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Steps and Challenges of Problem-Based Learning

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Abstract

Problem-Based Learning (PBL) was designed to reduce the hours of conventional lectures in McMaster university, Canada. It is not only providing a lively learning process, but also student-centered approach. Therefore, PBL is considered a tool for the 21st Century skill development (Suwastini et. al., 2021). PBL is not only enabling students to gain their knowledge through self- direct learning, but also other necessary skills, such as, cooperative learning, critical thinking and problem-solving skills (Hung, Jonassen & Liu, 2008). This article aims to elaborate on the seven steps of PBL, roles of teacher and learners in the PBL process, its challenges and how to overcome obstacles for each step of PBL. Furthermore, the PBL implication is also presented in this article.

Keywords: Problem Based Learning, 21st Century skills, Student centered, Self- directed learning

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Background

Problem-Based Learning (PBL) is a student-centered approach which enables students to develop their problem-solving skills. PBL allows them to research relevant knowledge and evidence, as well as apply their findings to resolve a problem in practice (Savery, 2015). Although there are several PBL concepts available, the most popular one is from the medical school at McMaster University in Canada. The use of PBL at McMaster University was launched in 1960's by Howard S. Barrows, who aimed to improve teaching methods for medical students. Instead of conventional lecturing without patient context, he assigned a clinical problem with patient context. Therefore, students could learn from the PBL process by making a decision involving patients based on their knowledge, evidence, and problem-solving skills (Norman & Schmidt,1992; Savery, 2015; Puttiwanit et al., 2020).

It is vital for current education to prepare students for 21st century learning by teaching them self-directed and lifelong learning skills (Puttiwanit, et al., 2020). Furthermore, PBL could influence students to have more long-term knowledge retention than conventional lecture. PBL not only helps students to learn from real-life situations, but also enables them to gain problem-solving skills and experience working in teams (Murphy et al., 2011). Researchers found that learners significantly improve their cognitive skills more using PBL compared to those using usual, lecture-based learning styles ($t = 7.23$, $p < .001$) (Boonpleng et al., 2018).

The three main criteria for Problem Based Learning education

The Department of Chemical Engineering at McMaster University (2022) indicated the three main criteria for PBL education are small group learning, student self- directed learning (SDL), and student self-assessment. Here are more details on each of the three criteria:

1) Small group learning with a student and teacher ratio of 5-7: 1 is recommended (Department of Chemical Engineering, McMaster university, 2022). This is good for building rapport between students and teacher because they could know each other perspectives and preference in a small group discussion (Sybing, 2019). Furthermore, group learning could pressure students to actively do complete the self-study assignments and submit their works on time (Schmidt et al. 2011).

2) Self-directed learning (SDL) is crucial for influencing student centered learning (Department of Chemical Engineering, McMaster university, 2022). Teachers need to assess students regarding learning concepts, knowledge gaps, and missing concepts. This enables teachers to know which topics that students should be required to self-study (Strobel & Van Barneveld, 2009). Teachers act as facilitators who influence students to learn from a problem with real- life context. The teacher does not judge whether the students' decisions are right or wrong, but instead focuses on the students' learning process and building of skills afterwards (Savin-Baden, 2001; Savery, 2015). Evidence shows that PBL helps students to better understand and connect the PBL case to real-life, for example, using a case of psychiatric patient scenario based on a real patient case (Norman & Schmidt,1992). Therefore, students also better retain contents and improve their practice skills (Strobel & Van Barneveld, 2009; Lobuteva et al. 2019).

3) The PBL process also helps students develop the important 21st Century skills of self-assessment. The importance of this step is to improve student's learning by developing student self-motivation, self-confidence, helping students to see where they are (Woods, 1996). Specifically, students could practice their reflective thinking, analytical thinking, critical thinking, problem-solving skills, cooperative learning, and holistic thinking skills

(Blumhof et al. 2001; Savin-Baden, 2001; Hung, Jonassen, & Liu, 2008). Therefore, the key principles for student self-assessment should be a clear purpose and measurable as well as based on variety of performances and evidence (Woods, 1996).

