HONG KONG JOURNAL OF SOCIAL SCIENCES

香港社會科學學報

第一的第 58 期 (2021 春/夏) Vol. 58 Autumn/Winter 2021

Open Access Article

Implementing IBL in Teaching Project Courses: Experiences and Advice

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Received: October 15, 2021 ▪ Reviewed: November 17, 2021

▪ Accepted: December 23, 2021 ▪ Published: January 28, 2022

Abstract:
Information and communication technology have produced changes in the demands of modern-day society and have negated the effects on students in classrooms. Encouraging students to be active, team leaders, and responsible is one of the challenges of higher education. The inquiry-based learning (IBL) approach is one of the techniques recently used to make students take the initiative and be active. However, little research has been done on the experiences of using IBL in teaching project courses in higher education, particularly for diploma students. This study aims to discuss applying inquiry-based learning in teaching project courses and the implications of employing PBL in teaching diploma students. The novelty of this study lies in applying this strategy to associate degree students. There are inadequate studies for this degree. Most researchers and studies that have applied inquiry-based learning approaches focus on bachelor's and higher-level degrees. These studies are needed to improve the outcomes of project courses at community colleges and technical colleges. This article will discuss the impact of the implementation of inquiry-based learning in the teaching capstone project course in detail. The application of this approach shows better academic results than traditional lecture-based teaching. In addition, students' soft skills were improved successfully. Finally, the students' responses were positive and motivating.

Keywords: inquiry-based learning, teaching, project course.

在项目课程教学中实施IBL：经验与建议

摘要：
信息和通信技术已经产生了现代社会需求的变化，并否定了对课堂学生的影响。鼓励学生积极主动、团队领导和负责任是高等教育的挑战之一。基于探究的学习（IBL）方法是最近用来使学生主动和积极的技术之一。然而，关于在高等教育项目课程教学中使用IBL的经验的研究很少，特别是对于文凭学生。本研究旨在探讨探究式

学习在项目课程教学中的应用以及在文凭学生教学中采用PBL的意义。本研究的新颖之处在于将这一策略应用于副学士学位学生。该学位的研究不足。大多数应用基于探究的学习方法的研究人员和研究都集中在学士学位和更高级别的学位上。需要这些研究来改善社区学院和技术学院的项目课程的成果。本文将详细讨论探究式学习在教学顶点项目课程中的影响。这种方法的应用显示出比传统的基于讲座的教学更好的学术成果。此外，学生的软技能也得到了成功的提高。最后，学生们的反应是积极和鼓舞人心的。

关键词：探究式学习、教学、项目课程。

1. Introduction

Students could be better prepared for innovation in the workplace by following an inquiry-based learning approach (IBL), which mimics the processes scientists use to construct knowledge (Oguz & Aybars, 2019).

An IBL methodology and the implementation of an SRS using technological applications were used to compare a traditional lecture method with an innovative one (Tirado-Olivares et al., 2021).

The IBL structure is also used when teaching mathematics. Branwen (2021) explored the relationship between students' social and mathematical experiences in the classroom and the IBL structure.

In order to make PBL more accessible to math teachers, this study merges several existing PBL frameworks with the various recommendations for math education into one framework of core teaching practices for implementing PBL in a math classroom (Borden, 2021). There are very strong PBL frameworks for teachers who wish to learn how to use PBL to teach math, such as the Gold Standard PBL Teaching Practices and Design Elements (Larmer, 2019).

A learning environment allows for asking questions, making inquiries, forming hypotheses, and collecting data. To provide students with an environment like this, inquiry-based learning (IBL) is a very effective approach. Using interactive learning, students can relate their prior knowledge to scientific definitions of concepts (Xingwei & Liang, 2021). Çiğdem et al. (2021) investigate how simulations support inquiry-based learning with pre-service teachers in conceptual understanding of capacitors.

Throughout this study, we reviewed and analyzed 31 empirical studies (34 articles) that investigated mIBL in secondary school science education from 2000 to 2019. In addition, we explored which types of mIBL exist and how mIBL can benefit secondary school science education (Caihua et al., 2020). In recent years, growing support for IBL has been noted in science education due to its potential for facilitating more positive student attitudes toward science and a deeper understanding of scientific concepts (Shreenath & Gayana, 2021; Suárez et al., 2018).

Therefore, using the IBL approach to encourage students to be active, responsible, and participate in the classroom is crucial. Furthermore, it will assist the administration of academic institutes in making pedagogical decisions when designing the teaching strategies for curriculum content, which will lead to achieving good outcomes according to the learning objectives of the course and the program, and for the whole institute.

2. Methodology

The main objectives of this study are:

1. To explain how to use the IBL in project courses;
2. To discuss the effects of using PBL in teaching;
3. To evaluate the quality of the PBL approach;
4. To develop a recommended model based on the study findings.

