focus of research related to problem-based learning, especially for middle school students?

## Methods

The bibliometric analysis research method is used to answer research questions by looking at research developments and literature (Julia et al., 2020; Phoong et al., 2022; Suherman & Vidákovich, 2022; Zyoud et al., 2015). Because Scopus is the largest abstract indexing database, the authors chose it for the study while seeking for data sources related to "problem-based learning in middle school students". Researchers used the Scopus database because of its very broad interdisciplinary coverage. There are several steps in perfecting the data that has been collected. The first is identification, then followed by screening, eligibility and finally the inclusion step (Moher et al., 2009).

Topic and Scope

Topic: problem-based learning in middle school students

Scope and Coverage (Database: Scopus)
Search Field: Article title and subject area (Time Frame: 1998-2023)

Identification

Search String:
TITLE ( " problem-based learning" ) AND ("education")

Data Extraction Date:
10 Januari 2023

Total Number of Documents Identified: 15296 → Number of Duplicate: 0

Total Number of Documents after Eliminating the Duplicates: 15296

Sceening

Total Number of Documents Screened: 15296 → Documents Excluded: 15165

Eligibility

Total Number of Documents Assessed for Eligibility: 131 → Documents Excluded: 51

Included

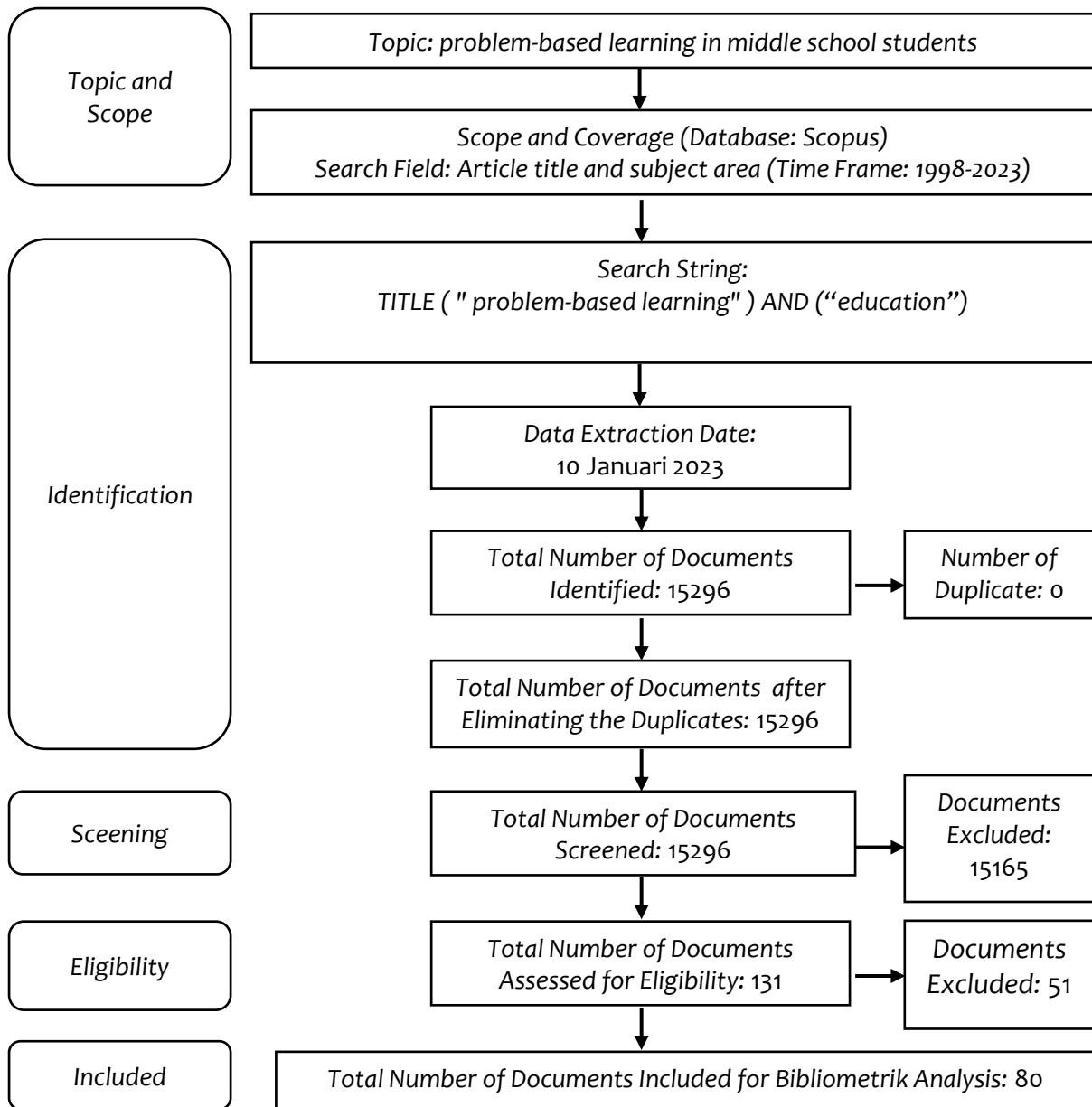Total Number of Documents Included for Bibliometrik Analysis: 80

