

A systematic literature review of project-based learning: research trends, methods, elements, and frameworks

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ABSTRACT

Project-based learning (PjBL) has been considered an effective learning model to improve the quality of learning in today's world of education. This study aims to identify research trends of PjBL, research methods, elements or essential skills that can be improved, and a framework for implementing PjBL from 2016 to 2023. This review procedure includes searching, screening, evaluating, and synthesizing publications on PjBL. There were 34 articles published in Scopus-indexed popular journal. The research shows that the trends of PjBL from 2016 to 2023 have been conducted by using qualitative research for 26.47%, quantitative research for 35.29%, mixed methods for 8.82%, action research for 5.88%, descriptive research for 17.65%, and development research for 5.88%. The main elements that could be developed for students from PjBL are creativity, collaboration, critical thinking, communication, concept understanding, innovative thinking, motivation, problem-solving, and self-confidence. In this study, there are five frameworks studied. By criticizing those frameworks, a new framework is proposed called project-based learning and simulation (PjBLS).

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1. INTRODUCTION

The challenges facing higher education are to empower students to respond the current and future conditions by finding out how to solve problems critically, creatively, and innovatively in various issues [1] and have good abilities and skills [2]. These challenges are difficulties in managing, controlling, and utilizing technology in learning [3], as well as difficulties in understanding and mastering subject matter [4]. Higher education is faced with an urgent challenge, which is empowering students to respond to the challenges of the times with creativity and innovation in solving various problems. Not only that, it is also essential to ensure that students have strong abilities and skills. However, on this journey, two main obstacles must be overcome. First, universities must overcome difficulties in managing technology and utilize it optimally in the learning process. Second, it is also essential to help students overcome obstacles in understanding and mastering the subject matter. By overcoming these challenges, universities can ensure their students are ready for the world with solid knowledge and skills.

Project-based learning (PjBL) plays an important role in overcoming these challenges and difficulties [5], [6]. Through the contributions of various experts, researchers, educators, and practitioners, PjBL has grown rapidly over the past few years, and it is widely applied in various disciplines [7]. PjBL allows students to connect concepts to the material being studied with real-world problems [8]. The collected information provides an opportunity for them to understand difficult concepts or abstract concepts and be

able to improve the skills that they will need in the future. Challenging and complex problems will be able to guide students to collaborate with each other in designing, investigating, making decisions, and solving problems.

Actually, PjBL is not a new learning model for developing in-depth learning competencies needed to achieve skills [9], [10]. It is a method using problems as the first step in gathering information and integrating knowledge and skills based on real-world experiences, as well as learning that implements theory into practice [11]. This means that the implementation of PjBL has several principles, such as student-centered learning, projects focused on problems, involving students in investigations to construct knowledge and completion of projects carried out by students collaboratively. A good learning environment can help students develop their skills through a learning community [12] and can improve their cognitive, affective, and psychomotor abilities [13] to solve real-world problems [14]. PjBL is also defined as a constructivist learning method in which students are actively involved [15] and work together in solving problems [16], as well as helping to train critical thinking skills, communication skills, and problem-solving skills [17]. Therefore, PjBL is still appropriate to be applied at a higher level of education [18]. Research by Cervantes *et al.* [19] highlights that PjBL positively impacts students' academic achievement in learning. They found that students involved in the project improved their learning outcomes. However, most of the studies reviewed were observational and were not always able to isolate the effects of PjBL from other variables affecting student achievement. Carrabba & Farmer's research shows that PjBL can increase student engagement and motivation in learning [20]. This study tends to use subjective assessment instruments, which can affect the validity of the results. Then, Martinez's research also shows that PjBL implementation is effective in developing 21st-century skills, including critical thinking, collaboration, and communication skills [21]. Yet, the study may not pay attention to contextual factors that may affect skill development. Although these studies provide insight into the effectiveness of PjBL, there are limitations to note. The results obtained may vary depending on the proper implementation of the PjBL, teacher involvement, and the design of the chosen project.

Although many previous studies have proved the impact of PjBL implementation in learning, and many have been published separately in complex ways, essential elements that can optimize PjBL implementation in learning need to be investigated. This systematic literature review (SLR) aims to identify significant journal publications; most active and influential researchers; research methods used in PjBL; essential elements in PjBL; the most reported method for PjBL; framework used for PjBL; project-based learning, and simulation. Therefore, a few research questions are developed: i) which journal is the most studied about PjBL? ii) who are the most active researchers in implementing PjBL? iii) what kind of research methods are often used in PjBL? iv) what kind of skills or elements can be developed in PjBL? v) what kind of methods or ways are used to implement PjBL? and vi) what kind of framework is used in implementing PjBL? By identifying these parts, there are three significant contributions. First, this research provides an overview of current PjBL trends based on our systematic analysis. Second, it illustrates how PjBL develop the student's skills. Finally, it highlights the essential elements of PjBL and make recommendations for further research.

2. METHOD

Systematic literature review plays an essential role in building theoretical foundations, identifying research gaps, strengthening methodologies, supporting arguments, and avoiding duplication of previous studies [22]. It is known as a promising structured literature review to examine previous research [23]. It was conducted as a SLR following the original guidelines proposed by Linnenluecke *et al.* [24]. Comprehensively, this literature review is used to search data, such as selecting reliable database sources, identifying search strings, determining inclusion or exclusion criteria, determining quality criteria [24], [25]. The literature review aims to detect themes, theoretical perspectives, and general issues and to identify the theoretical concept components [26], [27] from recent studies. It will contribute to the research by synthesizing the existing research to create a further research agenda [26]. It is defined as the process of identifying, assessing, synthesizing, and interpreting studies in a more effective manner [24], [28]. As a literature review, this study relied on secondary sources, such as reputable and high-quality journal articles. The database is considered the main source that has a broad impact compared to other databases [29].