There are five types of IBL. Every type has its features and characteristics. In this study, we used project-based learning, a dynamic classroom approach in which students actively explore real-world problems and challenges and acquire deeper knowledge. The summary of the IBL types and the type used in this article are shown in Fig. 1.

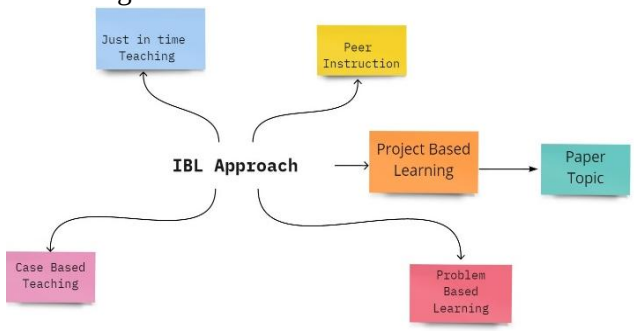

Figure 1. IBL types

3. Project-Based Learning

We implement this approach in the capstone project course. In this course, the students work in teams on an applied real-world problem of their interest and go through its software development lifecycle to develop a prototype software solution for the problem at hand. The capstone project offers the opportunity to integrate the knowledge acquired in preceding courses and promote and instill communication and writing skills and lifelong self-learning.

In the traditional teaching approach, the key element is the teacher, but in the IBL approach, the key element and the main player is the student. First, the teacher/instructor has to provide the case study, problem, and observation, and the student should investigate, search, and explore

their findings. After that, the instructor should guide them without answering their questions. The main idea of using the PBL is shown in Fig. 2.

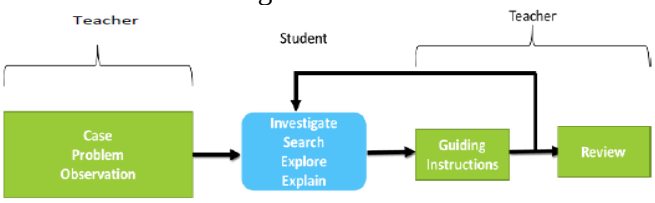

Figure 2. PBL main components

Eight essential elements of project-based learning will be covered throughout the semester. Students should search, work, design, discuss and submit different reports/presentations to satisfy each essential element (Table 1).

Table 1. PBL essential elements and the required reports

Report	PBL Essential Element
Report 1	*Challenging problem or question:* The project is framed by a significant problem to be solved or a question to answer. *Prototyping phase:* In the prototyping phase, students design and develop their ideas into a solution, product, or artifact to quickly convey how a solution to the problem might look and feel. A prototype might take many forms: a mock-up, a storyboard, a role-play.
Report 2	*Sustained inquiry:* Students engage in a rigorous, extended process of posing questions, finding resources, and applying information. The instructor creates a driving question that guides the project work, creating interest and a feeling of challenge.
Report 3	*Student's voice and choice:* Students make some decisions about the project, including how they work and what they create, and express their ideas in their voices.
Report 4	The learning goals are central to the project assignment. The project begins by establishing the expected outcome(s) and creating a learning journey whereby students encounter and assimilate ideas of relevance to a topic.
Report 5	*Reflection:* Students and teachers reflect on the learning, the effectiveness of their inquiry and project activities, the quality of student work, obstacles that arise, and strategies for overcoming them.
Report 6	*Critique and revision:* Students give, receive, and apply feedback to improve their processes and products.
Final Presentation	*Public product:* Students make their project work public by sharing it with and explaining or presenting it to people beyond the classroom.

4. Effects of Using PBL

Using PBL was an excellent experience for the author as an instructor and the students. The summary of how the PBL affects the students are summarized in the following figure:

Figure 3. PBL effects

The most important effect of PBL is that the students' awareness of self-learning is increased. Students should read, research, analyze, explore, design, develop, and present. So they have to become self-learners. Students who take this course's "capstone project" are in the final semester of their associate degree, even though they have learned how to search for the idea, do the literature search, summarize and analyze the solutions.

Because of using PBL, the author asked the students to work as a team. We had 2-3 meetings every week, and the author asked every group to present their work in front of other groups. In this way, every student in the group should have contributed to their work. So it is obvious that students improved their skills to be effective at working as a team and be responsible. More than that, students like sharing their knowledge and ideas in the meetings. Sharing knowledge and ideas among students leads to improved relationships between them and between the instructor and the students. Students felt that all of us were concerned about gaining the knowledge, learning, and contributing, not how to submit the report and how the instructor graded it and sent the grades back to students. In summary, we can say that we succeeded in breaking the wall of traditional teaching.

5. Evaluating the Quality of the PBL Approach

The university conducts the survey to measure the effectiveness of using IBL in teaching.

