

Challenges and research gap in project-based learning – A review

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Abstract

The 21st-century learning requirements are different from the 20th-century learning requirements. Critical thinking skills are requirements for learning, and to achieve critical thinking skills, various new learning techniques and strategies have been developed and applied. By applying new learning techniques and strategies, various challenges have been faced by researchers and instructors. The objectives of this study were to highlight the project-based learning (PjBL) used at different educational levels; to discuss the challenges and their solutions; and to present the research gap in the PjBL strategy. This was achieved using the literature review methods, with resources from previous studies. This study will help the researchers and instructors to carry out more research on the challenges and solutions of PjBL.

Keywords: Critical thinking skills, instructors, learners, learning strategies, problems;

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1. Introduction

Learning is an important element in the development of a country. Various learning strategies are available for the teaching–learning process (Hafeez et al., 2020). Project-based learning (PjBL) is a constructivist learning–teaching strategy in which students work together on a project to find the solution to a specific problem (Kokotsaki, Menzies, & Wiggins, 2016). This learning strategy allows the learners to actively participate in the learning process (Chen & Yang, 2019; Uzunboylu & Sukran, 2019). Furthermore, the learners become active in searching for solutions to problems and decision-making ability by increasing their practical knowledge and critical thinking skills (Anazifa & Djukri, 2017).

Sasson, Yehuda and Malkinson (2018) stated that PjBL develops the scientific knowledge of the learners by following the scientific process. The learners try to find the solution to the real-life problems through observations, questioning, discussion, experiments, data collection and analysis and drawing conclusions. Actually, in PjBL the learner takes on responsibilities and works together as a team member (Widyaningsih & Yusuf, 2018). In PjBL, there is a close relationship between the learning process and nature (Dimmitt, 2017). Moreover, PjBL increases the learner’s metacognitive skills, and they make useful plans and assess their solutions to the problems (Uziak, 2016). Finally, the learners achieve better academic grades by producing more learning environments (Gary, 2015).

1.1. Related studies

Krajcik and Czerniak (2018) purported in a study that there is no solid lesson plan available for PjBL. This allows the learners to think deeply and investigate thoroughly. In PjBL, the work is assigned to every member of a group individually or collectively. The topic is selected with the help of a teacher. The topic of a project work consists of a real-life problem that has to be solved by experimenting on the project (Birgili, 2015).

PjBL brings about opportunities for learners to increase their cognitive skills and improve their academic achievements. Each member of a group works to find the information on a particular topic selected for the project. Thus, each learner or group of learners offers different solutions to the problem (Trisdiono, Siswandari, Suryani, & Joyoatmojo, 2019). Then, the information from each group member is collected and transferred to a document. This written document is used for the experiment to find the solution to the problem (Bell, 2010). The results of the project works are discussed with the teachers and other learners in the classroom (Sada, Mohd, Adnan, & Yusri, 2016). Barak and Asad (2012) suggested in a study that PjBL improves self-learning abilities and promotes conceptual and motivational learning. The important characteristics of PjBL are shown in Figure 1.