Systematic literature review, alternatively recognized as the structured literature review, emerges as a potent instrument for scrutinizing antecedent studies, thereby fortifying the respective field [23]. Within this review, a thorough protocol has been outlined, delineating the criteria for data exploration. This includes the selection of dependable database sources, formulation of search queries, establishment of inclusion/exclusion parameters, determination of quality benchmarks, and other pertinent aspects [30].

2.1. Database source

The significance of databases lies in their role as the primary reservoirs of publication metadata and bibliometric metrics. Ensuring the selection of an appropriate data repository is pivotal in assessing the credibility of a study. It is imperative for a SLR to utilize more than one database [31]. As per existing literature, the Web of Science (WoS) and Scopus emerge as the two predominant bibliographic databases employed [29]. These databases are widely favored in systematic review endeavors owing to their global recognition, comprehensive coverage, and competitive citation indexing [29], [32]. Li *et al.* [33] described the WoS from Clarivate Analytics as "the world's leading scientific citation search, instrument, and analytical information platform across knowledge." As a result, the main data source for the study will be Scopus.

2.2. Preferred reporting items for systematic review and meta-analysis

The "preferred reporting items for systematic reviews and meta-analyses" (PRISMA) review process is adhered to by this SLR. Initially introduced in 2009, PRISMA has been succeeded by PRISMA 2020, which incorporates updated reporting criteria to account for developments in the processes of identifying, selecting, assessing, and summarizing studies [34]. PRISMA serves as a valuable tool for researchers to enhance the clarity and effectiveness of their communication in reviews of literature and meta-analyses. Within PRISMA, there are 27 assessment criteria specifically tailored for randomized trials [35].

2.3. Identification and screening

Finding words or phrases that have the exact same meaning as each other (synonyms) and related terms, including all word variations, is the first step in the identification process. In the process of identification, researchers enlarge crucial keywords. When researchers use more keywords, the database might find publications that are more relevant to them. It is important to establish a few fundamental ideas before choosing keywords that work. The keywords from the previous articles, the database, web resources full of synonyms, and professional keyword ideas are the four main sources used for keyword research [36]. The keywords for searching are: "PjBL".

The string link is used because it can make the searching will be effective and efficient. The search is arranged by considering the need of each database. The database is searched by determining the title, abstract, and keywords. The searching is started from 2016 to 2023. It is limited to Scopus-indexed articles. There are 123 articles in Scopus that were found with the above-mentioned advanced search. We classified each study as quantitative (empirical), qualitative, conceptual, or literature review after compiling the articles for review.

2.4. Extraction, synthesis, and eligibility

We thoroughly inspected the article to find duplicate articles as we moved forward with the article identification procedure. Screening followed, with consideration given to the inclusion and exclusion criteria listed in Table 1. During the third phase, known as eligibility, 123 complete journal articles were viewed. 89 of the eligible publications that were reviewed were excluded because they had nothing to do with the goals and methods of the study. The synthesis and eligibility phase was the next step, during which 34 whole papers were carefully read and assessed. The systematic review methodology of [23], [36] will serve as the foundation for an extensive synthesis of the academic literature on PjBL.

Table 1. Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Study type	Quantitative research Qualitative research	Review paper Conceptual paper
Language	English	Any other language
Document types	Final journal article	Book, book chapter, proceeding, report, and short survey
Study topics	Related to PjBL	Other than PjBL

2.5. Data abstraction and analysis

The remaining papers underwent a thorough evaluation and analysis, with an emphasis on particular research that addressed the review's objectives. After reading the abstracts, the data was first extracted, and then the complete articles were carefully examined to determine the relevant themes. Figure 1 shows a comprehensive synthesis of academic literature on PjBL. As shown in Figure 1, this evaluation was conducted through the identification, screening, eligibility, and inclusion phases [35].

