Going Remote during COVID-19 Pandemic: Effects of Problem-Based Learning towards Improving Students' Critical Thinking and Problem-Solving Skills

Low Kah Choon*1, Siti Syuhadah Mohamad2, Chong Say Lee3

1,2 School of Government, Universiti Utara Malaysia, UUM Sintok, Kedah, Malaysia
3 Independent Researcher, Kedah, Malaysia

Corresponding Author: *kahchoon@uum.edu.my

Article History: Received: 10 November 2020; Revised: 12 January 2021; Accepted: 27 January 2021; Published online: 05 April 2021

Abstract: COVID-19 pandemic spreading all around the world, the higher learning institutions were forced to shut or limit the person in contact to control the spread of diseases. Under this circumstance, remote learning that emphasized learning via online setting embraced in higher education to replace the physical classroom during the pandemic time. This study designed a single Problem-Based Learning (PBL) module using remote learning to examine the students experience in PBL, and to what extent the PBL module helps students to improve their critical thinking and problem-solving skills. The remote learning PBL module conducted using reflection method to assess the students' experiences in PBL learning. On the other hand, a set of survey questionnaires was distributed to 34 undergraduate students to gather the responses for the assessment of critical thinking and problem-solving skills. This study employed both quantitative and qualitative analysis to investigate the students' critical thinking, problem-solving skills and their experience in remote learning PBL. Using paired sample t-test to test the difference between pre- and post- remote learning PBL class, results indicated that there was a significant improvement of students' critical thinking and problem-solving skills after remote learning PBL class. On the other hand, thematic analysis on students' feedback on remote learning PBL class first, second, and third meeting, indicated that students gradually improved their critical thinking and problem-solving skills. Although students implied positive feedback on the class, however, some of them were facing difficulties in understanding the module or physical disruptions that distract their learning. The findings gave insights for the lecturers to design a suitable learning course during the pandemic time. Moreover, the findings highlighted challenges that gave insights for the lecturers to look at the students' feedback from time to time to improve the learning mechanisms and to create a better learning environment.

Keywords: Remote Learning, COVID-19, Problem-Based Learning, Critical Thinking Skills, Problem-Solving Skills, Students

1. Introduction

The employers in Malaysia were facing challenges to find the right candidates with the skills that meet their operational requirements. According to Hays Asia Salary Guide 2019, there were 46% of employers not confident in recruiting candidates that have the required skills. Indeed, this report cited that employers in Malaysia are looking for candidates' aptitudes in problem-solving, team working, and critical thinking. From the report, it indicated that problem-solving skill is featured in the top three priorities as the most desirable
employability skills. Problem-solving skills required critical thinking ability. However, a study on the state of critical thinking among Malaysian students ranged from low to moderate level (Fadhlullah & Ahmad, 2017). The disparities between the employers’ expectations and students’ ability revealed that there was a gap in the employability skills and suggesting that universities were necessarily to nurture students for developing abilities that are critical to the labour market.

The COVID-19 pandemic has resulted in the public university shut temporarily across the country. The virus recorded high transmission risks because it was spread between people via the fluid produced by sneezing, coughing, and talking. This so-called airborne virus resulted in people to keep social distancing and caused the university to shut temporarily to control the spread of the disease. The temporarily shut of universities caused the teaching and learning disrupted, and the lecturers were urged to find the learning methods that suit the current situation. The remote learning was seen as an alternative solution for lecturers and students to an immediate problem (Rahiem, 2020; Ghazi-Saidi et al., 2020).

Remote learning was closely related to distance education. In general, remote learning employed similar pedagogy with distance education whereby the distance in time and space between learners and learning resources exists between lecturers and students, but, Bozkurt and Sharma (2020) argued that remote learning and distance learning are not equal. Indeed, distance learning was more systematic where the teaching and learning were designed to encourage learners' interaction and learning was enhanced with the use of wide-spectrum technologies during the process (Greenberg, 1998).

