

# Effective Learning Through Project-Based Learning: Collaboration, Community, Design, and Technology



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**Abstract** Project-based learning assists students in several ways. It gives students greater control and flexibility to prepare and engage more in their learning. It integrates cooperation with industry or professional communities to build real-life issues to provide students with authentic learning experience. Project-based learning has been very popular in higher education. However, there appeared to be a gap in past studies in that they defined PBL differently and so developed PBL from a limited perspective. This research aims to explore current project-based learning studies in higher education to explore their learning advantages, implementation design, and technology support. In the last two decades, a search for project-based learning yielded 698 publications. Following a focus on higher education and the removal of irrelevant articles, 142 articles published between 2003 and 2019 were chosen for further research. The studies' abstract was analyzed, yielding four key themes: collaboration, community, design, and technology. These themes are further addressed regarding learning processes. Implications and further studies have been discussed.

**Keywords** Project-based learning · Pedagogy · Collaboration · Community · Curriculum design · Technology

## 1 Introduction

### 1.1 What is Project-Based Learning?

Project-based learning (PBL) requires the incorporation of various stakeholders into the curriculum so that learners are actively engaged in the process of establishing connections with the experiences of others (e.g., Haydari & Kara, 2015).

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Project-based learning promotes independent study through involvement in initiatives, although some still rely heavily on direct education as the key source of knowledge (García-Aracil, 2012). Earl et al. (2018) address, under Dewey’s behavioral change theory, educational interactions focused on pattern disruption and real-world learning contribute to innovation in the creation of new behaviors. It presents a series of reflections by instructors and participants on the relationship of the program to the core themes of habit, disruption, creative action, and dialog within the five components of adaptive education: stakeholders, real-world learning, off-campus, transdisciplinarity, and non-traditional rewards. Adaptive education builds potential for future sustainability leaders and educators. Project-based learning has the benefit of promoting a more inclusive approach to education, in particular “by increasing student control over learning” (Harmer & Stokes, 2016, p. 531) and real learning experience in “distributed and decentralized working environments” (Lahiff & Guile, 2016, p. 302). It promotes educational aspirations, enthusiasm, and attainment through involvement (Johnson & Lewis, 2013).

The below table summarizes the various learning advantages, process design, and distinct features (see Table 1).

**Table 1** Selected works on distinct features of project-based learning

Distinct features	Studies
Better learning achievement: <i>PBL aims to increase the overall performance of students and their satisfaction with the course</i>	E.g., Chipere (2017), García-Aracil (2012), Mariage and Garmon (2003)
Engaged and deeper learning: <i>PBL facilitates committed learning and as an effective resource to improve meaningful learning and to increase their commitment to learning</i>	E.g., Fernandes et al. (2014), Smallwood and Brunner (2017), Wilson and Fowler (2005)
Professional skills: <i>PBL effectively provides the appropriate skills to future professionals according to market demands</i>	E.g., Llorens et al. (2017), Rand (2016), Tinnirello et al. (2010)
Industrial and professional partnership for authentic learning experience: <i>PBL designs involve the collaboration of student, university, and employer representatives that authentic experience of PBL encourages students to relate their teaching activities</i>	E.g., Diamond et al. (2011), Hanney (2018), Wilson et al. (2016)
Service-learning in Real-world Situation: <i>PBL promotes students to adapt theory to real-world circumstances and to apply them to their service-learning that helps to alleviate student anxiety and uncertainty about theory application and service-learning</i>	E.g., Gerstenblatt and Gilbert (2014), Ricke (2018)

## ***1.2 Research Questions***

However, previous studies appeared to have a gap in that they defined PBL differently and hence created PBL from a narrow perspective. As a result, the purpose of this study was to investigate current project-based learning studies in higher education to examine their learning benefits, implementation design, and technological support in order to establish a comprehensive framework in project-based learning. The following research questions were addressed in this study:

- RQ1: What is a project-based learning study in higher education?
- RQ2: What are the typical enablers for the design and implementation of project-based learning?
- RQ3: What are the common themes in project-based learning studies?

## **2 Methods**

### ***2.1 Background***

This study analyzed previous empirical research to examine project-based learning. The analysis is limited to higher education studies which have documented empirical findings on the design and implementation of project-based learning. Learners can be undergraduate and master's graduates, teachers, and community professionals in professional development.

### ***2.2 Data and Sample***

One way to understand the recent work that has been done on project-based learning is to study previous research studies on the topic. Important sources include empiric studies that review the literature, gather opinions of human subjects, or observe the behavior of human subjects in relation to project-based learning. Papers documenting such studies usually include a literature review to identify relevant constructs, a description of the study designs used, a summary of the techniques used to gather empirical data, and an overview of the findings and conclusions of the data. Therefore, each of these studies provides us with a deeper understanding of project-based learning. An analysis of these empirical studies will help address our research questions.