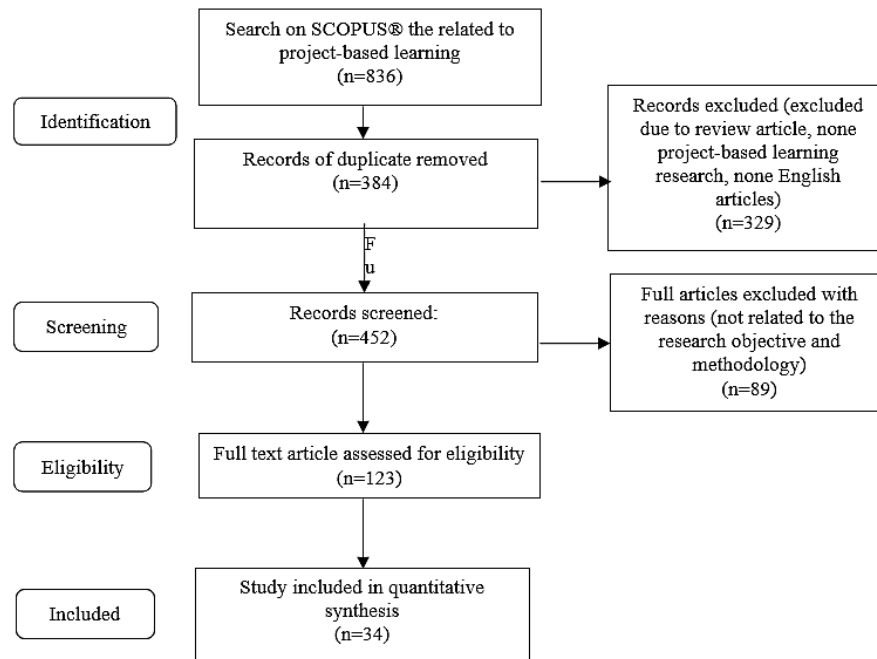


Figure 1. The searching and selecting the primary study

3. RESULTS AND DISCUSSION

In the results of the analysis that has been conducted in this study, there are several significant findings. First, significant journal publications. It was identified that there are significant journal publications related to the theme of this research. These publications have made important contributions to our understanding and developments in learning. Furthermore, the analysis also highlighted the most active and influential researchers in this context, whose contributions have shaped the direction of research and best practices in PjBL. Furthermore, the analysis also reveals the various research methods used in PjBL. These methods include both qualitative and quantitative approaches. In addition, important elements in PjBL that influence the effectiveness and success of implementation were identified. Furthermore, a proposed method for PjBL was formulated. In addition, a framework is proposed to guide the implementation of PjBL in various educational contexts. Lastly, the integration of PjBL and simulation is covered in the analysis. Simulation is used as one of the approaches to enhance students' learning experiences in projects that are relevant to the real world. It allows students to face complex challenges and situations, thus strengthening the understanding and skills acquired through PjBL.

3.1. Significant journal publications

In this literature review, there are 34 main articles analyzing the implementation of PjBL in education. The main articles were published from 2016 to 2023. By analyzing the published articles within this timeframe, this literature review can reflect the current trends, research methods, important elements or skills, and the framework used by researchers before implementing PjBL. In fact, it can track the recent changes and identify the approach, theory, or concept used. The analyzed articles were also limited to the leading and Scopus-indexed journal databases. In this case, the conference proceedings were not included in the literature review, as shown in Figure 2. In addition, Table 2 shows the Scimago journal rank (SJR) and Q category (Q1-Q3) journal values. It is also included in the journals studying and implementing PjBL. The Journal publications are sorted by SJR value.

3.2. Most active and influential researchers

Based on the selected main articles, researchers have contributed to implementing PjBL. Figure 3 shows researchers who are active in implementing PjBL. Investigators who were enrolled according to the literature review were included in the main study. In particular, Yulia Muchnik-Rozanov, Afriana, Ai-Jou Pan, Akhsanul In'am, Alexander MacDonald, Alison Boardman, Anazifa, Ashley Seidel Potvin, Booyuel Kim, Cheng-Huan Chen, Chin-Feng Lai, Dewi, Dian Safitri, Dina Tsybulsky, Djukri, Dustin Van Orman, Dwi Listyorini, Eliana are active researchers in PjBL.

Significant Journal Publications



Figure 2. Journal publications and distribution of selected studies

Table 2. SJR of selected journals

No	Journal Publications	SJR	Q Category
1	Educational Research Review	3.27	Q1 in education
2	Teaching and Teacher Education	1.62	Q1 in education
3	Thinking Skills and Creativity	1.15	Q1 in education
4	International Journal of Science and Mathematics Education	1.06	Q1 in education
5	International Journal of Management Education	1.06	Q1 in education
6	Studies in Educational Evaluation	0.91	Q1 in education
7	Learning, Culture and Social Interaction	0.77	Q1 in education
8	Asia Pacific Education Review	0.72	Q1 in education
9	Journal of Educational Research	0.65	Q2 in education
10	Journal of Hospitality, Leisure, Sport & Tourism Education	0.58	Q2 in education
11	Journal on Mathematics Education	0.52	Q2 in education
12	International Review of Economics Education	0.43	Q2 in education
13	Jurnal Pendidikan IPA Indonesia	0.36	Q3 in education
14	International Journal of Evaluation and Research in Education	0.31	Q3 in education
15	Journal of Technical Education and Training	0.24	Q3 in education

Influential Researcher

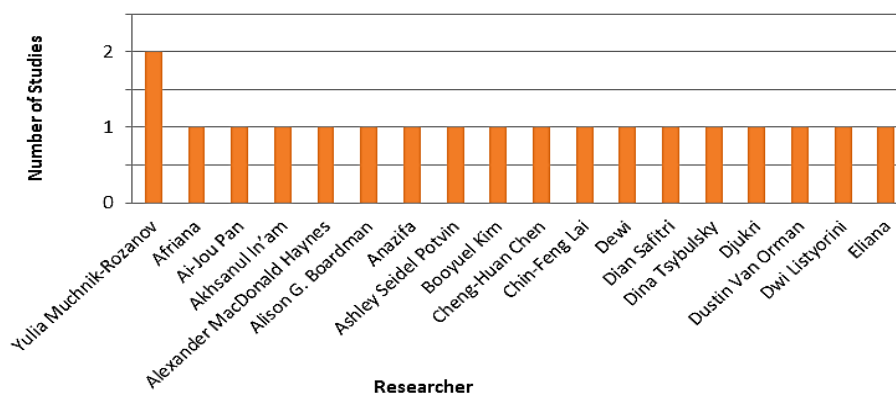


Figure 3. Influential researchers and number of studies

3.3. Research methods used in project-based learning

Although the research methods used in education are various, there are six research methods used in implementing PjBL, as shown in Figure 4. The figure shows the quantitative research method is the most dominant method used by previous researchers in implementing PjBL [8], [37]–[45]. Meanwhile, the quantitative research method is a research approach using data collection and analysis based on numbers and