Figure 1. Data Collection Process

In Figure 1 above it can be seen that the first step in the data collection process is the identification process, the researcher enters keywords in the search on the Scopus database. The keywords entered are (" problem-based learning " ) AND ("education"). From the results of this identification obtained publication data of 15296 articles. The next step is the screening process, namely the researcher screens according to the criteria, namely, publications must be in English, must be in the form of articles published in journals. From the results of this screening, 131 publications were obtained that met the above criteria. This means that there are 15,165 publications that have been discarded and not continued in the next process.

Publication of screening results, then carried out the feasibility process. In this process the researcher does it manually regarding publications that are eligible to be included in the included stage. Researchers looked at the abstracts and titles of 131 publications and assessed publications that had included or included creative thinking variables in middle school students. At the end of the third phase, 80 publications were obtained that were eligible for inclusion in the next stage.

The trend of publications related to problem-based learning applied to middle school students is carried out by using descriptive analysis taken from the Scopus database using

bibliometric analysis. The number of publications and a linear line of publication trends each year from 1998 to 2023 will be displayed in a graph using Microsoft excel software.

**Data analysis method**

Publication trends and citation trends related to problem-based learning in middle school students are separated by year starting from 1998 to 2023. The number of publications each year is displayed with diagrams with the help of Microsoft Excel software. Then the average publication citations are also calculated using Microsoft Excel software. PoP software is used to easily calculate the h-index and g-index of publications.

The geographical distribution of countries is displayed with the help of Microsoft Excel software, but to see cooperation between countries researchers use the VOSviewer application. In displaying journal rankings based on quartile values, researchers use Microsoft Excel software to display journal ranking diagrams. The data that has been obtained from the Scopus database of 80 publications will be grouped based on (Q1), (Q2), (Q3), and (Q4). This shows that 80 publications obtained related to problem-based learning applied to middle school students have been published in the journal ranking above.

The focus of research related to problem-based learning that is applied to middle school students is carried out with the help of the vosviewer application by analyzing events with keywords. The researcher sets a threshold for displaying the research focus, namely the researcher sets a minimum of 3 publications that use the keywords together.

**Results and Discussion**

Publications related to problem-based learning that are applied to middle school students who have gone through the process of collecting data so that 80 publications are obtained in the range from 1998 to 2023 which comply with the criteria then a descriptive bibliometric analysis is carried out. Publication trends, citation trends, country and journal distribution and research focus will be discussed further.

**What are the publication trends related to problem-based learning applied to middle school students?**

The trend of publications related to problem-based learning applied to middle school students from 1998 to 2023 is shown in Figure 1. A total of 80 publications are grouped by year of publication which can be seen in Figure 2 below.
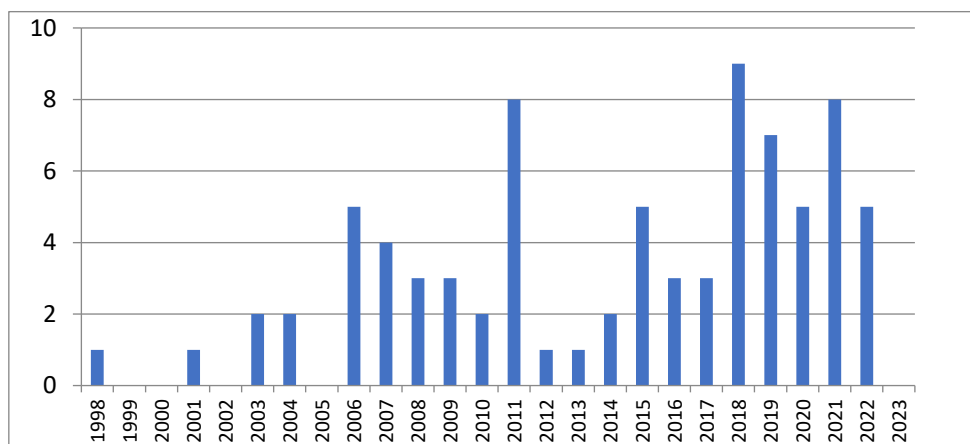