During the pandemic, the teaching methods in higher education institutions forced to adopt the remote learning immediately without proper planning and the learning system was not ready in place (Bozkurt & Sharma, 2020). In this regard, remote teaching was the temporary solution during the pandemic to provide access to instruction and instructional supports quickly during the crisis (Youmans, 2020). The shift of face-to-face instructional mode to remote learning mode has placed the technology as the technology-centric solutions. Weller (2020) indicated that we have to be cautious and not to set hopes on technology and wishing it acts as the only solution to cure all education problems. The technology was only a tool, and students should not learn from technology, but rather, learn with technology. In this regard, remote learning was not just a tool to solve the current crisis, but it should design in the way that emphasized the learners’ learning experiences that can enhance the learning of the learners.

The world is changing, and we do not know when the pandemic ends, or maybe there is another pandemic that will hit our life and changes our lifestyle. Thus, remote learning should not be treated as a temporary solution. Designing a good remote learning education setting is a must to ensure the sustainability of the education system. In the current situation, remote learning is more on one-way interaction, where lecturers instructed the learning module in front of a webcam and the students are simply being bombarded with the information provided by the lecturers.

Problem-based learning (PBL) was the approach that complemented the weakness of remote learning. PBL
was a constructivist pedagogy based on hands-on, active learning that worked on developing real-life problem-solving skills, flexibility, creativity, and productivity (Lazakidou & Retalis, 2010). Due to this active learning nature, the PBL empowered students’ engagement in solving real-world or open-ended problems, and thus enhanced students’ critical thinking and self-regulated learning (Klegeris & Hurren, 2011). Besides, two-way communication between students and lecturers, and among students, occurred during the discussion session on the problems. This approach contributed to strengthened students’ responses to the learning situation (Ortiz, 2004).

PBL was the learning strategies to enhanced critical thinking and problem-solving skills through students’ hands-on, active learning in solving a real-world problem. PBL required technology supports (Wan Hussin, Harun, & Shukor, 2018). PBL confronted students with authentic problems and these helped the students to practice through hands-on learning and gain higher-order thinking skills, as well as increasing the students’ ability to transfer problem-solving process into new and more complex circumstances (Mergendoller, Maxwell, & Bellisimo, 2006). This was aligned with the outcome of the public management program to produce graduates with the competitive knowledge, principles, and critical thinking skills in linking theoretical and practical foundation for designing, implementing and managing information technology solutions and resources.

The teaching issues in this study were critical thinking and problem-solving skills, which related to the fifth learning outcome of the subject GMGM2023 Human Resource Management in Public Sector, which was to evaluate the level of effectiveness of human resource management. In the current practice, students were given a case study to solve. Based on the result, most of them were lack of critical thinking and problem-solving skills.

Based on our observations, the remote learning PBL was limited in Malaysian Higher Education Institutions. In Universiti Utara Malaysia (UUM), to the best of our knowledge, there were a limited number of classes that implemented remote learning PBL in their program module. Hence, this research attempted to investigate the impact of remote learning PBL approach in Public Management Program toward students’ performance in terms of their critical thinking and problem-solving skills as well as their feelings and attitude toward the remote learning PBL approach.

**Research Objectives**

i) To investigate the effect of remote learning PBL in improving students' critical thinking skills.

ii) To investigate the effect of remote learning PBL in improving students' problem-solving skills.

iii) To assess the impact of remote learning PBL based on students' answer on a set of open questions.

**Research Hypotheses**
i) H1: There is a difference of students’ problem-solving skills between pre-remote learning PBL class and post-remote learning PBL class.

ii) H2: There is a difference of students’ critical thinking skills between pre-remote learning PBL class and post-remote learning PBL class.

2. Literature Review

Remote Learning in Higher Education Institutions

The Covid-19 pandemic has now forced the higher education institutions to engaged in remote learning. In Asia countries, higher education impacted on academic activities and this caused the short-term switch to remote learning rather than face-to-face tutorial (Cham, 2020). According to a report concluded by Cham (2020), the challenges for remote learning involved the “hardware” limitation such as internet accessibility and assessment tools to accessed students’ study performance. Internet accessibility or assessment tools were tools used in implementing remote learning. Although the tools were important, however, the core for learning and teaching focused on students’ interest and the quality of course instructions.