statistics to answer research questions. Quantitative research is based on collecting empirical data such as surveys, measurements, experiments, or secondary data analysis. Then, for the analysis, it uses statistical techniques to identify relationships or significant differences between the variables studied. Although they use the same method in conducting their research, the types of research conducted are different. The following research uses experimental methods in their research, such as [43], [44], [46]. It analyzed the causal relationship between the dependent variable and the independent variable. They reveal that the experimental method can involve full control of the variables being studied. The researcher actively manipulates the independent variables and measures their impact on the dependent variable. It is different from other researches [8], [37], [38], [41], [42], [45], [47]. They used a quasi-experimental. In their research, the pretest-posttest design was used to identify student changes during PjBL. Then, it compares the results between the experimental group and the comparison group.

In addition to these two research methods, previous studies also carried out mixed-method. It is used by several researchers [48]–[50]. The data were collected in their research by using quantitative and qualitative data. Quantitative data is used to assess student performance based on the test scores. Then, it is analyzed by using statistical tests. In contrast, qualitative data are obtained from observations and interviews with students. Meanwhile, other methods were also used in previous studies, such as the descriptive research method [51]–[56], development research [57], [58], and action research [13], [59]. The method used [60], [61] for collecting the research data is by using triangulation. Qualitative data collection is conducted through observation and distribution questionnaires.

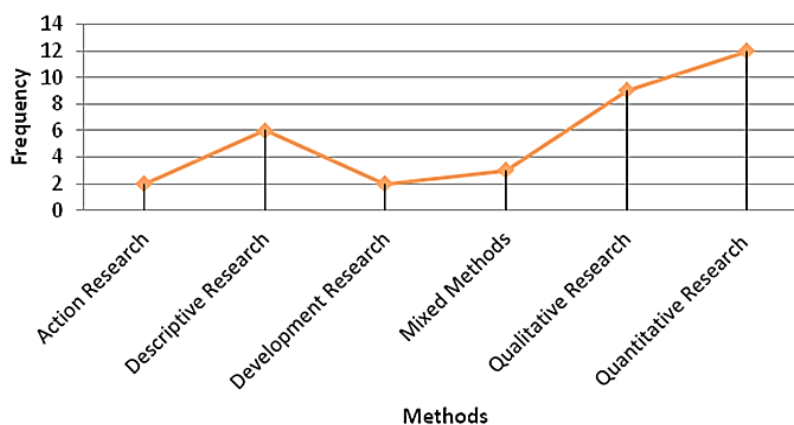


Figure 4. Methods used in PjBL

3.4. Essential elements in project-based learning

Overall, experts agree that PjBL is learning involving students through project activities, and it is able to support students in developing their skills to solve everyday life problems [38], [52], [60], [61]. Meanwhile, Chen and Yang [54] reveal that PjBL, as a systematic learning method, involves the students in real-world tasks, produces products, and enables them to gain knowledge and skills. Through a series of structured and systematic projects, PjBL can help to improve students' knowledge and skills [60] toward appropriate projects for real life. So that the students learn meaningful learning directly [62].

The results of the literature review's analysis in previous studies show that the student skills can be developed through the PjBL process, include creative [37]–[39], [41], [42], [55], [57], [63]–[65], collaboration [42], [43], [52], [55], [60], [63], [62], [64]–[67], critical thinking [37], [39], [42], [46], [50], [62], communication [42], [43], [62], concept understanding [23], [36], [49], innovative thinking [49], [63], [68], motivation [7], [38], problem-solving [63], and self-confidence [69]. There are still other skills that can be developed through PjBL, but they are not too dominant. The distribution of each skill that can be developed is shown in Table 3.

Table 3 shows that the most dominating elements or skills from the literature review conducted are creativity, collaboration, critical thinking, communication, concept understanding, innovative thinking, motivation, problem-solving, and self-confidence. A total of 23.53% of the research focuses on creative skills, 19.61% relates to collaboration skills, 11.76% focuses on critical thinking, 5.88% directs their research on communication skills, 5.88% on the ability to understand concepts, 3.92% of the research develops innovative thinking skills, 3.92% motivation, 3.92% problem-solving skills, and 3.92% focuses more on self-confidence.

Meanwhile, for other skills, the research conducted was relatively small, with a respective coverage of 1.96%. So, it can be concluded most researchers only focus on a few skills in implementing PjBL.

PjBL is considered an approach that can develop critical thinking skills, problem-solving skills PjBL is seen as an effective method for fostering critical thinking, problem-solving abilities, and collaboration [70]–[72]. The PjBL process encourages students to develop these skills. Students are faced with complex problems or challenges that require abilities and skills to find solutions. According to research conducted by Rupavijetra *et al.* [52], skills that can be developed through PBL are creativity, collaboration skills, problem-solving, critical thinking, and communication. To motivate students' learning and develop their collaborative skills, PjBL is the most effective model [37], [63].