**Table 2** Search process and results of project-based learning studies from the e-database *Academic Search Complete*

Steps	Keywords	Duration	Articles
1	“Project-based Learning”	1988–2019	698
2	AND Subject term, “education”	1988–2019	463
3	Remove irrelevant studies	2003–2019	142

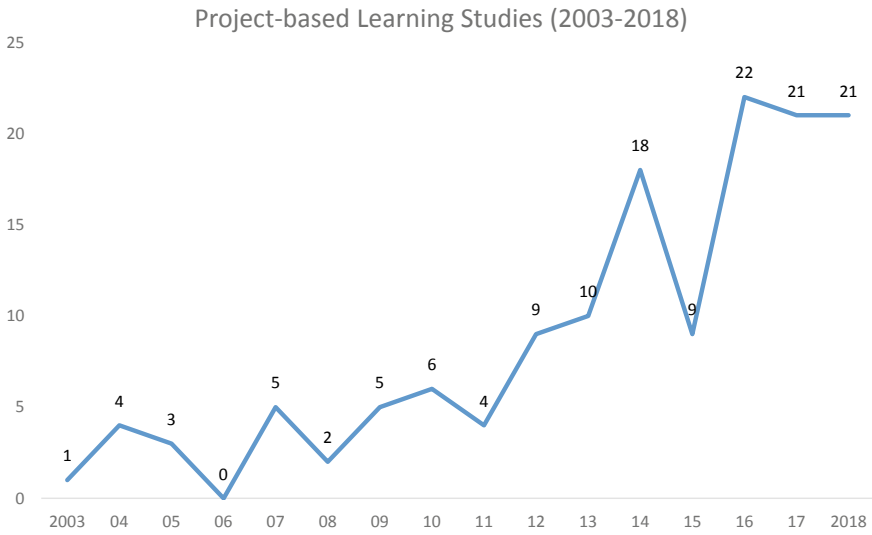
*N.B.* The scope of the search was limited to the abstract field. Limiters included: *Scholarly (Peer Reviewed) Journals*; *Research Article* document type; and *English language*

### 2.3 Data Collection

The data for this research were empirical findings on project-based learning aiming at defining effective learning and teaching. Such studies were found using the *Academic Search Complete* online database, which includes the full text of more than 5,900 publications in various disciplines, including the full text of more than 5,030 peer-reviewed titles. The contents of this database go back to 1887. A description of the search process is shown in the table below (see Table 2). From the 463 studies, each was reviewed one by one. Irrelevant studies of higher education project-based learning were removed, for example, book reviews and meta-analysis were removed; specific disciplines research reports not related to PBL were removed, and so on. Finally, 142 studies have been included for further analysis.

### 2.4 Data Analysis

All 142 abstracts were inductively analyzed using NVivo 12.0 (Bazeley, 2002) to classify main topics and concepts in line with qualitative textual and content review procedures (e.g., Neuman, 2006; Punch, 1998). The research generated lists and word clouds showing the most commonly used words, concepts, and phrases. The initial stage of open coding concentrated on the definition of key terms; afterwards, further analysis attempted to organize words and concepts into groups (e.g., Glaser & Strauss, 1967; Glaser, 1978). The results were derived from a combination of inductive and deductive reasoning. For example, terms were grouped inductively, where possible, on the basis of synonym grouping and derivative words in abstracts.



**Fig. 1** Year versus number of studies on project-based learning

### 3 Results

#### 3.1 Year and Number of Studies

Between 2003 and 2019, 142 articles appeared in 81 peer-reviewed academic journals. There has been a progressively growing pattern of studies since 2003 when the first applicable study on project-based learning emerged (see Fig. 1).

#### 3.2 Journal and Year of Publications

The journal publications and the year of publications were analyzed, and 81 publication journals were identified. The highest count was from European Journal of Engineering Education which had 11 studies published. The second was from Innovations in Education and Teaching International which had 7. The third was from Assessment and Evaluation in Higher Education; Interactive Learning Environments; Journal of Geography in Higher Education, they all had 5 studies published. For the remaining others, there were 1–4 studies published (see Table 3).

**Table 3** Five or more appearances of PBL studies on journal publications (2003–2019)

Publications	Studies	Year
European Journal of Engineering Education	11	2014 (×3), 2015, 2016, 2017 (×4), 2018 (×2)
Innovations in Education & Teaching International	7	2011, 2012, 2014, 2015 (×2), 2016, 2017
Interactive Learning Environments	6	2012, 2014 (×2), 2016, 2018
Assessment & Evaluation in Higher Education	5	2004, 2005, 2016 (×2), 2018
Teaching in Higher Education	5	2014, 2016, 2017, 2018 (×2)

**Table 4** Appearances of discipline keywords in the studies

Disciplines	Count
Engineering, Science	68
Language	31
Management	20
Health	15

*Note* Education was not included in the table

### 3.3 Subject Disciplines

Most project-based learning initiatives have been incorporated in interdisciplinary project designs. Nevertheless, the PBL has also been developed and implemented for different disciplines (see Table 4).

