Research Trends in Project-Based Learning Models in Facilitating 21st Century Skills: Systematic Literature Review

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Abstract: The 21st century is a century where knowledge has increased drastically. Science and technology are growing rapidly and related to human life. Project-based learning is considered as an innovative approach for use in learning in many countries today. So that in the last decade it has raised a lot of interest in researchers to research related to this learning model. Although PjBL is becoming increasingly popular, to date there have been no reviews providing information on the use of PjBL across a wide range of disciplines and at various levels of education. Therefore, this review aims to find out where Project-Based Learning is used, adapted, and researched; and how Project-Based Learning has been used in learning to facilitate 21st century skills over the last 6 years. This systematic literature review used the PRISMA-P 4-step process and bibliometric analysis for 69 appropriate journal articles from 47 journals in 18 countries published from January 2016 to December 2021. A database search was performed with Scopus. The results of this review cover a variety of educational institutions. This review identifies the methods used and their developments over the last 6 years which were published in 69 journal articles in 47 journals in 18 countries and 8 disciplines. The findings are summarized bibliographically and thematically so as to provide important information for educators, researchers and software developers.

Keywords: 21st century; Project-based learning; Research trends; Systematic literature review

Introduction

The 21st century is a century where knowledge has increased drastically. Science and technology are growing rapidly and related to human life. So that there is a demand for Indonesia to be able to prepare a generation that is able to face the challenges of the 21st century, especially by preparing students to have the necessary skills. The skills needed today include critical thinking and problem solving, communication, collaboration, and creativity or what is commonly known as 4C (Agustin et al., 2021).

One of the recommended learning models for improving 21st century skills is project-based learning, which is considered an innovative approach to use in learning (Duke et al., 2021). Anazifa & Djukri (2017) also explained that project-based learning models, problem-based learning, discovery learning, and guided inquiry are the recommended learning models for facing the 21st century. The application of the PjBL learning model is expected to facilitate the improvement of students' skills, especially thinking skills, critical thinking, and students' creativity. PjBL is a learning model that is widely applied in developed countries such as the United States. PjBL was also introduced to Qatari public primary schools as it was seen as an effective method of bridging the gap between the current ability status of students and societal demands for twenty-first century skills (Du & Chaaban, 2020).

Project Based Learning in Indonesian means project-based learning. The PjBL learning model was initiated by the implications of the Minister of Education and Culture Circular Letter No. 4 of 2020. The main objective of PjBL is to provide training for students to

collaborate, work together, and empathize with others. In PjBL learning, students are required to solve problems with the early stages of defining problems, discussing ideas, designing questions, collecting and analyzing data, and finding solutions to questions that develop with new projects or findings (Krajcik & Shin, 2014). The PjBL model is very effectively applied to students by forming small groups in learning to work on projects, experiments, and innovations (Hermawan, 2021; Nurohman, 2015).

Project-based learning is considered an innovative approach to use in learning, so that in the last decade it has generated a lot of interest from researchers to research related to this learning model. Thomas suggested that further research could explore PjBL aspects, including the subject matter, problem areas, and their implementation, because PjBL planning, implementation, and management are all related to the learning process and student achievement (Hallermann et al., 2011).

Although PjBL is becoming increasingly popular, to date there have been no reviews providing information on the use of PjBL across a wide range of disciplines and at various levels of education. This review aims to comprehensively analyze the literature on the adaptation of PjBL as a learning model over the last 6 years to provide information for stakeholders such as educators, researchers and other education practitioners. This review addresses two main research questions: where is Project-Based Learning used, adapted, and researched? and how is Project-Based Learning used in learning to facilitate 21st century skills?

Method

This systematic review focuses on recent research (January 2016–December 2021) on the application of PjBL learning models in academic institutions. The review takes a multidisciplinary approach to cover all subjects and levels within academia. To align with the first research question, where was Project-Based Learning used, adapted, and researched? a bibliometric analysis was conducted to identify the distribution of the literature and summarize the publication bibliometrics. Then, a thematic analysis was carried out to answer the second research question, how is Project-Based Learning used in learning to facilitate 21st century skills?