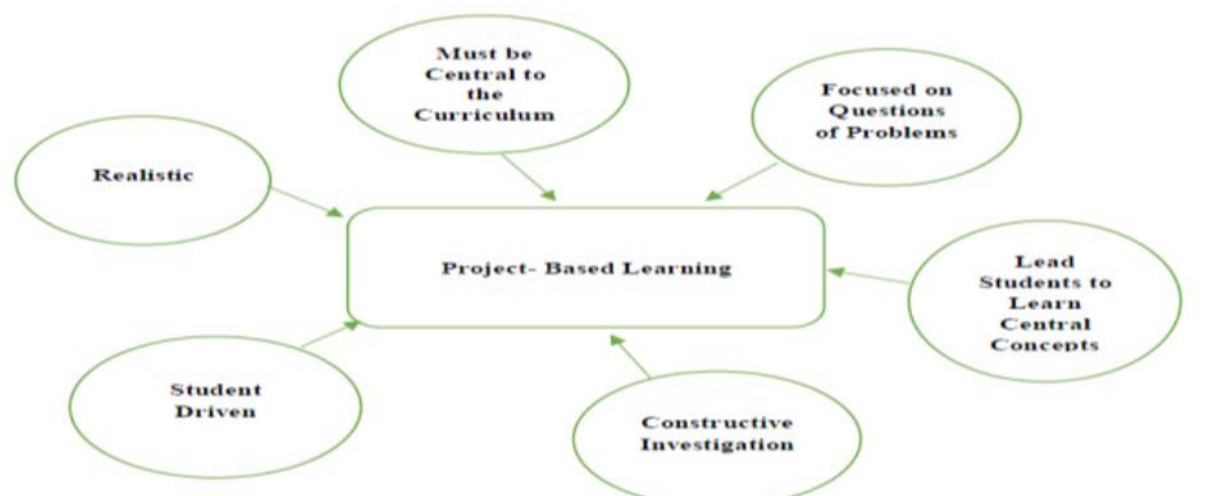


Figure 1. Characteristics of project-based learning (Robinson, 2013)

Han, Yalvac, Capraro and Capraro (2015) concluded in a study that PjBL provides challenges and freedom to the learners to work collaboratively. This strategy can develop a high level of learner engagement. The results of the project are presented in form of videos, maps, photographs, models and sketches. PjBL strategy has a close relationship with other pedagogical strategies like problem-based learning (Bédard, Lison, Dalle, Côté, & Boutin, 2012). In another study, McGibbon and Van Belle (2015) argued that the learners actively participate in the PjBL process to share their ideas in the group and find possible solutions to the problem.

1.2. Purpose of the study

There are many studies found in the literature about PjBL (Beier et al., 2019; Hosseinzadeh & Hesamzadeh, 2012; Ngereja, Hussein, & Andersen, 2020; Pinter & Cisar, 2018; Tascı, 2015). The perception of the challenges and effectiveness of PjBL at different levels of educational studies is yet to be evaluated. So, the objectives of this study are (i) to present the effectiveness of PjBL at different educational levels and (ii) to highlight the challenges, possible solutions and research gap for implementing PjBL.

2. Materials and methods

This was achieved using the literature review methods, using resources from previous studies. This study also discusses the challenges and solutions of PjBL. The study also presents the research gap in the PjBL strategy.

3. Results

PjBL is a constructivist learning strategy involving the construction and transformation of new information for learners (Oguz-Unver & Arabacioglu, 2014). In PjBL, students give the solution to the problem by indicating the problem, discussing the problem, designing procedures to solve the problem, collecting and analysing data and sharing the results with other learners (Stefanou, Stolck, Prince, Chen, & Lord, 2013). According to the study conducted by Chiang and Lee (2016), PjBL is a systematic teaching–learning process that enables the learners to solve complex real-life problems and presents their results before the audience for implications. This teaching strategy also increases the life-enhancing and knowledge acquisition skills of the learners.

3.1. Factors effecting the implementation of PjBL strategy

The study conducted by Al-Balushi and Al-Aamri (2014) concluded that PjBL instructional strategy can be implemented with little available resources like traditional lecture strategy within the time allocated for learning in the classroom on a particular topic. The 21st century is an age of information and technology-based learning. The modern sources of technology are the major helpers for learners to easily understand the design and development of a project and digitally document their whole learning process (Patton, 2012). Now information technology has become an effective and necessary part of all learning processes, especially for the construction knowledge-building process in PjBL (Wekesa & Ongunya, 2016). However, Aldabbus (2018) pointed out that the learners need to be supported and guided in applying information technology effectively and safely to create an effective and critical thinking learning environment. So, the application of information technology is an important factor in the implementation of PjBL.

According to the study by Lestari, Sarwi and Sumarti (2019), the effective implementation of PjBL in the educational learning process lies in the instructor's ability to successfully incorporate the information technology in PjBL and continuously motivate and guide the learners during the whole project. The effective and dynamic instructions with quality experiences from the instructor will assist the learners to build their knowledge in the learning process and reduce the cognitive load of the learners (Woods, 2014). The important factors for implementing PjBL are shown in Figure 2.



Figure 2. Factors for implementing PjBL

3.2. Project-based learning in different educational studies

Many studies have been conducted to prove the effectiveness of PjBL in various subjects and at different levels of education (Barak & Asad, 2012; Eliana, Senam, Wilujeng, & Jumadi, 2016; Gerhana, Mardiyana, & Pramudya, 2017; Morales, Bang, & Andre, 2013; Rosyida, Wirahayu, & Insani, 2019; Siswono, Hartono, & Kohar, 2018; Ulya, Achmad Rifai, & Sulistyorini, 2020). Most of these researches were based on pre- and post-test quasi-experimental designs in different subjects and at different educational levels. The stages for implementation of PjBL are presented in Table 1.