### 3.4 Instrument Development: Keywords and Themes

NVivo 12.0 was used to run a word frequency test with stemmed terms to produce both an exact word count list and a word cloud (see Fig. 2).

NVivo 12.0 was used to preliminary analyze the studies using the theme auto-code function. The resulting auto-code themes were reviewed one by one with respect to the meaning and context, in order to remove and combine repeating themes, to create themes not appeared in the auto-code, to rearrange keywords to the corresponding themes, and so on. Finally, four primary concepts emerged from the keywords concerned, relating to three facets of project-based learning: *collaboration, community, design, and technology* (see Table 5).



Fig. 2 Word cloud generated from word frequency query results

Table 5 Frequency (f) table of keywords under the four main themes

Collaboration	Community	Design	Technology
Group(s)/team(s) (126)	Community/ communities (104)	Engage(ment)/ participation (61)	Online (58)
Collaborative/ collaboration (81)	Work/working (82)	Action/active/ activities (70)	Support (45)
Social (72)	Experience(s) (78)	Assessment (46)	Environment (39)
Global/international/ world (62)	Knowledge (77)	Outcomes (31)	Tool(s) (34)
(a)Cross (32)	Skills (52)	Understanding (25)	Technology (33)
	Service (51)	Self (22)	Wiki (s) (32)
	Practice (46)	Effective (17)	Discussion (18)
	Authentic/real (36)	Motivation (17)	Virtual (15)
	Professional (26)		
	Theory (25) Feedback (15)		
	Industry (14)		

\* Keywords or conceptual phrases that had a frequency count lower than 10 are not included

## **4 Collaboration**

### ***4.1 Group-Based/Team-Based Learning***

Project-based learning usually emerged as group-based learning or team-based learning for peer learners. For example, Evans et al. (2018) examined on the design and implementation of a project-based learning where female faculty and students voluntarily collaborate on extracurricular mathematical research projects (p. 287). Leszczynski et al. (2017) explored that students were asked to create a free-standing movable structure as a means of testing and applying their understanding of the theoretical and conceptual elements of the course. The instructor guided the research of the groups while providing them with guidance on the basic concepts of physics principles (p. 27).

### ***4.2 Interdisciplinary/Multidisciplinary***

On the other hand, multidisciplinary was another crucial factor in the introduction of project-based learning. This has been applied across departments, across faculties, across institutions, or even through universities, locally and internationally. Students have also served together in the classroom or through disciplines. For example, Diamond et al. (2011) carried out a cross-faculty project in which UK higher education students worked as professional developers to create innovative educational games for academic clients from other subject areas. Brewer et al. (2015) announced that six faculties from the same university worked together to incorporate virtual teams into their classrooms (p. 208).

To sum up, project-based learning has been structured to include learners from various learning styles as in a small group or team-based collaboration; various competencies and technical preparation as in interdisciplinary collaboration; different cultures and ways of working/thinking as in collaboration across countries. This main function offered a learning opportunity for learners to work together to complement each other and to solve problems from different perspectives.

## **5 Community**

### ***5.1 Authentic Learning***

In order to integrate real-life issues into project-based learning, students display greater motivation and commitment, as well as a deeper understanding of the



application of principles in real-life circumstances, as essential project results for students.

For example, in the first year of the Industrial Engineering and Management Program at the University of Minho, Portugal, Alves et al. (2016) implemented real-life PBL (p. 123). In the design of the curriculum, Svensson and Gunnarsson (2012) reported the success of the Design-Build-Test course in electronics based on professional and industry-like routines. Winther (2018) reported on a collaborative co-production film production project in which, through real-world learning processes, joyous, vulnerable, and subjectively experienced risk-filled circumstances became part of a shared creative educational journey (p. 1).

## ***5.2 Development of Communities of Practice***

PBL initiatives have fostered peer learners/professional communities of practice that have established a distinct way of learning centered on peers' similarly peripheral community involvement and have allowed students to support peers or professionals.

For example, Rand (2016) looked at a social science learning environment to create communities of practice that fostered learning experiences of students through anxiety, academic uncertainty, and emotional settlement during the learning process (p. 773). In addition, Fearon et al. (2012) have identified community practice approaches using group work emulating real-world practice to help develop transferable skills; building community membership through simulated teamwork roles encourages motivation; and group leadership helps to achieve a common goal (p. 114).