Bibliometric Analysis
PRISMA-P

This study adopted a rigorous systematic review protocol following the 4-step PRISMA-P process (Moher et al., 2015). This process has the following steps: Identification of literature that is relevant and related to this research; Screening uses criteria determined by the author; Classification of articles that are filtered methodically using the code and themes that have been determined by the author; and determine articles for inclusion in this review.

Identification: Scopus is used to conduct literature searches because of the journal's comprehensive coverage, ease of keyword search, accessibility within academia, and popularity in various disciplines (Colares et al., 2020; de Souza et al., 2019). Searching for articles uses several terms, namely "PjBL", "Project Based Learning", and "Project-Based Learning" so that it finds articles with various topics when used in the search database, while the initial search for articles. Scopus searches are limited to selected years with only "Articles" or "Reviews" selected along with using titles, abstracts, and keywords to identify "PjBL" articles. The last database search was executed on November 10, 2022.

Screening: At this stage, the identified literature is then screened to exclude articles that: (1) were published before 2016, (2) were written in any language other than English, (3) were published but have not gone through a peer review process (eg book chapters), and (4) are not relevant to this review. The relevance of the article is determined by examining the title, abstract, results and methods. Any articles that did not meet these screening criteria were excluded from this study.

Classification: The articles identified and screened are multidisciplinary; therefore, these articles are then classified. Initially, the classification process assigns codes to journal articles related to the article's research discipline which includes subject matter in science, technology, engineering, mathematics, languages, and others. If more than one discipline is covered in the article, the code used is multidisciplinary (MD). The articles are then classified into specific subject matter and educational levels, starting from elementary school, junior high school, high school, undergraduate/postgraduate, and multi-level. These codes are based on the categories of the International Standard Classification of Education (ISCED, 2012). The Not Defined (ND) code is used if necessary, for the level of discipline and education.

Table 1. Table of Classification Codes and Descriptions

Discipline		Subject and Grade	
Code	Description	Code	Description
S	Science	ES	Student of Elementary School
T	Technology	ET	Teacher of Elementary School
E	Engineering	JS	Student of Junior High School
M	Mathematic	JT	Teacher of Junior High School
L	Languages	SS	Student of Senior High School
MD	Multi-discipline	ST	Teacher of Senior High School
		GS	College student
		GT	Lecturer
		ML	Multi-level
		ND	Not Defined

Inclusion: Articles selected for review are limited from January 2016 to December 2021 and include the words or sentences "PjBL", "Project Based Learning", and "Project-Based Learning" either in the title, abstract or keywords. These four steps are applied to select articles to be reviewed, the flow according to the PRISMA protocol can be seen in Figure 1.
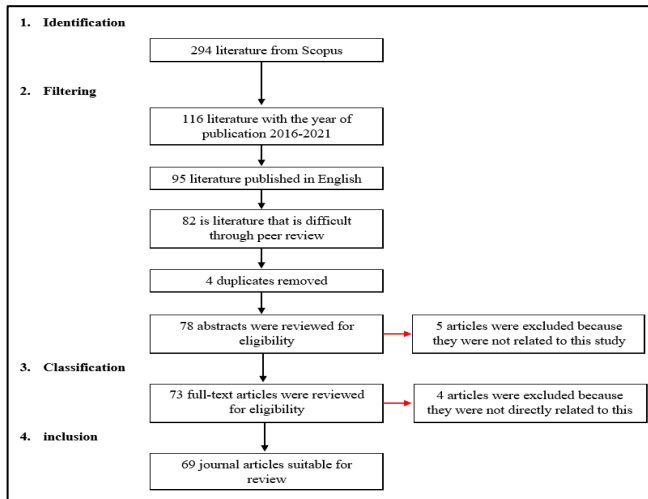

Figure 1. Flow according to the PRISMA protocol

Bibliographical Analysis

VOSviewer software version 1.6.18 was applied for bibliometric analysis using Scopus database search results. VOSviewer is software developed by Van Eck and Waltman of the University of Leiden in the Netherlands to build and visualize econometric networks. It can build networks for journals, researchers, keywords, and publications based on co-citation, coupling and co-authoring relationships, and visualize the results (Meng et al., 2020). Downloads from Scopus are used to create RIS files. The RIS file was updated after the 4-step systematic review protocol process and articles irrelevant to this study were removed from the file. The RIS files are then loaded into Vosviewer to create a co-occurrence map of the bibliographic data. This software allows users to create a shared map of events in various fields, such as keywords, number of journal citations, and publication titles (van Eck & Waltman, 2022). Bibliometric analysis was performed on each article, including year of publication, keywords, number of journal publication citations, and country of publication.