Preparation for PBL process

The crucial preparation for PBL teaching could be categorized into four groups: 1) learner, 2) teacher, 3) infrastructure and learning resources, and 4) problem or scenario that students will address in the PBL process.

4.1 Learner

Learners should be informed about course objectives and course behavioral objectives. Therefore, they could prepare themselves for their roles in advance. This could help them to achieve learning outcomes more successfully than if they were not aware of expectations ahead of time (Puttiwanit, et al., 2020).

4.2 Teacher

Teachers should be trained in advance with regard to these topics:

1) Teachers need to emphasize the concept of problem solving as a starting point. They should encourage learners to combine existing knowledge with new knowledge in order to create a novel body of knowledge to solve problems together within their group. The teachers facilitate the learners to learn through PBL process, rather than focusing on the answer. Teachers encourage students to develop their skills in problem solving, creative thinking, critical thinking,cooperative learning, and self-directed learning. In this way, teachers promote authentic student-centered teaching and learning (Puttiwanit et al., 2020; Department of Chemical Engineering, McMaster university, 2022).

2) Teachers must adjust to being facilitators, instead of lecturers. Teachers create a non-threatening atmosphere and provide formative feedback to reduce possible group tension (Wood, 2003; Puttiwanit et al., 2020).

3) Teachers need practice in creating scenarios, piloting them with a PBL teaching team, and refining their scenarios. A team of teachers can write and give tutor notes to each other. Each teacher can revise their scenario incorporating peer feedback before implementing their scenarios with students (Wood, 2003, p.329).

4) The teachers are not only required to have a broad knowledge of the changes in the social context. They also need to have knowledge of health systems, society, culture, factors contributing to physical and/or psychiatric disorders (Puttiwanit et al., 2020). This will enable teachers to apply these concepts when planning their PBL activities in detail.

4.3 Infrastructure and learning resources

Teachers need reference lists regarding textbooks, hard copies of relevant nursing journal articles, databases for electronic health sciences journals, and websites that are relevant for self- directed learning. Teachers and students all need adequate computers and Internet access to complete online searches.

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4.4 Scenario that students will address during PBL process

Scenario design is crucial for assisting learners to acquire a variety of knowledge. Wood (2003) and Hmelo-Silver (2004) indicate seven criteria to develop a good scenario for the PBL process. The criteria are: 1) identifying learning objectives in advance, 2) using an authentic scenario, 3) adapting the scenario to the students' prior knowledge level, 4) engaging students in discussion, 5) leading students to identify appropriate issues that require more learning, 6) stimulating self-directed learning (SDL), and 7) creating an interesting scenario.

The seven steps of PBL process and roles of teachers and students

Teachers and students participate in the seven steps of the PBL process. We provide greater details about the teachers' role, students' role, as well as potential problems and solutions for each step in the tables below. We suggest weekly timeline in which these steps can be completed.

Week 1: Processing step 1- 5

Step 1: Clarifying unfamiliar terms of PBL

Teachers' role	Students' role	Potential problem and possible solution
Presenting the scenario by video clip or paper-based scenario.	Watching video clip or reading a paper-based scenario with other members in the group.	**Potential problem**: Teachers tend to be lecturer instead of a facilitator. **Possible solution:** Teachers provide students with prompt questions in a PBL manual instead of giving a lecture.

Step 2: Problem definition

Teachers' role	Students' role	Potential problem and possible solution
1. Emphasizing student centered learning by motivating students. Asking questions related to the scenario. Encouraging them to identify what they have observed and discuss observations among themselves. 2. Encouraging students to express their opinions and listen with intention. Provide them positive feedback when learners demonstrate the desired skills based on learning outcomes.	1. Assigning responsibilities within the group regarding head of the group, secretary, and members. 2. Identifying issues from the scenario. 3. Sharing and discussing opinions among group members.	1. **Potential problem**: Teacher centered learning. **Possible solution:** Providing a manual and prompt questions for in-depth discussions. 2. **Potential problem:** Students remain silent and find it difficult to have a group discussion. **Possible solution:** The teacher asks the students to share their previous experiences related to the scenario. For example: Have they encountered a

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	Teachers' role	Students' role	Potential problem and possible solution
3.	Summarizing and expanding on students' opinions.		situation similar to the PBL scenario? If yes, how was it similar?