## ***5.3 Work-Based Learning with Professionals and Field Practitioners***

Work-based learning program designed to provide opportunities for effective applied learning experience where students have formed partnerships with community stakeholders, including academics, senior university managers, and employers' representatives (Smith et al., 2013).

For example, Dubus (2014) developed a project-based learning opportunity for successful applied learning experience for graduate social work students who formed a relationship with community members to support and address the social justice needs of the host community where each host community defined its own needs. In addition, Lockrey and Bissett Johnson (2013) reported on a connection between an industry partner and undergraduate students of Product Design Engineering for the Design for Environment course. Students have contributed to reducing the environmental crisis when they are based in industry, integrating credible technology options

with effective Design for the Environment methodology into the design process and outcomes (p. 70).

#### ***5.4 Work with the Local Community***

The PBL involved collaboration with the local community, and the students benefited from the experience of enhancing the learning experience of students, engaging students in broader and deeper learning concepts.

For example, Ellis and Weekes (2008) reported on a local community project where a group of students working on their master's thesis were working together on sustainable regeneration issues in a small Irish market town (p. 482). In addition, Bobroff and Bouquet (2016) reported on an outreach project where students decided on their own theme and format and ended up in a public show. Student production also covered all fields of physics, and various formats were used, including experimental devices, animation or fiction films, games, live events, photography. Kim (2018) reported a project-based community participation course in which students choose research topics that are relevant to the local community. The projects have received favorable reviews from community stakeholders and professional geographers (p. 235). Sheffield et al. (2017) reported a study in which female tertiary students were trained to mentor small groups of primary school students to complete the STEM MakerSpace project in classrooms (p. 148).

In conclusion, PBL has been widely implemented with local community initiatives, professional community partners, and community of practice creation. This increases the motivation and dedication of students. It encourages students to apply learning to real-life problems in local communities and professional communities through community projects and service-learning projects.

## **6 Design**

### ***6.1 Research Projects as the Learning Tool***

Many students experience difficulties in acquiring knowledge and skills in research methods and statistics, although basic competence in this field is central to many undergraduates. PBL has been widely used in the teaching of research methods. Students participate in research projects and learn better in a variety of ways, including a better understanding of the material, ability to write, experience in the development of experiments and/or research design, and better data evaluation.

For example, Kosinski-Collins and Gordon-Messer (2010) have implemented a project-based laboratory curriculum. Simple exercise has been found to improve students' comprehension of the content and their ability to write abstracts and solidify

the underlying relations between multi-week procedures (p. 578). Wyatt (2005) incorporated original research projects into the work of college courses. Students gain not only expertise in setting up an experiment, but also the ability to better determine experimental parameters and better interpret data in text, periodicals, and news stories (p. 83). Al-Maktoumi et al. (2016) reported on research-based arid zone hydrope-dology learning projects conducted by teams of undergraduate students. Results found a high level of student satisfaction and projects best suited to research-based learning (p. 321). Boyle et al. (2014) used a game-based approach to teaching research methods. By asking students to prepare a narrative review of games, animations, and simulations, students used their research skills to engage in the process and finally produced a synthesis of the relevant papers.

## ***6.2 As an Alternative Assessment Approach***

PBL has combined with other pedagogies to assess the competencies of students from different perspectives. Studies have also measured obstacles using PBL as a method of assessment. The evaluation is one of the main issues in the application of the PBL.

For example, Frank and Barzilai (2004) reported on the implementation of a PBL design for the appropriate research method course for pre-service teachers studying for a Bachelor of Science in science and technology education in parallel with the study of the Faculties of Science or Engineering. The final results of the project are group and individual written reports, a portfolio, a multimedia presentation, and a physical model. The study shows that PBL could be an alternative approach to assessment (p. 41). Menéndez-Varela and Gregori-Giralt (2016) looked at the validity of a rubric-based performance assessment. The achievement of the learning objectives and the proof of learning success have shown the validity of the inferences derived from the evaluation method, which should be regarded as a first-order teaching mechanism and not only a scoring tool (p. 228).

## ***6.3 Learning Outcomes from PBL***

In the design of the PBL, one of the key issues is to clearly define learning outcomes, while in the PBL process, students have a rich learning experience during the journey.

For example, Smith and Thondhlana (2015) investigated the demands of a first-year business case study group undergraduate project. The project document was found to be comprehensive and multifaceted, and the interconnected activities were highly collaborative and exceedingly complex in terms of cognitive and code difficulty and communicative stress (p. 14). Pomales-García and Barreto (2014) conducted a comparative study of student self-reflections on course projects in two engineering design courses for 161 undergraduate engineering students. Results

have shown that “application,” “true life,” “satisfaction,” and “communication” are common keywords shared in the reflection (p. 685).

## ***6.4 As an Innovative Pedagogy***

PBL has been considered as an innovative pedagogy in many empirical studies. PBL has been integrated into the curriculum as both a learning tool and an assessment tool.