Result and Discussion

PRISMA-P

The initial database search identified 294 articles related to Project-Based Learning. The literature was then filtered for the period Jan 2016–December 2022,

reducing the number of literature to 116. Literature was filtered by type of journal or review articles only, and articles published in English. This screening reduced the identified articles to 82. These initially screened articles were downloaded from the relevant database and checked for duplicates. After screening for duplicates, the abstracts of the remaining 78 articles were reviewed, resulting in the deletion of 5 articles. The full text of 73 articles was further reviewed, omitting 4 articles as not directly related to this study. Thus, a total of 69 journal articles were used in this systematic review.

Bibliometric Analysis
Journals and citations

Project Based Learning is widely used in various disciplines, as revealed by 69 articles relevant to this research. The relevant articles come from several journals. Titles of journals that publish two or more articles are shown in Figure 2.
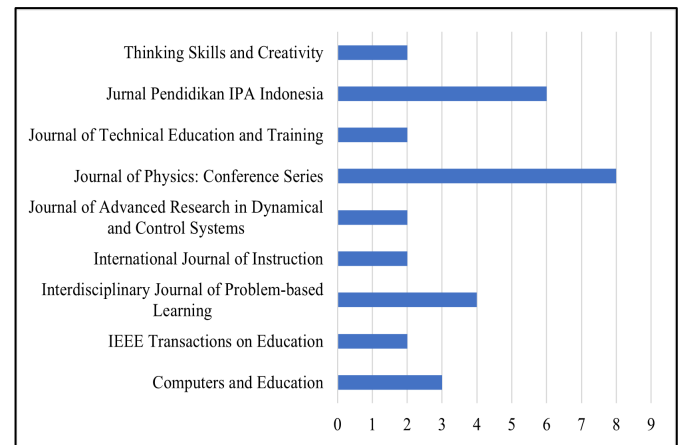

Figure 2. Title of journal with publication of more than 2 articles used in research

The journal with the most Project Based Learning articles published by the Journal of Physics: Conference Series (8 articles), followed by the Indonesian Science Education Journal (6 articles), then the Interdisciplinary Journal of Problem-based Learning (4 articles).

Scopus via Publish or Perish is used to count citations, the 69 articles reviewed in this study have a combined number of citations of 2029 with the most cited being 166 times. The total number of article citations by year of publication was 201 in 2016, 334 in 2017, 488 in 2018, 244 in 2019, 540 in 2020, and 222 in 2021.

Table 2. Journal Articles with Top Citations

Rating	Article Title	Authors	Journal Title	Year	Citation
1	Vocational student interest in applying project-based learning (PjBL) approach through google classroom in new normal era	Hidayah N & Arum A	Proceedings - 2021 7th International Conference on Education and Technology, ICET 2021	2021	166
2	How to enhance interdisciplinary competence-interdisciplinary problem-based learning versus interdisciplinary project-based learning	Brassler M & Dettmers J	Interdisciplinary Journal of Problem-based Learning	2017	128
3	Integrating project-based learning and project management for software engineering teaching: an experience report	Fioravanti M, Sena B, Paschoal L et al.	SIGCSE 2018 - Proceedings of the 49th ACM Technical Symposium on Computer Science Education	2018	78
4	Applying project-based learning and SCAMPER teaching strategies in engineering education to explore the influence of creativity on cognition, personal motivation, and personality traits	Wu T & Wu Y	Thinking Skills and Creativity	2020	76
5	The effect of STEM-PjBL and discovery learning on improving students' problem-solving skills of the impulse and momentum topic	Purwaningsih E, Sari S, Sari A et al.	Jurnal Pendidikan IPA Indonesia	2020	74