Table 3. Essential elements in PjBL

Essential elements	Percentage (%)
Algorithmic thinking	1.96
Collaboration	19.61
Communication	5.88
Concept understanding	5.88
Confidence	1.96
Cooperativity	1.96
Creative	25.53
Critical thinking	11.76
ICT literacy	1.96
Initiative thinking	1.96
Innovative thinking	3.92
Islamic values	1.96
Motivation	3.92
Problem-solving	3.92
Scientific literacy	1.96
Self-confidence	3.92
Self-direction	1.96
Self-efficacy	1.96

3.5. Most reported method for project-based learning

Various ways and methods have been used to optimize the implementation of PjBL and develop students' skills. The proposed methods or innovations are: i) using various learning media [65]; ii) creating project assessment instruments from the early stages to the final stages of learning, and conducting an assessment [62], [67]; iii) the PjBL process is carried out online [59]; iv) modifying PjBL [48]; v) integrating PjBL with science, technology, engineering, and mathematics (STEM) [8]; vi) the use of information technology during learning [37], [54]; and vii) adapting and combining PjBL with other learning [7], [38], [46], [47]. Although various ways or methods of PjBL have been proposed, no one has stated that the proposed framework is truly capable of optimizing processes and improving student skills. So, a new PjBL framework is needed to optimize the process, improve the effectiveness and quality of learning.

3.6. Frameworks used for project-based learning

3.6.1. Williams's framework

Williams [59] developed his research framework by combining processes and products. The students themselves carry out the assessment process. Meanwhile, the teacher's group scores are based on the final product of the students. Through the framework he developed, the researcher attempted to create process and product assessments based on student self-assessment. The evaluation is seen from the hard work and activities carried out by students during the process of working on the project. This assessment tends to be subjective because it allows students to assess based on their own wishes. To see student contributions when working on projects, researchers utilize online media, which is useful for monitoring student activities and project progress. It is to gather much information to draw a detailed picture of the process before assigning a value. Williams argues that the group assessment process is complex, where each individual collaborates to produce a product. Through this stage, the researcher proposes to monitor the project, and the assessment carried out needs to be considered. Because the assessment carried out is still subjective, and the assessment method carried out is not perfect. Teachers should gather more information regarding the project process and use a number of assessment steps, such as self-assessment, peer evaluation, and online tools. By making evaluations visible to ensure fair assessments and by giving students greater awareness of the assessment process and expectations, this process can be made more efficient. Figure 5 shows Williams' PjBL framework [59].

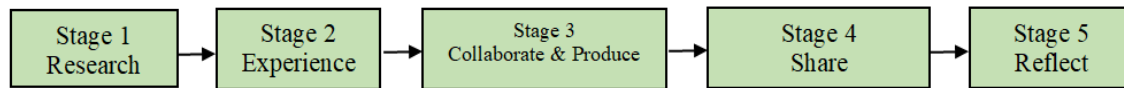


Figure 5. Williams's framework [59]

3.6.2. Barak and Yuan's framework

The framework developed by Barak and Yuan [49] focuses more on students' innovative ideas. They consider that the five stages of PjBL, which have been developed, have a positive effect on students' abilities and skills and can stimulate innovative ideas. The implementation of the developed framework can encourage students to think for themselves about real-life problems. Students are encouraged to exchange ideas, choose a problem, and look for alternative solutions so as to produce a feasible product from the projects they are working on. Students are involved in constructing feedback for their peers and perfecting their projects. Then, present their project in an interesting and innovative way. Overall, the PjBL framework developed by Barak and Yuan can be used as an instructional framework, which is capable of developing innovative thinking and innovative ideas for students. In the research conducted by Barak and Yuan the level of students' innovative thinking was examined through a questionnaire, and it was validated. The results show that although the implementation of PjBL has an effect on students' innovative thinking in both groups, the innovative ideas provided by the two groups are different. Differences in students' innovative thinking depend on the attitudes and behavior of students in learning. Overall, the five stages in PjBL are a learning framework that can be adapted to various educational programs. Nevertheless, further research is recommended to evaluate students' skills through peer assessment and project outcomes. Figure 6 shows the PjBL framework of Barak and Yuan.

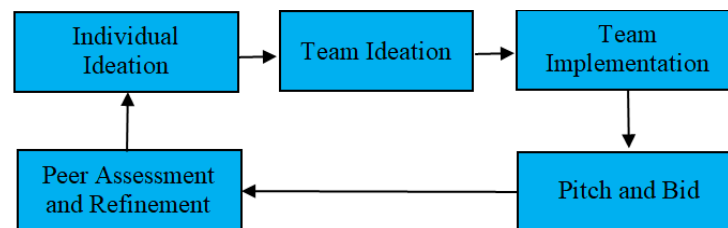


Figure 6. Barak and Yuan's framework [49]

3.6.3. Wu's framework

Wu [44] conducted PjBL and SCAMPER instructional activities to investigate students' cognitive abilities, motivation, and attitudes in working on projects or assignments. They adopted Moodle as a learning platform. They are guided to design, develop and construct projects. To investigate and see students' cognitive abilities, motivations, and attitudes, Wu and Wu [44] carried out experimental activities by grouping students into two groups, called high and low-creativity students. The results of their research show that students with high creativity are more proficient and enjoy their work than students with low creativity. In this study, they put more emphasis on how students are motivated and can generate many ideas during discussions and interactions. Even though the given projects challenge the students with high creativity, the results are consistent with the attitudes shown by students. Students' skills in working on projects increase, and difficulties experienced can be overcome. They are active in finding solutions. Meanwhile, the thinking skills of students with low creativity also increased. Even though during the discussion, they are passive and just accept ideas or views from others. They tend to accept other people's views without conveying ideas and are used to developing ideas based on knowledge or concepts they have previously obtained. These findings are largely the same as the results of a literature review that students who have high creativity are challenged to solve problems in different ways. Therefore, Wu [44] combined SCAMPER's PjBL and instructional activities before creating a PjBL framework. By adopting Moodle as a learning platform, it allows students who have low creativity to solve difficult problems and can improve students' concept understanding skills and problem-solving abilities. Figure 7 shows the PjBL framework of Wu and Wu [44].