Table 1. Stages for the implementation of PjBL

No	Stages	Description
1	Decision	The decision is made by the administration, managers and instructors of higher education institutions.
2	Preparation	Some institutional and organisational changes can be made during the preparation of the project according to the industry and business demands.
3	Incorporation of PjBL into course curriculum	To integrate PjBL into the course curriculum, the curriculum committee reviews the existing course content.
4	Business and industry sector involvement	It is one of the difficult stages. The incorporation of PjBL needs a lot of effort to make it commercial.
5	Preparation of instructors for PjBL	The instructor's training is conducted at this stage to make the project useful for commercial purposes.

3.3. PjBL in K–12 education

PjBL is an instructional strategy in which the instructors and students work in a group to find the solution to a problem in real life. Many researchers have explored how to evaluate the effectiveness of PjBL in K–12 studies (Chen & Yang, 2019; Condliffe, Visher, Bangser, Drohojowska, & Saco, 2016; Lokey-Vega & Bondeson, 2017; Saleh, Muhammad, & Abdullah, 2020; Yang, Swanson, Chittoori, & Baek, 2018). Previous studies have extensively reported the positive effects of PjBL in K–12 studies.

Angelle (2018) conducted a review to evaluate the effectiveness of the project and problem-based learning on different levels of education, especially in K–12 classes. The results of the review indicated that PjBL is more effective than problem-based learning. The student's academic and critical thinking performances improve in PjBL. The students' thinking behaviour and mental ability also increase in the PjBL process. Jacques (2017) conducted a study to examine the effectiveness of PjBL in K–12 classes in mathematics subjects. Two groups were made to evaluate PjBL. One group studied with the traditional lecture method and the other with PjBL.

The results of the study indicated that the academic achievements of students were better in the PjBL group. The learners also achieved better creative and critical thinking abilities through the PjBL process. Togou, Lorenzo, Cornetta and Muntean (2020) concluded in a study that PjBL improves the cognitive skills of the learners by increasing their critical thinking skills. Moreover, they also concluded that learners' ability to deal with the business and social community is also improved by PjBL.

3.4. Teachers' motivation in using PjBL

The application of PjBL in the classroom also increases the motivation of the instructors. By implementing PjBL, the teachers explore their abilities by using various technological tools. The teachers' motivation increases when they explore new knowledge and implement that knowledge for social and industrial applications (Chiang & Lee, 2016; Lam, Lam, Cheng, & Choy, 2010; Revelle, 2019). By conducting PjBL in the classroom, the teaching strategies of the instructors also changed according to the learners' abilities and project requirements (Rahardjanto, 2019).

Habók and Nagy (2016) carried out a study to evaluate the effectiveness of PjBL on the students and teachers' confidence and motivation. The study concluded that after working on the project, the motivation of teachers and students improved significantly in the learning process. In another study, Gómez-Pablos, del Pozo and Muñoz-Repiso (2017) indicated that the motivation and involvement of teachers and learners increased during PjBL. The study conducted by Wongdaeng and Hajihama, (2018) also improved the learning process and motivation of the teachers and learners.

3.5. PjBL in engineering education

A lot of studies have been carried out on the effectiveness of PjBL in engineering and technology education (Bédard et al., 2012; Chowdhury, 2015; Hellany, Nagrial, & Rizk, 2019; Horton, Jordan, Weiner, & Lande, 2018; Mills & Treagust, 2003; Pérez & Rubio, 2020; Reis, Barbalho, & Zanette, 2017; Shekar, 2014). The PjBL in engineering education is conducted to clear the concepts and principles of the scientific process.

Aqlan and Nwokeji (2018) carried out a study to evaluate the effectiveness of PjBL in industrial engineering. The outcomes of the study indicated that PjBL improves the students' learning and confidence level. The students worked collaboratively and performed well in the learning. Christie and Graaff (2017) proposed in their study that PjBL is an important instructional and learning strategy in engineering education. The students who work on the projects have a better command of the subject matter. The students who worked on the projects in their degrees performed well in the industry and social matters. Naji, Ebead, Al-Ali and Du (2020) carried out a study to evaluate the effectiveness of PjBL in civil engineering courses. The study concluded that the learners who worked on the project performed well in their studies.