Author Affiliated Countries

Figure 3 shows a density map of the country that published the article. Eighteen countries contributed research to 69 articles, with 6 countries publishing more than two articles. Indonesia contributed 25 articles, the United States 10 articles, Taiwan 8 articles, Israel 4 articles, Malaysia 3 articles and Spain 3 articles.
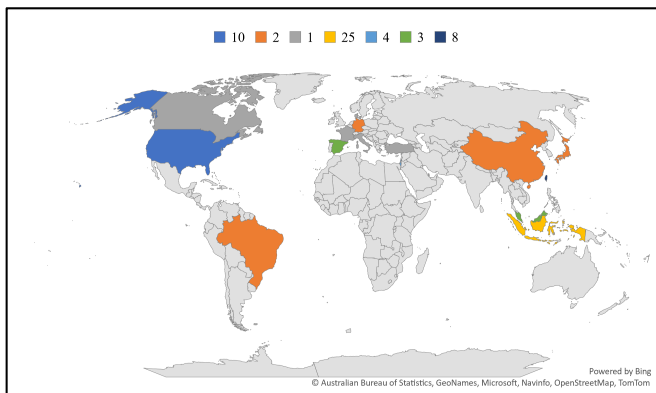

Figure 3. Map author affiliation country distribution

Popular Keywords

Keywords from 69 articles analyzed on Vosviewer. In total, 213 keywords were used, 154 of which were used three or more times. Figure 4 shows the top 10 keywords. The keywords that appear the most are project-based learning (54), followed by STEM (13), problem-based learning (8), teaching (6), education (6), critical thinking (5), creativity (5) , science education (4), self-efficacy (3), and problem-solving skills (3).

Along with the ability to extract the top keywords used in articles, VOSviewer generates keyword cluster graphs. The most significant keywords are project-based learning, STEM, problem-based learning, and science education. The map also has a feature to zoom in and out, show more keywords and highlight the keywords

that appear the most. The higher the item weight, the larger the item's label and circle will be. The color of an item is determined by the cluster in which the item is located. The lines between items represent links. The distance between the two journals in the visualization shows how related the journals are in terms of shared citation links. In general, the closer two journals are to one another, the stronger their association. The strongest shared citation links among journals are also represented by lines (van Eck & Waltman, 2022). The five strongest citation links are the keywords project-based learning (190), STEM (26), and problem-based learning (23).
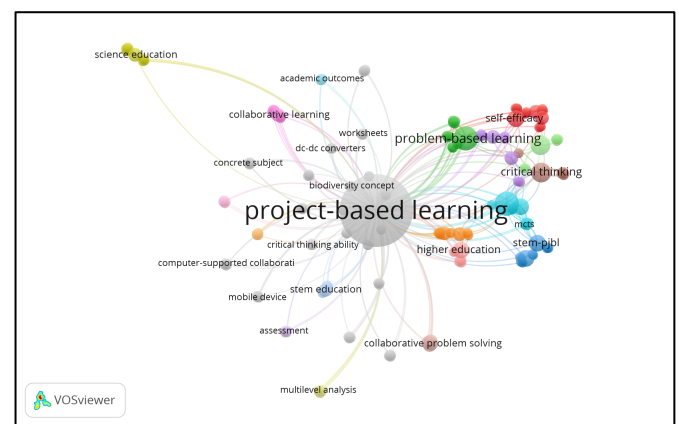

Figure 4. VOSviewer cluster graph of keyword results

Discipline and Level of Education

Research related to project based learning is applied in many different fields of study, such as science, technology, engineering, mathematics, social, language, marketing, and multidisciplinary. Figure 5 shows the percentage of the number of article publications per year 2016-2021 by discipline. The three disciplines with the most number were in science with 33 articles (48%),

followed by engineering with 15 articles (22%), and mathematics with 7 articles (10%).
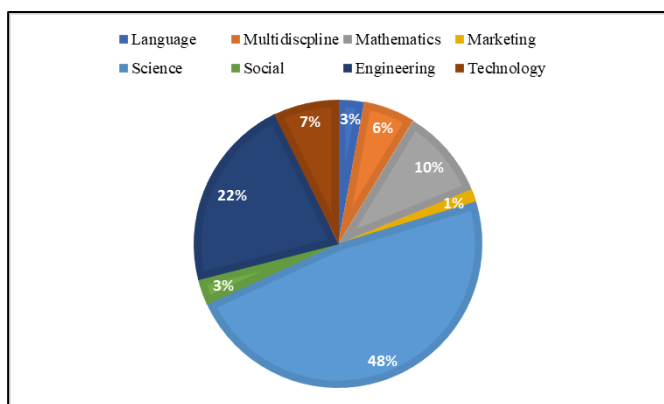