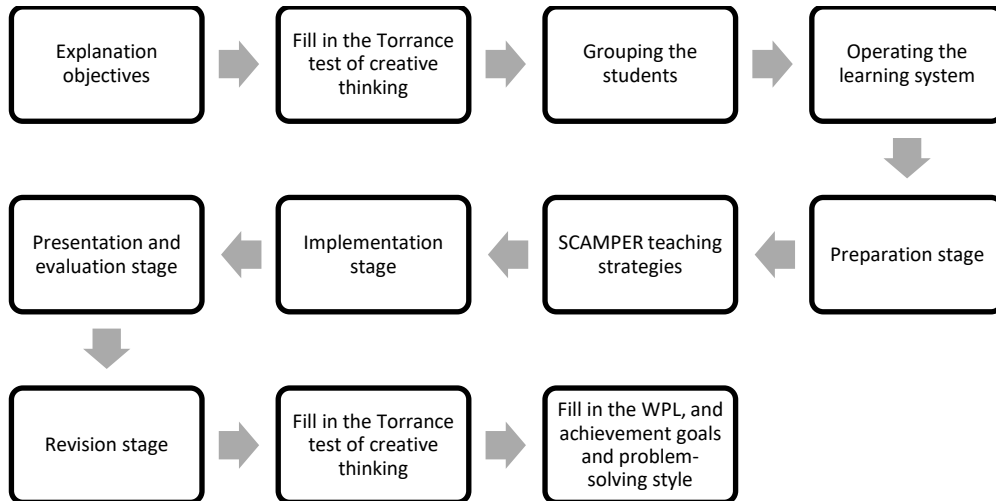


Figure 7. Wu’s framework [44]

3.6.4. Mustapha’s framework

This literature review finds eight important elements or skills that facilitate PjBL. The eight elements are knowledge, supervision, collaboration, communication, creativity, e-SOLMS, facilities, and accessibility. The lecturer's and students' knowledge increases before starting to work on the project. In this case, knowledge and skills are obtained from institutions through training on technical skills and supervision of PjBL. Collaboration and communication play an important role in completing a project. If collaboration and communication in working on a project are weak, it will make the project unfinished. Another element that must be possessed is critical and creative thinking in completing a project. This can be shown in their final product. The research results of Mustapha *et al.* [53] showed that the projects completed by students are not innovative. This is due to the lack of creativity of students in working on projects. Other important elements are e-SOLMS, facilities, and accessibility. Based on this research, the framework for PjBL needs to include new elements so that projects or assignments can be carried out properly and optimally. The framework developed is considered necessary to include new elements so that its implementation is able to optimize the improvement of students' soft skills. In addition, it is necessary to ask for input from various parties, such as experts, lecturers, students, and others, for the improvement of the framework. Figure 8 shows the PjBL framework of Mustapha *et al.* [53].

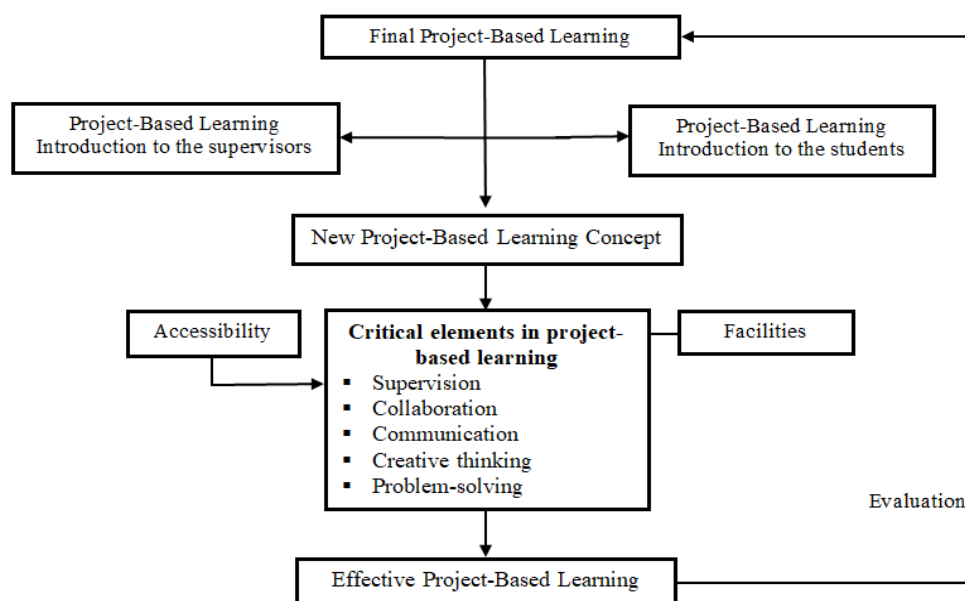


Figure 8. Mustapha’s framework [53]