Figure 2. Publication trends (1998-2023)

From Figure 2. it can be seen that in 2018 there were 9 articles published, this was the largest number of publications compared to other years. Judging from the trend line, it can be seen that publications go up and down every year. It can also be seen that in 2023 there have been no publications regarding problem-based learning at the middle school level. The rapid increase in the number of publications occurred from 2010 to 2011 and from 2017 to 2018.

**What are the citation trends related to problem-based learning applied to middle school students?**

Trends in citations related to problem-based learning applied to middle school students from 1998 to 2023 are shown in table 1. Similar to publication trends, as many as 80 publications are grouped by year of publication which will then be seen based on total publications per year, NCP, TC scores. , C/P and others which can be seen in table 1 below.

Tabel 1. *Citation Analysis of Publications*

| Year | T | NCP | TC | C/P | C/CP | h | g |
|------|---|-----|-----|--------|--------|---|---|
| 2023 | - | - | - | - | - | - | - |
| 2022 | 5 | 1 | 1 | 0,20 | 1 | 1 | 1 |
| 2021 | 8 | 6 | 26 | 3,25 | 4,33 | 4 | 4 |
| 2020 | 5 | 4 | 20 | 4,00 | 5 | 2 | 4 |
| 2019 | 7 | 7 | 31 | 4,43 | 4,43 | 4 | 5 |
| 2018 | 9 | 9 | 126 | 14,00 | 14 | 8 | 9 |
| 2017 | 3 | 3 | 81 | 27,00 | 27 | 3 | 3 |
| 2016 | 3 | 3 | 27 | 9,00 | 9 | 3 | 3 |
| 2015 | 5 | 5 | 81 | 16,2 | 16,2 | 3 | 5 |
| 2014 | 2 | 2 | 22 | 11,00 | 11 | 2 | 2 |
| 2013 | 1 | 1 | 18 | 18,00 | 18 | 1 | 1 |
| 2012 | 1 | 1 | 25 | 25,00 | 25 | 1 | 1 |
| 2011 | 8 | 7 | 370 | 46,25 | 52,85 | 7 | 8 |
| 2010 | 2 | 2 | 58 | 29,00 | 29 | 2 | 2 |
| 2009 | 3 | 3 | 41 | 13,67 | 13,67 | 3 | 3 |
| 2008 | 3 | 3 | 189 | 63,00 | 63 | 3 | 3 |
| 2007 | 4 | 4 | 291 | 72,75 | 72,75 | 3 | 4 |
| 2006 | 5 | 5 | 138 | 27,60 | 27,60 | 5 | 5 |
| 2005 | - | - | - | - | - | - | - |
| 2004 | 2 | 2 | 51 | 25,50 | 25,50 | 2 | 2 |
| 2003 | 2 | 2 | 825 | 412,50 | 412,50 | 2 | 2 |
| 2002 | - | - | - | - | - | - | - |
| 2001 | 1 | 1 | 25 | 25,00 | 25 | 1 | 1 |
| 2000 | - | - | - | - | - | - | - |
| 1999 | - | - | - | - | - | - | - |
| 1998 | 1 | 1 | 4 | 4,00 | 4 | 1 | 1 |

*Notes. TP=total of publication, NCP=number of cited publication, TC=total citations, C/P=average citations per publication, C/CP=average citations per cited pblication, h=h-index, g=g-index*

From table 1 above it can be seen that the value (NCP) in 2018 is 9, which is the year with the highest NCP compared to other years. then if seen from the number of citations, the publication in 2003 has been cited more than any other year, with 825 citations. Even though the number of publications in 2018 was more than the previous year, the previous year, especially 2003, had a large research impact. but there were also many years that did not have a number of citations, namely in 1999, 2000, 2002, 2005, 2003. This was because in those years there were no publications related to problem-based learning in middle school that fit the researcher's inclusion criteria.