For example, Kantola and Kettunen (2012) reported the design of a combined model using PBL teaching methods. The integrated model structure included approaches to innovation pedagogy, strategic higher education planning and research, growth and innovation (RDI) in order to promote the export of higher education. Findings have shown that drop-out rates have decreased; the duration of the study has decreased; knowledge transfer has increased; student supervision has increased; project students’ experience has increased employment opportunities and an integrated model of innovation pedagogy could be exported to other countries (p. 7). Altay (2014) has studied a human factors course that applies learner-centered methods to teacher-centered design. It was found that the tasks developed the knowledge, attitudes, and skills of students reflecting on themselves, their social and physical environment. Learner-centered training complements tutorial sessions and one-on-one to improve user-centered learning in various stages of cognitive and affective domains (p. 138).

In conclusion, project-based learning curricula design provides creative pedagogy rather than conventional classroom tests of predetermined responses with the only right solutions. Educators need to be more open to careful consideration in designing the learning environment so that students can achieve a rich learning experience in the learning process.

## **7 Technology**

### ***7.1 Technology-Enhanced Learning in General***

Technology can enhance the learning process. It enhances communication, collaboration, and peer interaction through the use of information and communication technology. The online and virtual learning environment provides access to learning resources at anytime and anywhere. This facilitates cooperation across campus and across countries. It also facilitates more convenient communication between students, teachers, industry partners, and community stakeholders who do not need to meet at a physical location.

For example, Tesdell et al. (2005) reported on a technology-enhanced educational reform initiative at the University of Eastern China to better prepare English majors to use new technologies for international communication, collaboration, and research. Project-based teaching has been shown to enhance learning processes and outcomes by increasing authentic engagement, allowing greater flexibility to be learned, and delivering material that is more important to students' lives and careers (p. 104). Cutrim Schmid and Hegelheimer (2014) introduced a vocational development plan that included the creation of school-based research projects that student teachers needed to design, introduce and test technology-enhanced EFL lessons in partnership with in-service teachers. School-based experience has helped them to use technology in realistic language teaching scenarios and to assess the effect of technology on language teaching and learning (p. 315).

## ***7.2 Collaborative Tool Enhancing Communication and Co-work***

Collaborative tool promotes teamwork and collaboration within and between groups and teams. It promotes communication and interaction through collaborative technology. It improves the learning experience of the project process.

For example, Van Rooij (2009) explored the impact of project management tools on the PBL. Teams engaged with interconnected conversations during the lifecycle of the project. Results showed that the project established online project-based learning and encouraged intra-team contact and constructive collaboration actions (p. 210). Kim and Lim (2018) documented a collaborative design of the PBL in a real environment. Collaborative scripts used to help socially shared metacognitive control have been shown to have a positive effect on participants' experiences in team planning and information building (p. 194). Chen and Teng (2011) reported on computerized tool support for the design, management, and maintenance of the collaborative teamwork required for senior software engineering projects. The program was found to promote cooperation and ensure that collaborative efforts were maintained during the creation of the project (p. 802).

## ***7.3 Specific Systems and Applications Enhancing Learning***

Simulation, virtual reality, and e-portfolio are some of the examples that enhance learning. They provide a rich learning experience and engage students more in learning for deeper conceptual building.

For example, Plank et al. (2011) reported on an interdisciplinary collaboration using an agent-based simulation project where students learned about complex

systems and environmental issues, including climate change and watershed protection, through a simulation game (p. 35). Morales et al. (2013) focused on project-based learning in a virtual reality class. Students are expected to program an industrial Virtual Reality (VR) machine and at least one educational application of VR where students learn independently. Project-based learning can be found to be successful even with limited instructor guidance (p. 791).

#### **7.4 Collaborative Writing Wiki**

In addition to collaborative communication-promoting tools, in particular, there are collaborative writing tools that promote collaboration, for example, Wiki has been widely used to foster collaboration among learners. Collaborative writing platform wiki allows multi-users to co-edit and co-write at the same time that all updates are preserved in history.

For example, Roussinos and Jimoyiannis (2013) reported on a wiki project designed to promote collaborative writing and learning by university students. It helped understand the commitment of students, the contribution to content, the patterns of collaboration, and content co-creation followed during the timeline of the project. Stoddart et al. (2016) reviewed a variety of collaborative wiki-based writing projects. It was found that these writing assignments support the acquisition of second language (L2), peer-to-peer learning (P2P), communication and immersion in emerging technologies that educate students' social and professional lives. The climate encourages student happiness, motivation, and learning (p. 142). Page and Reynolds (2015) documented a case study in a collaborative writing project with and across wiki contexts. Studies have shown that participation in the project has had a positive relationship with student exam success and site familiarity (p. 988).