Step 3: Brainstorming

The learners brainstorm to analyze the problems and to search for possible causes or contributing factors for the problem based on the group members' prior knowledge. This is collaborative learning that uses rational thinking. Students practice summarizing knowledge and concepts of the group members to solve their problem. Students create a reasonable proposal to solve problems and/or possible hypotheses for why their problem occurs. Students may use a mind map as a tool (Boromarajonani College of Nursing Sawanpracharak Nakhonsawan, 2018; Department of Chemical Engineering, McMaster university, 2022)

	Teachers' role	Students' role	Potential problem and possible solution
1.	Encourage students to express their opinions about problems they are interested in and want to learn.	Sharing opinions and asking questions. Encouraging each other to learn within the group.	**1. Potential problem:** Some questions and analytical information do not cover the key points. **Possible solution:** Teachers provide hints for students to give them possible directions, but do not lecture. 2. **Potential problem:** Some students are silent, but some are dominant. **Possible solution:** Teachers treat each student equally. Encourage silent members to speak up by using questions for all group members. For example, "Do you agree with your peers/group members? Why or why not?" Silent learners may not want to voice their opinions because they fear their opinions would be rejected. Thus, it may be helpful to explicitly ask for all members to provide feedback. Furthermore, the "think, pair, share" technique is a good option for encouraging group discussion (Vicki et al., 2016).
2.	Provide additional information for the scenario.		

Step 4: Analyzing the problem

The group of learners brainstorms, proposes possible solutions, and hypothesizes different reasons for the problem based on scenario. The group prioritizes solutions and hypotheses based on the learners' prior knowledge. This process should emphasize rational thinking and student expression. Furthermore, students can outline additional content that they need to research using a mind map. Therefore, this process helps students obtain accurate data and complete information before presenting it to the group members (Boromarajonani College of Nursing Sawanpracharak Nakhonsawan, 2018; Department of Chemical Engineering, McMaster university, 2022).

Teachers' role	Students' role	Potential problem and possible solution
1. Encourage students to make assumptions and propose learning topics. 2. Appraise mind maps and point out the similarities and differences of each mind map with learners. 3. Encourage learners to suggest what they need to explore further and search from different sources of knowledge.	1. Hypothesize the causes of the problem(s)/ topic(s) and the person(s) involved in the scenario. 2. Prioritize the interesting and important issues for 3-5 problems. 3. Indicate the learning topics and identify sources of knowledge. 4. Create and present mind map of the group. 5. Manage and assign topics for further information searches.	**Potential problem:** Students may identify missing issues or topics which require further study. **Possible solution:** The teacher gives an example of a hypothesis and learning topic or factors that may be related to the problem.

Step 5: Formulating learning objectives/issues

Students indicate learning objectives and issues for their PBL scenario. They use the objectives to search for relevant groups of information. In addition, the first round of student self-evaluation and reflection regarding on their work and the PBL learning process should be undertaken at this stage (Boromarajonani College of Nursing Sawanpracharak Nakhonsawan, 2018; Department of Chemical Engineering, McMaster university, 2022).

Step 5: Formulating learning objectives/ issues

Teachers' role	Students' role	Potential problem and possible solution
1. Assist learners to achieve learning objectives by designing the strategies that are focused, achievable, complete/ comprehensive and appropriate (Wood, 2003, p.329).	1. Evaluate the satisfaction of their own work, the PBL learning process, and behavior while working together in groups.	**Potential problem:** Learners are reluctant to assess the group teachers because of fear of bias in the assessment of scores. **Possible solution:** Use online survey and conceal the names and identity of the learners for

Teachers' role	Students' role	Potential problem and possible solution
2. Ask students to reflect on the PBL learning process and working in groups. 3. Ask students to evaluate and feedback themselves. 4. Give positive reinforcement, such as complimenting and encouraging learners based on their individual behavior.	2. Give feedback to the group teacher.	confidentiality and obtain information for further development.