The highest h-index and g-index values were published in 2018 with h-index = 8 and g-index 9. So it can be said that 2018 also had a big impact on this research. There were 9 publications in 2018 which had 126 citations. The 9 articles published in 2018 can be seen in table 2 below.

Table 2. Articles published in 2018

| No | Author (year) | Title | Sources | Citation |
|---|---|---|---|---|
| 1 | (Burrows et al., 2018) | Integrated STEM: Focus on informal education and community collaboration through engineering | Education Sciences | 31 |
| 2 | (Chan & Blikstein, 2018) | Exploring problem-based learning for middle school design and engineering education in digital fabrication laboratories | Interdisciplinary Journal of Problem-based Learning | 18 |
| 3 | (Gomoll, Šabanović, et al., 2018) | Between the Social and the Technical: Negotiation of Human-Centered Robotics Design in a Middle School Classroom | International Journal of Social Robotics | 15 |
| 4 | (Lawless et al., 2018) | Promoting students' science literacy skills through a simulation of international negotiations: The GlobalEd 2 Project | Computers in Human Behavior | 15 |
| 5 | (Bartholomew & Strimel, 2018) | Factors influencing student success on open-ended design problems | International Journal of Technology and Design Education | 14 |
| 6 | (Liu et al., 2018) | Examining science learning and attitude by at-risk students after they used a multimedia-enriched problem-based learning environment | Interdisciplinary Journal of Problem-based Learning | 9 |
| 7 | (Gale et al., 2018) | Implementing NGSS engineering disciplinary core ideas in middle school science classrooms: Results from the field | Journal of Pre-College Engineering Education Research | 9 |
| 8 | (Alemdar et al., 2018) | The impact of a middle school engineering course on students' academic achievement and non-cognitive skills | International Journal of Education in Mathematics, Science and Technology | 9 |
| 9 | (Gomoll, Tolar, et al., 2018) | Designing human-centered robots: The role of constructive failure | Thinking Skills and Creativity | 6 |

From table 2 above it can be seen that articles written by (Burrows et al., 2018) published in the Education Sciences journal with the title "Integrated STEM: Focus on informal education and community collaboration through engineering" have been cited 31 times. The research presents STEM as an interdisciplinary field where the disciplines reinforce and support one another (rather than as separate disciplines of science, technology, engineering, and mathematics). The authors focus on complex and open-ended problems as a primary teaching and learning task. Whereas the publication in 2018 that received the second most citations was research conducted by (Chan & Blikstein, 2018) published in the journal "Interdisciplinary Journal of Problem-based Learning" with the title "Exploring problem-based learning for middle school design and engineering education in digital fabrication laboratories" has been cited 15 times, the article is a research study of design and engineering classes using a problem-based learning (PBL) approach in digital fabrication workshops in two middle schools. This article is widely cited for providing insight into PBL in the non-traditional, technology-rich FabLab environment.

**What is the geographical distribution of publications and patterns of cooperation between countries in research related to problem-based learning applied to middle school students?**

The country shown in Figure 3 below is the country of origin of the publication author. Geographically, the distribution from the author's country of origin can be seen in Figure 3 below.
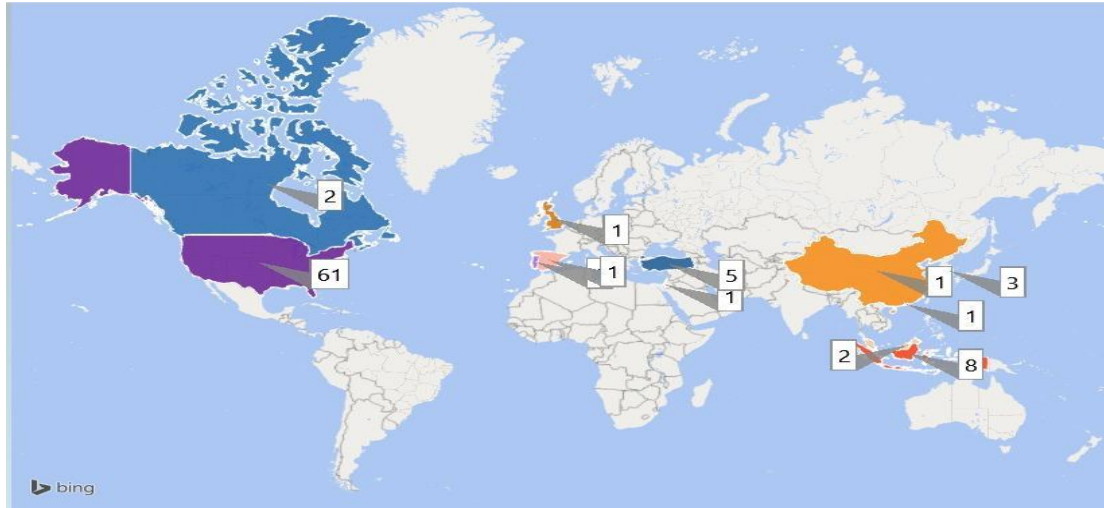