Figure 5. Disciplines that implement project-based learning

The main discipline during this publication period was science. The research results of Tsybulsky & Muchnik-Rozanov (2019) show that the practical experience of teachers when leading PjBL in science classes within the teaching framework is considered significant by student-teachers, because it provides a context that leads to meaningful processes. These findings contribute to preconceptions about PBL and other inquiry-based practices. More specifically, PjBL provides student teachers with the opportunity to actively experience didactic practices as a way to form their professional identity. This finding is in line with previous studies which demonstrated the positive effects of practical classroom experiences on student teachers' views, attitudes and pedagogical practices in PjBL learning. Although PjBL originates from a form of instruction that emphasizes investigation and experimentation, if used correctly, PjBL may be more effective when used in language lessons (Baş & Beyhan, 2010), because projects and authentic assessment can also be implemented in social studies and language arts (Jane Krauss, 2013). The results of research by Duke et al. (2021) also show that PjBL can be an effective way to improve student achievement in social studies and reading information. Larmer (2015) noted that projects are effective for language learners, because reading and writing are purposeful and connected to students' personal experiences that are meaningful.

Of the 69 articles, 34 articles examined project-based learning in a university environment, 12 articles at the high school level, 11 at the junior high school level, 8 articles at the elementary school level, 1 article at the multi-level level, and 3 articles did not define (ND) level of education for studies or not focused on individuals but systems. If reviewed based on research subjects, 39 articles focused on students, 7 educator articles, and 3 articles used both as subjects, namely students as well as educators.
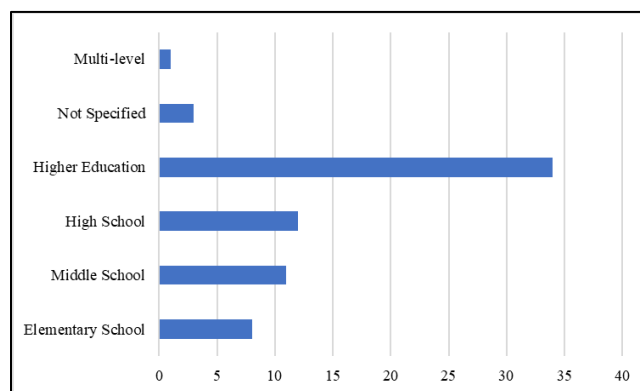

Figure 6. Research subjects based on education level

The application of PjBL in postgraduate education makes students appreciate the process of discovering knowledge and their ability to solve industry challenges. In undergraduate education, the PjBL learning approach can foster student discipline and resilience. All of these benefits are important aspects that can improve students' abilities to face real-world challenges (Daun, 2016). PjBL learning is recommended learning for students, especially engineering students who tend to be considered less creative, because they tend to receive less creativity training in their subjects than students in other fields. In addition, in engineering, technical training is valued more than creativity, and students rarely receive teacher feedback and opinions and have few opportunities to discuss innovative and creative processes. Besides, instructing students in innovative thinking can be difficult for teachers, most engineering students realize the importance of creativity for future job performance (Wu & Wu, 2020).

Learning Focus

Based on the 69 articles analyzed, the largest percentage was obtained regarding the focus of learning and also aspects of improved 21st century skills, namely aspects of critical thinking and problem solving (28%), creativity (16%), collaboration (14%), and communication (8%). In addition, there are aspects outside the demands of the 21st century, namely learning motivation (17%), professional skills (10%), and interest in learning (7%).