Week 2: Processing step 6

Step 6: Self-study/ Self-directed learning

Learners collect information from the media and various learning resources related to the learning objectives before participating group discussion (Boromarajonani College of Nursing Sawanpracharak Nakhonsawan, 2018; Department of Chemical Engineering, McMaster university, 2022)

Teachers' role	Students' role	Potential problem and possible solution
Give advice and help students to examine learning resources which students search for.	Research for knowledge on assigned topics through information sources such as libraries, online media, experts, etc.	**Potential problem:** Learners choose information from untrusted sources of knowledge. **Possible solution:** Teachers suggest ideas on how to select trustworthy sources for credible references. During the first week that students are researching their problem, check resources and give advice to the students both face-to-face and online discussions.

Week 3: Processing step 7

Step 7: Reporting and group shares results of their private study

Learners present information obtained by researching various sources of information, media, and learning resources that are relevant to the learning objectives (Wood, 2003, p.329) . The students test their hypotheses by using the obtained information and connecting to new knowledge. They present and exchange knowledge including a comparison of research data related to their learning goals (Boromarajonani College of Nursing Sawanpracharak Nakhonsawan, 2018; Department of Chemical Engineering, McMaster university, 2022).

Teachers' role	Students' role	Potential problem and possible solution
Arrange learners to present information that they have researched. Encourage the group members provide feedback on the missing parts that students need to address to achieve their learning objectives.	1. Present the information that has been assigned. 2. Do self-assessment regarding ones' own performance according to learning goals for validation and completeness of work.	**Potential problem:** Students do not research and/or present their work. **Possible solution:** The teacher askes for reasons to come up with a solution to the problem together, but do not blame the students.

PBL Learning evaluation by the instructor

After completing the PBL process, the instructor should do authentic assessment of the practice by evaluating the learners' behaviors while participating in the group activities. Teachers should observe systematically. They should assess the skills of student group members regarding their performance on expressing their opinions, group work collaboration, and punctuality (Puttiwanit et al., 2020).

Challenges and limitations of Problem Based Learning

The challenges of PBL comprise of transitioning learning process from conventional learning process to PBL; student-centered learning process. The teacher may explain and teach students if he/she found that the students lack of knowledge. Hence, the teachers need to be trained how to use appropriate prompt questions (Boromarajonani College of Nursing Sawanpracharak Nakhonsawan, 2018; Department of Chemical Engineering, McMaster university, 2022). Group dynamic could cause negative experiences during conducting PBL process, for example, blaming to each other (Ramlo, Salmon & Xue, 2021) and some students do not clear what they are required to do in PBL (Belland, Glazewski, & Ertmer, 2009). Furthermore, discrepancies of PBL assessment between students and teacher could be an issue because students tend to perceive their capabilities slightly higher than the teacher (Machado, Machado, Grec, Bollela, & Vieira, 2008). Therefore, the focus of assessment tool is crucial (Hung, Jonassen & Liu, 2008). Although PBL is recognized as a good process to improve student's knowledge retention, it may not suitable for a general education subject (Van den Bossche, Gijbels & Dochy, 2000). Evidence shows that basic knowledge scores of students with conventional learning are better than PBL students who are good at clinical reasoning skills (Nendaz & Tekian, 1999; Hung, Jonassen & Liu, 2008).

Conclusion

PBL is a learning tool to improve the 21st Century skills regarding critical thinking, problem solving, and communicative skills through resolving a realistic problem in a collaborative group setting (Ali, 2019; Suwastini et. al., 2021). In PBL, the teachers' role is not lecturing but facilitating the students to learn and achieve desired learning outcomes based on the scenario (Suwastini et. al., 2021). Our paper summarized seven steps necessary to achieve the desired goals of PBL. We also explained the different teacher and student responsibilities, roles, and actions needed to accomplish successful PBL. Finally, we indicated challenges and limitations of PBL. Therefore, it is necessary to well plan scenario, and train PBL teachers prior to apply it in a real class.

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