3.6.5. Pan's framework

Pan *et al.* [38] conducted research by integrating possibility-thinking (PT) and PjBL into instructional frameworks and looking at their impact on students' motivation, creativity, and understanding of concepts. In PT, the framework developed by Pan *et al.* [38], includes important features, including asking questions, answering questions, immersion, imagination, innovation, self-determination, development, intentional action, and peer collaboration. However, they consider the existing features incomplete. So, they also use "gold standards" in the PT-PjBL framework. The standards cover challenging questions, inquiry, originality, student voice and choice, criticism and revision, reflection, and public product. The activities conducted are to emphasize the interest and involvement of students. Researchers give time to students to identify the problems they will solve. Students are encouraged to identify, analyze, discuss, respond, and find solutions. To assist students in learning, process-outcome facilitates them in creating projects independently and based on their choice. Then, students are brave to make decisions. The outcome can facilitate them. They assume that the combination of PT and PjBL can increase students' creativity and learning motivation. In accordance with the results of his research, learning through PT-PjBL has a positive effect on student motivation and creativity. Figure 9 shows the PjBL framework of Pan *et al.* [38].

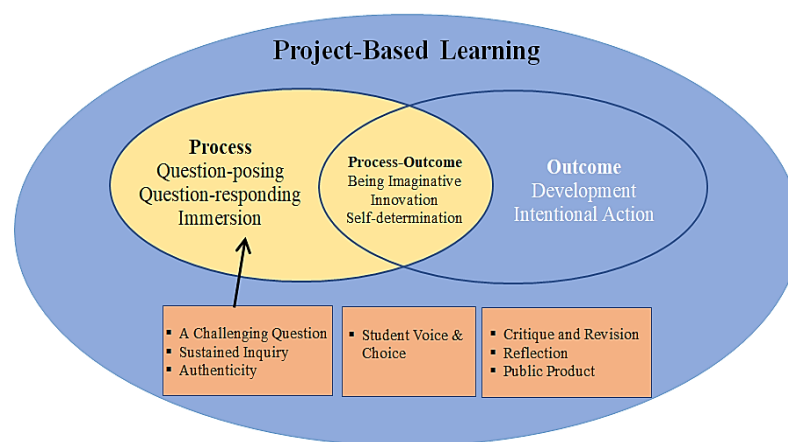


Figure 9. Pan's framework [38]

After reviewing and analyzing the existing PjBL implementation and framework in the literature, the authors assume several weaknesses. They are: i) inappropriate timing: PjBL takes time to plan, implement, and evaluate projects. If time is not well managed, students may have difficulty completing projects within the allotted time limit; ii) complicated organization: PjBL implementation requires good coordination and organization between teachers, students, and other resources. Otherwise, projects can become unstructured and difficult to complete; iii) difficulty in measuring results: in PjBL, assessment can be challenging because of the focus on projects and collaboration; it is not just based on individual knowledge or skills. Therefore, determining objective and relevant assessment criteria can be difficult; iv) limited resources: projects in PjBL often require additional resources such as equipment, technology, or materials that are not always available. This resource limitation can limit the project possibilities that students can undertake; v) classroom management challenges: PjBL encourages collaboration and independence, but in some cases, it can create classroom management problems. Students with varying levels of motivation or skill may encounter difficulties working in teams or overcoming project constraints; vi) dependence on the facilitator: the role of the teacher as a facilitator in PjBL is very important. However, if teachers do not fully understand the PjBL framework or do not have the necessary skills, the effectiveness of PjBL can be hampered; and vii) subjective evaluation: Project assessment in PjBL tends to be subjective, depending on the assessment of the teacher or assessment team. It can give inconsistent and different scoring results between different students or teachers.

3.7. Project-based learning and simulation

This study tried to integrate PjBL and simulation by reducing and adopting PjBL developed by previous researchers. It aims to increase student participation and challenge them to understand the concepts of the material. PjBL and simulation are two different learning models, but they complement each other in an effort to increase student motivation and ability to understand concepts. In this case, students use simulation

as a tool to assist them in solving problems related to a given project or task so that they can have a better understanding about the concept of the material being studied. Through simulations, students will experience an environment closer to the real situations. So that, they can test the ideas and concepts that they have learned in a safe and controlled situation. The stages of PjBL and simulation in this study consist of: i) formulating a project; ii) designing a project; iii) simulating; iv) monitoring students and project progress; v) evaluating; and vi) reflecting and presenting the project. In the context of simulation, PjBL will find its perfection. Students' skills will improve and practical competencies through immersive experience will be awakened. They combine theoretical knowledge with practical application in simulations that present real challenges. As a result, students do not only understand concepts but they also develop their skills. By combining of PjBL and simulation, the students will be ready to face the real world with confidence and strong expertise.

The existence of simulation as a supporting tool before making decisions can make it easier for students to understand the concept of material and help them solve the problems they face, time efficiency, simple and easy to obtain equipment. In this study, simulation contributes to problem-solving by connecting the concepts studied. Difficult concept challenges in the form of abstract can be overcome [73], [74]. The proposed new framework is seen in Figure 10.