Critical thinking and problem solving aspects have the greatest percentage, so it can be concluded that PjBL learning can train and facilitate students' critical thinking skills and problem solving. This was also written by Baran in his research that in learning with this project, most students experienced problems in the process, and they believed their problem solving skills might develop when looking for solutions to these problems. Some students stated that they succeeded in overcoming the problems they experienced in the project process thanks to individual efforts and with the help of collaboration. In addition, the students think

they should find more practical solutions to everyday life problems (Baran et al., 2021). The results of Anindya & Wusqo (2020) also show that the experimental class obtained a score of three indicators of higher problem solving skills due to the implementation of PjBL because it has several advantages which include (1) training students to think about the steps they will take to solve a problem; (2) creating products that contain elements of science, technology, engineering, art, and mathematics to make learning interesting and fun while stimulating creativity; and (3) improve students' communication skills both orally and in writing. Problem-based learning is considered by Anazifa & Djukri, (2017) as a learning model that is able to develop students' critical thinking skills.
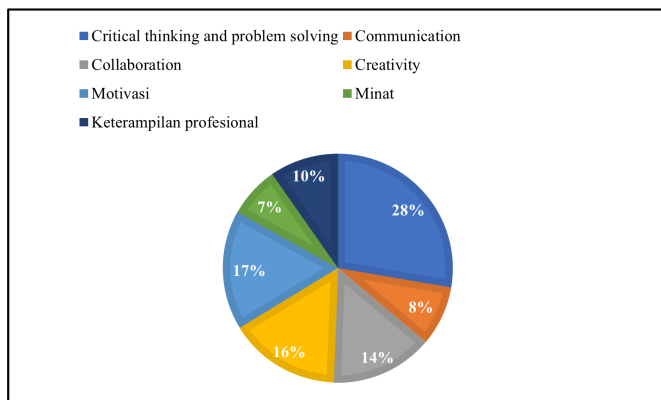

Figure 7. Learning focus

Types of Research

The type of research used was categorized into content analysis, mixed, descriptive, experiment, evaluation, qualitative, class action, RnD, case study, and survey. Of the 69 articles analyzed, 30 articles were experimental research, which aims to determine what variables are and how the relationships between variables are and to determine the effect of the independent variable on the dependent variable.
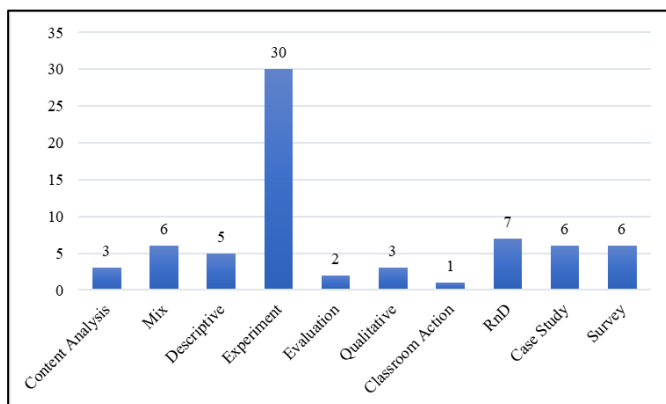

Figure 8. Various types of project-based learning research

Conclusion

A comprehensive systematic review of the implementation of Project-Based Learning in this study includes various educational institutions. The review identified the methods used and their developments over the last 6 years which were published in 69 journal articles in 47 journals in 18 countries and 8 disciplines. The findings have been summarized bibliographically and thematically where appropriate, providing important information for educators, researchers and other education stakeholders. A critical limitation of this review is that only the Scopus database was used for the search, and papers not covered by either database were not included in the analysis. Bibliographical analysis identified project-based learning as a learning model that can facilitate various disciplines and is especially used in science learning. Bibliographical analysis shows increasing trends in project-based learning educational research and provides information on top journals, leading authors, keywords, and high citations. Thematic analysis found that project-based learning is a powerful tool used to support learning in a variety of ways. Both educators and students benefit from using project-based learning, although currently at different levels. Project-based learning makes it possible to improve skills which are challenges in the 21st century such as critical thinking and problem solving, creativity, collaboration, and communication as well as beyond that such as interest in learning, motivation to learn, and also professional skills. The gaps identified in this review are significant for future research. Some of the gaps include integrating project-based learning with STEM. Future research can focus on the important aspects of PjBL's success in terms of time, cost, and effectiveness. Further research is needed to describe the experience of using PjBL at the junior high school level. Because only 11 out of 69 articles discussed the implementation of PjBL in junior high schools. More research on these aspects will help educators utilize PjBL in more meaningful science learning.

Acknowledgements

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