#### **7.5 Web 2.0 Tool**

Web 2.0 promotes self-publishing, social networking, multimedia, interaction, and community building. They have been integrated to enhance PBL learning.

For example, Huang et al. (2014) reported a study in the U.S. undergraduate education system reported their impressions through online surveys using Web 2.0 applications for a major course project. Web 2.0 applications have been found to be effective in helping to complete their projects by stimulating the attention of learners and promoting their trust during the learning process. The Motivational analysis of learners has influenced learning outcomes, which has led to increased use of Web 2.0 learning applications (p. 631). Knight (2016) reported on a joint project of two arts universities to create academic learning futures using collaborative writing of a fictional story/blog. Hung and Huang (2016) reported using blogs to upload audio entries as an English-speaking learning and assessment tool. It was found

that speaking blog scores were a significant predictor of student oral presentation performance; participants viewed their blogging experience as positive; the speech blog was a good tool to showcase their learning process and help them reflect on their learning progress in a blog-based environment.

To sum up, new technologies in recent years have provided means of linking students to the completion of project-based learning, connectivity, collaboration, community building. Technology enables the process of project-based learning. It also enables communication between students in geographically dispersed locations. Access to applications allows students to learn and participate in a more secure and productive manner.

## 8 Discussion

### Four common themes emerged from project-based learning studies

This study reviewed 142 prior project-based learning studies between 2003 and 2019. Four common themes emerged, including *collaboration*, *community*, *design*, and *technology*.

#### 8.1 Collaboration

Collaboration has emerged as a common theme in project-based learning studies. The collaboration as a theme is supported by various learning theories, such as the cooperative communication in the interactionist approach of Krashen's Input Hypothesis (1985); the role of social interaction in creating the environment of learning in the sociocultural perspective in part from the concepts of Vygotsky (1978), group awareness that reveals collaborative behavior of group members and regulates their participation (e.g., Lin, 2018). A recent review of deep learning studies identifies collaboration as effective learning (e.g., Ma, 2020).

Although project-based learning can be designed as an individual project and can be completed by one student, many of the previous studies are designed to be group work or team work. This composition of teamwork is not limited to a course or program, but also applied to interdisciplinary combinations across programs/departments/faculties, campuses, or even across countries. Most of the studies have been shown to have partnerships on a regional, multinational, and global scale. The learners have different educational histories. Learners come from different cultures and work together to find creative solutions to real-life problems.

The importance of working together is closely linked to the nature of the design of project-based learning. Students do things together, and work in various areas of knowledge.

Once it comes to various activities of project-based learning, such as a social problem, a business strategy, or a theoretical analysis, things get complicated. The same aspect can be interpreted differently by learners from different backgrounds. A design student may perceive the needs of a customer in a very different way from an engineering student when designing a new mobile phone or an information technology device. A student in northern Europe may find 10 degrees Celsius very warm, but it is very cool compared to a student in Southeast Asia. The argument from a learner's point of view may be contradictory to another learner. These may be perceived as biases between one student and another student. The discussion on open-mind and biases appeared in project-based collaboration work has been shared by scholars in international forum (TurkuAMK, 2020).

Learners are doing things together. When learners exchange information, they can work together to understand from each other's lens and to understand different backgrounds and cultures. The real essence of collaboration is the need to connect to turn certain differences into collaboration. The power to turn contradictory perceptions into collaboration enables learners to understand reality from a different angle. It helps learners to bring together the profound diversity of views to create something new that the learners have not yet known. This is done through negotiation and collaboration. It is about helping learners to become critical about the differences and helping them to generate ideas through critical thinking. Learners can bring about better change, better creativity, and better solutions as a result of real collaboration.

Open mind is the key to collaboration. Learners should concentrate on potential ideas rather than disagreements within the community. The members of the group have no prejudice of any kind to the ideas that are evolving or to the ideas that the member of the group says. It is important to allow for other voices. It is not supposed to not listen to voices that do not match with our own. It should not be empowered to exclude other roles. Collaboration, doing things together, means having different positions, exchanging, or sharing the power to have a voice and to be part of the decision-making process, to be motivated by the diversity that a community brings to the process. Collaboration community gives gratitude that produces ideas, and no one prevents the flow of ideas. A community or a team is working together to evaluate the resources. The group gives passion and emotions, including discomfort, fear, or optimism. All the roles must come together to create a synergy.

Similar minds are working together. However, if the learners are not of a similar mind, that is where the challenge lies, and that is where the members of the group should have an open mind to allow collaboration to take place. To be open-minded, to share understanding, to do things together, even though they are not the expected ones. That lies the most benefits from collaboration.

In the beginning of a new project, the educators may brief the participants on the aims and the goals for collaborative team work. The educators may explain the challenges during the collaborative process. The educators may outline the effective collaborative process to the students. Only then would participants benefit immensely from collaborating.