3.6. PjBL in social science education

Social science education is related to the studies of social behaviour. Many researchers have researched the application of PjBL in social science curricula (Arantes do Amaral, dos Santos, & Rodrigues, 2018; Brassler & Dettmers, 2017; Dahono, Kantun, & Sukidin, 2017; Jalinus, Nabawi, & Mardin, 2017; López, Meléndez, & Gámez, 2020).

Oh, Chan and Kim (2020) researched to evaluate the effectiveness of PjBL in sociology. The study concluded that students performed better during the work on the project. Indahwati, Tuasikal and Al Ardha (2019) researched to examine PjBL in physical education. The study concluded that the learners achieved better academic achievements in the subject matter. Moreover, students' critical thinking skills also improved.

The advantages of PjBL are shown in Figure 3.

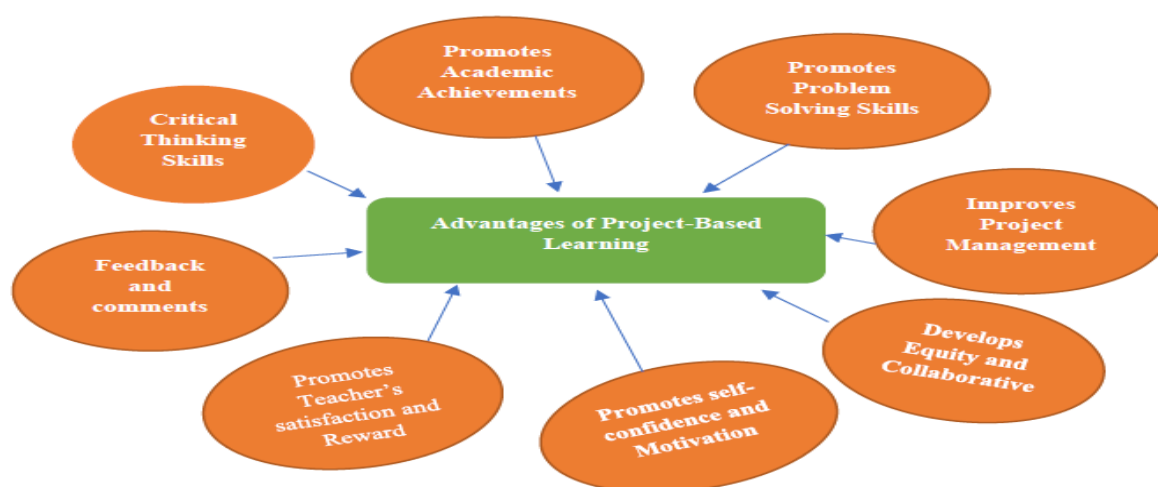


Figure 3. Advantages of PjBL

3.7. Challenges in the implementation of PjBL

Various challenges have been indicated by researchers in their research studies (Harris, 2015; Lewis, Gerber, Carlson, & Easterday, 2019; Pereira, Barreto, & Pazeti, 2017; Pedersen & Ritter, 2018; Wilson, 2020; Zafirov, 2013). Some important challenges are stated in this study.

3.7.1. Collaborative work

As PjBL is a group-based learning activity, Shpeizer (2019) stated that both instructors and students consider group work a challenge. However, they know its benefits for the future as they face a great challenge during its incorporation. The learners' attitudes towards collaborative work are uncertain. Some learners do not want to work collaboratively with the other students.

3.7.2. Lack of technical and labour skills

Technical and labour skills are requirements for the implementation of PjBL. Nwokeji, Aqlan, Olagunju, Holmes and Okolie (2018) suggested in their study that technical and labour skills are great hurdles for the implementation of PjBL in any country. The people in underdeveloped countries are less skilled, so it becomes very difficult to implement PjBL in underdeveloped countries.

3.8. Information technology problems

In the 21st century, information technology is playing an important role in all educational and instructional strategies. Information technology knowledge is also very important for the implementation of the PjBL. Vasilienė-Vasiliauskienė, Butviliene and Butvilas (2016) researched

that knowledge of information technology plays a vital role in PjBL. Most projects need the application of technology in their execution. Developed countries have better sources of information technology, so they can easily incorporate the information technology into their projects while the underdeveloped countries have limited information technology sources, and so it is very difficult to implement PjBL in underdeveloped countries.