Figure 3. Geographic distribution

From figure 3 above it can be seen that the United States is the most influential country in relation to problem-based learning research applied to middle school students, this can be seen by the many publications from the United States which have published 61 documents related to this field, in second place are countries Indonesia is the country that has the second influence on problem-based learning research on middle school students, namely with 8 documents that have been published. The Americas, Asia, and Europe are continents that have published documents related to problem-based learning in middle school students. The Americas are the most influential in this field because they have published 63 documents, this number is very far when compared to publications from other continents. This means that the United States is the country that has the greatest impact on research in this field. This is in accordance with what was stated by (Muhtar et al., 2021) that the United States is the country with the most authors regarding learning model research.

The pattern of collaboration between countries can be seen in Figure 3 below. Researchers do not set a threshold in this stage. This means that countries that only have 1 document related to this field will be displayed even if the country does not have a cooperative relationship with other countries.
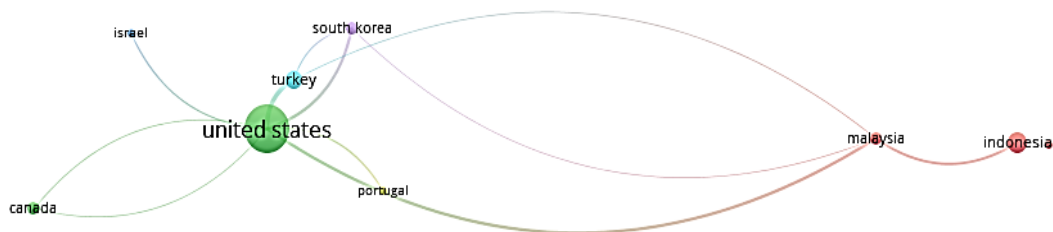


Figure 4. The pattern of relations between countries

From Figure 4 above it can be seen that the United States circle has the largest circle diameter when compared to other countries. This shows that the country has the highest level of cooperative relations. Then followed by Turkey. From the VOSviewer display, it can be seen

that the United States has collaborated with 7 other countries, only China is a country that does not have a direct cooperative relationship with the United States.

**How is the distribution of journal rankings based on quartile scores related to problem-based learning applied to middle school students?**

The distribution of journal rankings is seen from the quartile (Q) value of journals related to publications related to problem-based learning in middle school. Journal rankings can be seen on the scimagojr website.
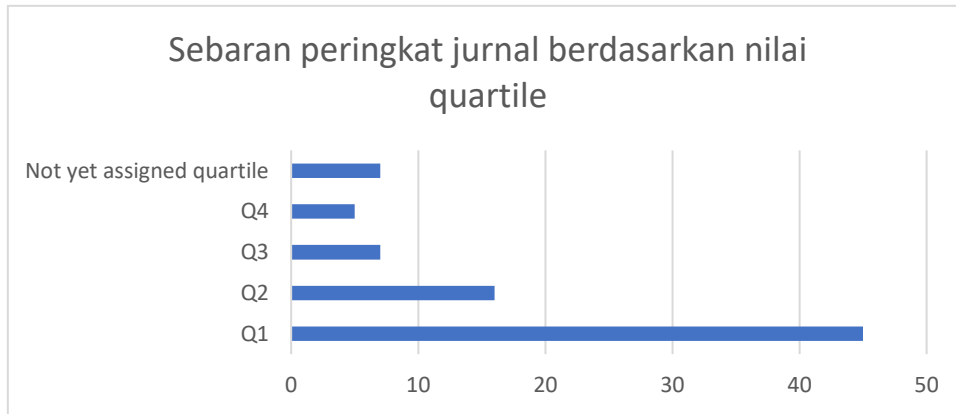


Figure 5. Ranking based on Journal Quartile values

In Figure 5 above, it can be seen that most publications in journals related to problem-based learning research applied to middle school students are mostly at the Q1 ranking, namely 45 journals. In second place is a journal with a Q2 rating of 16 articles. Then followed by journals with a Q3 rating and journals that do not yet have quartiles each with 7 articles. And the last sequence is the journal with a Q4 rating of 5 articles. There are still 7 articles published in journals that do not have a quartile value. This means that writing articles still needs to be improved so that authors of articles related to this field can publish them in journals that already have a quartile value.