Project-based learning requires the interdisciplinary collaboration of students who benefit from a broader perspective in solving challenges and presenting innovative solutions in the learning process.

## 8.2 *Community*

Community has emerged as a project-based learning theme. It is supported by John Dewey's educational and social philosophy which provides the theory of community service learning, including learning from experience, reflective activity, citizenship, community, and democracy (e.g., Giles & Eyler, 1994).

When educators design project-based learning curricula, they leave the traditional classroom setting. They are going to the community and they are looking for real-life problems. Educators work with professional bodies and industrial partners. They will also work with other people, such as NGOs and organizations. We address the challenges of daily life, the technical skills needed, the expertise and experience gained in solving the problems, how theory can be applied to the workplace and how practice informs education. Educators then design their curriculum to include partnerships with different stakeholders to enable learners to address real-life, genuine community issues and learn through the completion of real-life projects. Learners research real-life problems and suggest solutions to them. As they know, they also contribute to the overall well-being of the community.

Education is a matter of learning by life experience. As broad as life-experiencing learners, learners would be able to face diverse tasks, learn the necessary professional skills and experience, and be better equipped to meet the challenges of completing their studies.

The role of educators in project-based learning design is critical in coordinating and receiving input. If project-based learning is planned in collaboration with professional bodies and industrial professionals, it is about various ways beyond the conventional classroom. It is going to be challenging for working life in the real world. Industrial professionals and practitioners are people who work with challenges on a daily basis. Teachers, as teachers or as facilitators of learning, need to ask them to provide very constructive and very specific feedback to the learners on how to deal with the challenges, how to tackle the problems, or how they see the resources to solve them. If the learners propose solutions, what is the value of the solution? What needs to be changed regarding their initial proposal? Students seek input from experts and practitioners who have rich life experiences and everyday challenges. It is not necessarily a matter of judgment, assessment, score, or ranking. Students are interested in very specific remarks about what is working and what is not working, what needs to be improved. This is the process of learning.

On the other hand, this is still a purposeful learning process. Since the project is developing and operating in collaboration with real-life problems, educators are designing the environment as a learning tool. Within such a learning environment, educators need to encourage the creation of new concepts and trials. Students would

be permitted to fail and should not be afraid to fail. Students learn different skills when they are going through a failure cycle. They also learn to stand up with discomfort. Educators and community members will be able to help the trials. Educators should make clear the understanding and expectations of both students and industrial partners. Industrial partners should not expect students to work like an employee or a consultant company. Students are not expected to come up with commercial and quality final products to replace current employees.

Project-based learning is designed to collaborate with industrial partners and professional organizations so that students can benefit from project completion as a learning process.

### 8.3 *Design*

This theme emerges as a collection of different enablers in project-based learning processes. Project-based learning pedagogy is structured to inspire students to learn. Students engage in group events and participate in the learning process. This self-motivation to learn comes from several causes. The project, for example, allows students to plan their work. This autonomy gives greater satisfaction to individual learning. In fact, the idea is often followed by performances. Students are happier to come up with something that they create or construct. On the other hand, the assessment of project-based learning will be distinct from conventional classroom tasks and assignments. There should be no standard answer. Failure in the project does not mean failure of the assessment. The goal and expected outcomes should be clearly defined so that students learn and benefit from even the failure process. All of these integrate students' motivational resources into the curriculum to a success in learning that is well supported by motivational theories (e.g., Schunk & Zimmerman, 2012) and the self-determination theory which provides the explanation why autonomously motivated students thrive and it explains why students benefit when teachers support their autonomy (e.g., Reeve, 2002).

Project-based learning requires aspirations and innovation to solve real-life authentic problems with the focus on the process itself. The process should be self-organized. Students should understand that this confusion of not being told what to do is part of the learning process. Educators may provide support but should not take away the opportunity of the students to self-organize throughout the process.

Project-based learning requires aspiration and innovation to solve real-life challenges with a focus on the process itself. The method should be self-organized. Students should understand that this uncertainty over not being told what to do is part of the learning process. Educators may provide encouragement but should not take the opportunity for students to organize themselves in the process.

Project-based learning is not to repeat a traditional classroom setting of structured program, systematic content, fixed learning material, and standard answers. On the contrary, project-based learning involves real-life authentic problem in society, a lot of stakeholders where the problem can create confusion to students and the problem

can be complex and complicated. The learning should be flexible instead of organized, structured, and fixed. Assessment should not be based solely on the educators with one standard answer. Learning is not necessary to be successful, failure is also a part of the learning process.

Educators should tolerate insecurity and uncertainty. Educators might not see the results as planned or not planned but still can see that there will be good results in one way or another. Learners may learn different things as what learners think they would learn. Educators do not have to plan everything very seriously and in detail. Still, learners learn a lot of things and gain competences that learners will be able to use in future working life when they graduate from the institute as a learner.