3.9. Time management

Time management is another challenge. PjBL is a very time-consuming learning strategy. According to a study conducted by Keator, Vandre and Morris (2016), the PjBL strategy follows the scientific procedure for its results. This scientific process requires time to produce results. So, implementation of the PjBL strategy is a time-consuming process.

3.10. Social challenges

Some project works may harm the population partially or fully. If so, then it becomes difficult to implement PjBL. Kumar, Silva and Prelath (2020) conducted a study to view the effects of project-based learning on the population and in a social context. They concluded that it becomes very difficult to continue the project in regions where it affects the population or other social cultures.

3.11. Funding problems

Funding is also an important requirement for the implementation of PjBL. Without the availability of funds, it becomes difficult to incorporate PjBL. According to Rice and Shannon (2016), if the funds are made available for the implementation of PjBL approaches, then the industrial sector of the country progresses and becomes a research country.

3.12. Solutions to the challenges for implementing PjBL strategy

3.12.1. Regular training

PjBL requires skilled teaching faculty and labour. So, by conducting regular training of faculty members and labourers, the required skilled person can be prepared for the implementation of PjBL.

3.12.2. Free and non-stop resources of information and technology

The implementation of PjBL requires information technology resources to execute the performance of project works. So, free and non-stop information technology resources must be provided for the project works.

3.12.3. Funds for PjBL strategy

PjBL need funds for implementation. So, the government and NGOs must provide the funds for PjBL.

3.12.4. Interactions between industry, society and institution

To conduct PjBL, there must be a close link between society, industry and institutions.

3.12.5. Time management

With proper time management, this challenge can be resolved.

3.13. Research gap in PjBL

Researchers and instructors have always been trying to find the right and useful learning strategy for human and industrial development. For this, several learning strategies have been developed and applied till today (Biwer, de Bruin, Schreurs, & oude Egbrink, 2020; Chen et al., 2019; Kendal et al., 2018; Mayer, 1988; Nisbet & Shucksmith, 2017; O'Neil, 2014; Rosenberg & Foshay, 2002; Schmeck, 2013; Weinstein & Underwood, 1985). All these learning strategies have been developed according to the local and international learning environment. There are very few studies found in

the literature in which challenges and their solutions are present. So, to discuss the challenges and present their solutions, more research is needed on the PjBL strategy.

4. Discussion

PjBL strategy is a highly skilled and practical-based learning in which a systematic process is followed to solve real-life problems. According to Terasawa (2016), the implementation of PjBL requires a high level of technical skills. In underdeveloped countries, men's power with a high level of technical skills is not available. So, it becomes difficult to implement the PjBL strategy in the course curriculum.

In the present study, PjBL strategies in various educational fields and challenges for the implementation are reviewed. The review of the literature showed that a PjBL strategy requires proper planning and management for its implementation. It is a systematic and long-term procedure. In PjBL, scientific procedures and principles are followed to achieve the required results. The work is conducted collaboratively and then information is shared to find the solution to the problem. The challenges highlighted in this review are in line with the studies conducted by Brassler and Dettmers (2017) and Spikol, Ruffaldi, Dabisias and Cukurova (2018).

According to the study conducted previously (Mahasneh & Alwan, 2018), the implementation of the PjBL strategy improves students–instructors self-efficacy and academic achievements. They also concluded that this learning strategy builds the confidence level of the learners and instructors. Another study conducted by Munezero and Bekuta (2016) suggested some solutions to the challenges in implementing PjBL. These solutions include conduction of the training for instructors, provision of funds by the government for project works and availability of accessibility of free and fast information technology resources.

5. Conclusion

A review has been conducted to evaluate the effectiveness of PjBL strategies in various educational fields. The challenges and their possible solutions are also discussed in this study. This study indicates that PjBL is an effective learning strategy for the development of creativity and critical thinking skills.

There are also some challenges like lack of required skills and funds in implementing PjBL. The possible solutions to the challenges are regular conduction of training and involvement of the government sector and NGOs to minimise the challenge of funds.

Conflict of interest

The authors declare that they have no conflict of interest.

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