**What is the focus of research related to problem-based learning, especially for middle school students?**

The researcher sets the threshold at this stage, namely shared keywords that are displayed with a minimum of 3 publications, meaning that keywords that have been used together in 3 or more publications will be displayed on the shared keyword appearance with the help of VOSviewer. From 189 keywords after the threshold was set, there were only 22 keywords as shown in figure 6.
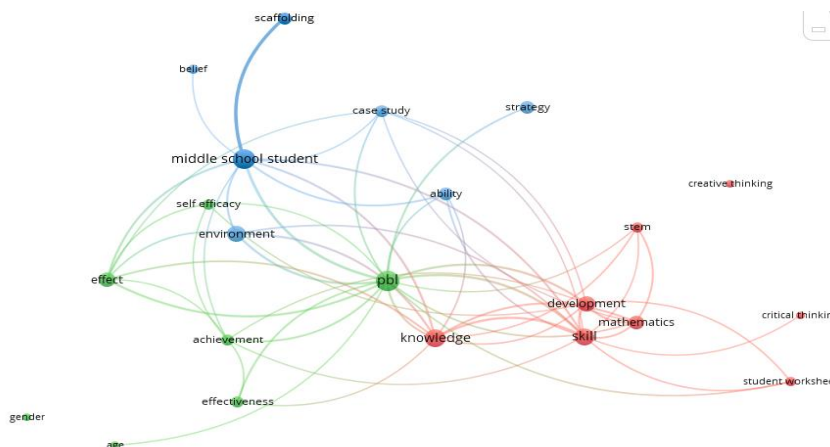


Figure 6. Keyword Co-occurrence (Occurrence Threshold ≥ 3)

The focus of the research can be seen from the clusters shown, in Figure 6 above it can be seen that there are several different colors. This color indicates a research cluster related to problem-based learning in middle school. There are three clusters, namely red is the largest cluster followed by green and blue. This means that the research focus is divided into 3 parts, namely 1) The first cluster (red in color) consists of 8 items, when viewed from the size of the circle in this first cluster, the keywords that have the largest diameter are the keywords knowledge, skill and development, meaning these keywords became the first research focus together with mathematics; 2) The second cluster (colored green) consists of 7 items, the keywords effect, self-efficacy, achievement and effectiveness are the largest circle in the cluster, meaning that these keywords are the focus of the first research together with PBL; 3) The third cluster (in blue) consists of 7 items, the keywords that are the focus of the last research are middle school students, environment and abilities.

The first research focus is knowledge, skills and development. Research conducted by (Hartman et al., 2013) have researched the effectiveness of problem-based learning in introductory business courses and have provided evidence that past research supports claims about positive effects of PBL on the development of cognitive skills and knowledge retention. The second research focus is effect, self-efficacy, achievement and effectiveness and the third research focus is middle school students, environment and abilities. Research conducted by (Liu, 2006) his study examined the effect of a computer-enhanced problem-based learning (PBL) environment on middle school students' learning, investigating the relationship among students' self-efficacy, attitude toward science, and achievement. The results suggest that students' self-efficacy towards science learning can be used to predict achievement. The three research focuses can be used as a reference for future researchers to determine the focus of their research related to problem-based learning

## Conclusion

Based on the results and discussion it can be concluded that publications go up and down every year. In 2018, there were 9 articles published, this is the largest number of publications compared to other years. Publications in 2003 have been cited more than any other year, with 825 citations. The United States of America is the most influential country in this field. publications in journals related to problem-based learning research applied to middle school students are mostly at the Q1 rank, namely 45 journals. The research focus is divided into 3 namely, 1) knowledge, skills and development; 2) effect, self-efficacy, achievement and effectiveness; 3) middle school students, environment and abilities. These three research focuses can be used as a reference for future researchers to determine the focus of their research related to problem-based learning. The limitation of this study is that data was taken only from the Scopus database on January 10, 2023, meaning that data or articles published after that date are not included in this analysis and may experience slight differences.

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