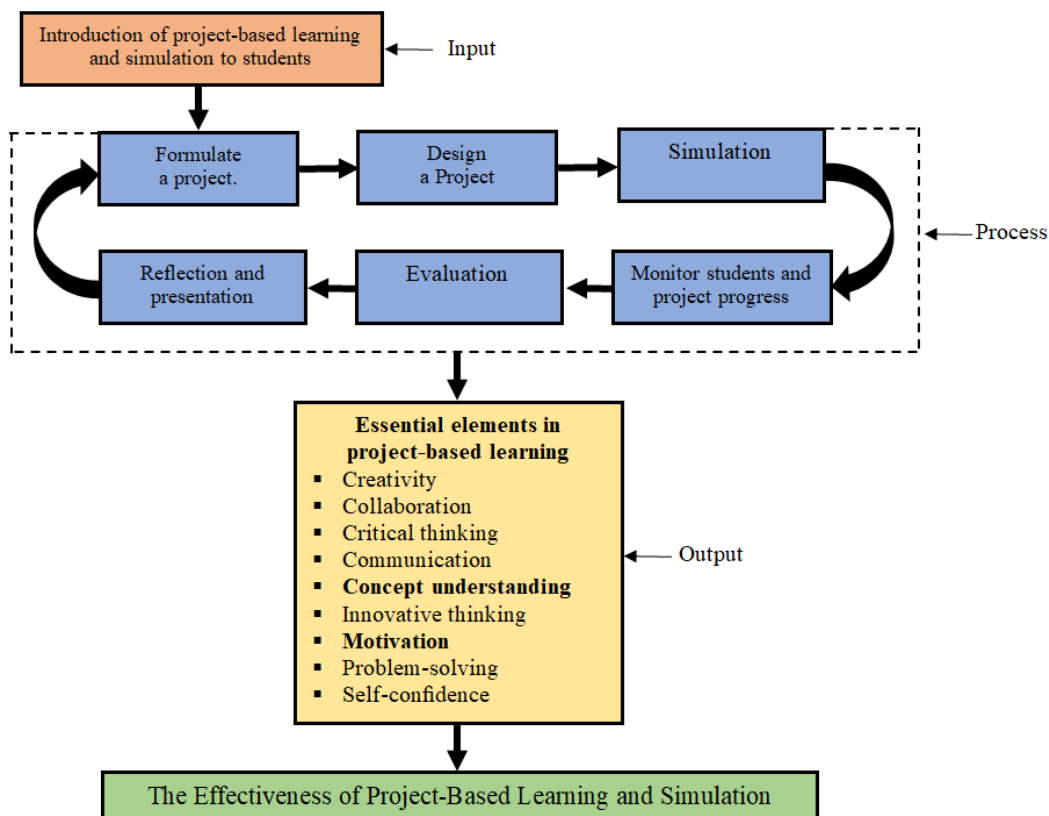


Figure 10. A framework of project-based learning and simulation (PjBLS)

The combination of PjBLS is a precious theoretical contribution to this study. This study tried to adopt several steps of PjBL implementation based on research conducted by previous researchers by considering the efficiency and effectiveness of the model. Then, it also investigated the important elements developed from the implementation of PjBL.

The practical contribution of this study is that it provides a deep insight into PjBL in various educational contexts and disciplines. This is very useful for educational practitioners, teachers, and curriculum developers in designing, implementing, and evaluating effective PjBL approaches that suit students' needs. Thus, they can choose or design PjBL that best suits the learning objectives and student characteristics, as well as consider the obstacles that may arise in the implementation of PjBL. Theoretically, this study can help in deepening the understanding of the methods used and the skills that can be developed through PjBL. This allows for the development of effective learning that is more holistic and inclusive.

Methodologically, this study provides a framework for PjBL that contains clear, systematic, and structured steps. As such, this study not only facilitates a more comprehensive understanding but also serves as a guide for educational researchers and practitioners in designing advanced learning or implementing PjBL. By providing a methodological framework and presenting a proposed new framework, this study supports the improvement of learning effectiveness and quality. It provides a strong foundation for stakeholders to use in designing and implementing PjBL approaches that are efficacious and relevant to educational needs. As such, this study is not only a practical, theoretical, and methodological contribution but also a foundation for continuous innovation and improvement in learning practices.

4. CONCLUSION

This literature review identified and analyzed research trends, research methods, essential elements or skills, and PjBL frameworks from 2016 to 2023. Based on inclusion and exclusion criteria, 34 articles on PjBL were analyzed and investigated. Its findings provide valuable insights for academics seeking to improve the learning process by implementing PjBL. The results of the literature review reveal that sequentially the research methods that are often used in PjBL are quantitative research methods, qualitative research methods, descriptive research methods, mixed methods, action research methods, and development research methods. The dominant elements or skills that can be developed through PjBL are creative, collaborative critical thinking, communication, concept understanding, innovative thinking, motivation, problem-solving, and self-confidence. This literature review also identified five frameworks used in implementing PjBL. Based on the findings from the literature review, a new framework is proposed.

The limitations of this study include several aspects that need to be considered. First, limitations in the scope of the literature used may affect the overall representation of each aspect studied. Although rigorous methodological measures have been applied in the literature search and selection, it is inevitable that some relevant literature may be missed. Secondly, in evaluating the quality of the included literature, there is potential for assessment bias. Although quality assessment criteria have been consistently applied, the assessment is still subjective. This may affect the validity of the conclusions drawn from this study. Thirdly, limited time resources may affect the depth of analysis and synthesis of the findings conducted in this study. Although efforts have been made, these limitations may restrict exploring each aspect in depth. Future studies should concentrate on deeply identifying the essential elements that can optimize the implementation of PjBL in learning and looking at the factors that can influence it, both internal and external. In addition, future researchers must also look at the potential influence of these elements in implementing PjBL, including choosing and using the PjBL framework that is suitable for the learning process.




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