Educators should design the curriculum to provide support, with a community of learners and a community of learning. Learners are being able to trust that community and go through challenges. That does not mean to have one correct ready solution but the awareness of having to come out with the solution. It is about having community to do it with the learners of not being alone. It is about the connection, the support and the network of support, the tools the learners have, being supported and being prepared with tools, with resources, with having the views from the peer learners.

Project-based learning is designed to give students autonomy and motivate them to prepare, coordinate, carry out their work, and to enable students to develop and acquire skills in the process, irrespectable to the final success or failure of the project itself.

## **8.4 Technology**

Technology emerges as one of the themes in project-based learning. Many project-based learning develops online and virtual learning environment that support interaction, communication, collaborative learning, and the sense of online learning community. This theme aligns with the arguments and evidence of prior studies on learning theories that the role of technology enhances learning (e.g., Gunawardena, 1995; Roberts, 2004; Warschauer, 1995).

Learners make use of the tools available to interact with other members. Learners join discussion forum to share learning experiences. It is because of the online learning environment, learners are able to communicate with other learners from other departments, other campuses, and even other countries. Online learning environment provides support for learners to communicate at any time and at any place. With the online learning environment, learning communities are formed. Members may come from different year of studies or different disciplines. Learners may support each other in various ways. There is also project-based learning designed to incorporate professional field practitioners. They act as mentors and provide practical feedbacks while projects are in process. There are also specific applications that facilitate communication and collaboration. For example, social media such as Facebook, Twitter, blogging are incorporated into the projects to enhance communication

among the learners; wikis are incorporated to enable collaborative writing for project work, self-reflection, and co-designed instructional guides.

It is because of emergent technology nowadays, in education, we have different platforms, different tools in ways to engage students. However, technology may also give fear that is not going to work. Learners in the group may feel lost. Learners should give very hard work putting people together to understand what is important. Therefore, it is important to understand why students do not use technologies offered to them; what kind of problems students meet in using the technologies; what support students expect to receive in order to fully utilize the technologies.

In the review of the project-based learning studies, many different types of technologies and applications were found to be developed and applied to facilitate students' learning and to engage students. For example, there are simulation applications to help students visualize the industrial environment they need while staying inside a traditional classroom. When students work on real-life projects, this helps a lot. Students do not need to go to the work sites every time. Students are able to understand the real-life problems and develop their prototypes during the process. They can then test their work at the very end of the process. Similarly, there are other studies adopted virtual reality/augmented reality applications that provides similar effect to help students understand the real-world context. Students can practice as many times as possible until they are familiar with the situation, before they really need to go to the work sites at a later stage.

Wiki has been suggested in a few project-based learning studies. Wiki is a collaborative writing platform. Students can create pages, edit content, at any time and at any place. It supports co-editing simultaneously. In many of the collaborative writing tasks, wiki provides a perfect platform for students to work together. There are several studies involved students from different places or countries. Wiki allows them to write at different time zone that the writing always grows: while one sleeps, another student is working alternatively.

In recent years, the mobile phones become the most convenient tool to access these applications and platforms at any time and at any place. A mobile phone functions the same, or even better at times, than a desktop computer. It facilitates communication, collaboration, and support always. Its ability to search for information around the globe enhances knowledge sharing and transfer throughout the project process.

Technology facilitates social contact, interacts, and offers encouragement to a group of learners. This is an important enabler in the design of project-based learning and in the learning process.

## ***8.5 Limitations and Further Studies***

This study reviewed project-based learning studies published in the past twenty years and included in a single multidisciplinary database. The review is not exhaustive. Further studies could conduct similar reviews using other databases to examine whether the same conclusions could be found in order to expand the applicability

and the generalizability of the results of this study. An additional limitation, as in other qualitative studies, is that the instrument developed for analysis might have involved the subjective judgment of the researcher, leading to validity issues in the different parts of the analysis process: the generation of keywords, the grouping into categories, and the extraction of the main themes. Further studies in the area could increase the generalizability of the results. This highlights the importance of evaluating the logic and reasons used to explain the relationship between the keywords and project-based learning. This study has attempted to cite the findings and arguments from selected references to provide the rationale behind the analysis. Therefore, the various learning theories have been cited to support the findings in this study in spite of the limitations in the research process.

## 9 Conclusion

This study sampled project-based learning studies in the last twenty years and came up with four themes identified in these studies, namely, collaboration, community, design, and technology. The studies reviewed demonstrated empirical evidence that shows the enablers and project-based learning. This study contributes to a better understanding of project-based learning: it defines the design strategies that are useful for achieving the ultimate goals of project-based learning, identifies the factors that explain project-based learning, and summarizes the effects of project-based learning.

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