Student responses are mostly based on 5-point Likert Scale ranging from strongly agree to strongly disagree:

- Strongly agree;
- Agree;
- Neutral;
- Disagree;
- Strongly disagree.

Collected responses were counted and then converted in terms of percentages. In addition, to have a better understanding of students' responses, "strongly agree" and "agree" responses were merged into "agreed." "Strongly disagree" and "disagree" were merged into "disagreed":

- Strongly Agree + Agree (or good & satisfactory) = Agreed;

- Strongly Disagree +Disagree = Disagreed;
- Neutral.

6. Survey Questions

The survey was designed to cover active partition, responsibility, curiosity to explore the subject, realizing the importance of questions and questioning, skills in analysis and reflection, and linking course topics to real-life issues. The author looks forward to other courses using the IBL method.

7. Students' Feedback

From Fig. 4, it is obvious that students are very satisfied with using the IBL in teaching project courses. The following figure shows the percentage of every question in the survey. Comments of the students are as follows:

- *Developing a sense of responsibility for the student:* The student will feel more responsible for their work. They will know when they are ready to present it, what they must do, and how to use different research methods to help them achieve their goal;
- The student extracts his capabilities in his field, as a person may not appreciate his capabilities, and this method identifies the student's strengths and weaknesses.

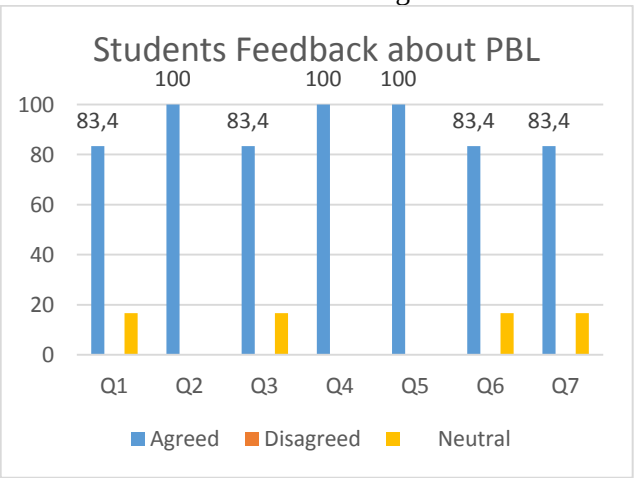

Figure 4. Students' feedback about using PBL

8. Conclusion

To the best of the author's knowledge, studies that use inquiry-based learning in community colleges are inadequate, especially in Middle Eastern countries. The novelty of this work is the implementation of IBL in the capstone project course. This approach is called project-based learning (PBL); it is a part of IBL. This approach consists of eight elements. The challenge is to employ this approach to create a course that will satisfy all elements that accommodate the requirements of the associate degree students while improving the level of the students to conduct research and develop projects by implementing this approach.

As a capstone project teacher, the author noticed that inquiry-based learning (IBL) effectively stimulates students to develop, discuss, analyze, and comment on explanations. During the semester, the author observed the effects of inquiry-based learning in the author's classes. In inquiry-based learning, the author found that the essential attributes connect previous knowledge and experiences with the problems learners have designing procedures to find answers to the questions, then search for the solutions and develop the system. Addressing the gap in educational research at the community college level is a crucial issue. So, this article will contribute to enhancing teaching project courses with an interesting approach that will improve students' ability to search, think, and design.

All students believe that they are satisfied with using IBL in teaching. They also highly appreciate the work of the instructors that prepared all the activities for this type of teaching. They are satisfied with their performance and the skills they have learned and improved. The existing traditional teaching methods are not efficient with information and communication technologies. This reveals that the PBL is more effective than the lecture method in teaching project courses. Fig. 5 shows the recommended model to enhance the IBL in teaching PBL. In this recommended model, students will investigate, search and explore, then submit a draft version of the report or work. Then, based on the instructor's guidance and the sharing session with students, they will do another round and submit the final version.

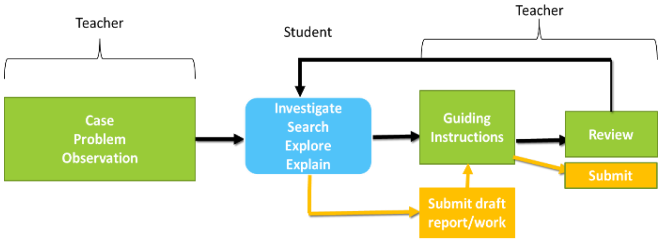

Figure 5. A recommended model to enhance the IBL in teaching PBL

Even though the findings of this study were satisfactory, using IBL in capstone projects can present some limitations. For example, students involved in inquiry-based learning are essentially learning how to learn, which is a very difficult skill to master. Having IBL can be a particularly difficult process for low achievers. There is much planning and preparation involved in an investigation. This approach does not work properly if there are many students in the class.

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