Remote learning biggest challenges were to attract student’s interest in learning and to maintain the quality of instructions (Valentine, 2002). Poor time management and students’ failure to engage in learning remained the issue for remote learning. Khan et al. (2017) stated that incorporating active learning model in remote learning helps to enhanced students’ interest in learning and improved students' thinking and knowledge level. In addition, an active learning curriculum design maintained the quality of instructions that actively engaged students in the learning process. Hence, it is important to designed curriculum that incorporates active learning using PBL approaches in remote learning to create better online education environment.

Problem-Based Learning (PBL) in Remote Learning Environment

PBL was part of active learning that emphasized the instructional method that engaged students in the learning process (Prince, 2004). Savery (2015, p. 7) defined PBL as “instructional learner-centred approach that empowers learners to conduct research, integrates theory and practice, and applies knowledge and skills to develop a viable solution to the defined problem”. In this regard, PBL was a pedagogy which students learn to think critically, define the problem, analyze and provide solutions to solve the real-world problems. PBL begins with the complex, ill-structured problem that described the real-world problem. Students engaged in knowledge construction with self-directed learning by constructing an understanding of the problem and discussed the problem, brainstorming the possible explanations and solutions, self-study, sharing and critically evaluating their findings after self-study, assessment and reflection of the learning (Loyens, Kirschner, & Paas, 2010; Sayadi, 2012).
Bloom’s taxonomy was a multi-level model in classifying learning objectives in cognitive, affective, and sensory domains. During the year 2001, Bloom’s taxonomy was revised into six cognitive levels; remember, understand, apply, analyse, evaluate and create (Anderson & Krathwohl, 2001). The revised Bloom’s taxonomy provided the measurement of the thinking level. Indeed, the taxonomy was cumulative hierarchical in nature with each cognitive level required the prior skill or ability before the next. For instance, before reaching the understanding level, one should remember the context. The cumulative level started from the lower level until the upper level on top of the hierarchy level. Intensively, the higher the level, the more complex it was, and it required a higher level of thinking.

Bloom’s taxonomy was closely linked to problem-solving and critical thinking skills (Forehand, 2010). PBL aimed to develop students’ critical thinking and problem-solving skills through organised problem-based activities. Problem-based activities required higher cognitive thinking level. Indeed, the lowest level cognitive level (remember, understand, apply) were not enough in this case, and the students were required to climb to a higher level of cognitive level (analysis, evaluate, create) to develop a viable solution to a defined problem.

Since PBL required higher-level cognitive level, the traditional classroom had a limitation in implementing PBL. Indeed, the traditional classroom provided limited time for students to involved in practical activities in the classroom. Moreover, for the traditional classroom, during class time, students were busy taking notes from lecturer’s lecture in explaining the theoretical materials resulted in them to have limited time discussing the issues or asking questions to lecturer or peers. Due to this fact, students suffered from lack of understanding on critical issues, and this resulted in the lack of critical thinking and knowledge building skills (higher thinking level required students to fulfil the lowest cognitive level).

The online classroom had overcome the limitation of the traditional classroom. This approach incorporated technology in the education process, and this made the interactions with the lecturer and peers more effective and fruitful. Hence, it created a better learning environment. In an online classroom, reading or learning materials provided to students prior to the class, and during class time, students expanded the material studied by solving practical tasks. Consequently, this improved students’ understanding of the learning content and help to developed critical perspectives on the topic. After class time, students were given time to continue working with electronic sources to test their knowledge and this triggered their cognitive skills. Figure 1 illustrates the PBL in the remote learning setting with Revised Bloom’s Taxonomy.
PBL can be applied in remote learning setting. In fact, past research indicated positive feedback of students regarding remote learning PBL courses (Blackburn, 2017; Cheaney & Ingebritsen, 2005; Chen, 2016; Duncan et al., 2013; Moallem & Igoe, 2018). Cheaney and Ingebritsen (2005) found statistically significant difference between the students with lower exam testing and PBL using remote learning, whereby the performance of students in PBL remote learning were better compared to traditional lecture-based approach. Likewise, Chen (2016) integrated online platform to support the PBL course, and they found that PBL using remote learning was effective as the traditional in-class PBL. Moreover, research indicated that students were more focused in class using remote learning PBL. The more passive students would have rooms to contribute in discussion freely and the used of emoticons in chat aid in ice-breaking, as well as encouraging the students to feel more comfortable to share their opinions in the group.

In the PBL approach, the students participated as active learners. In this sense, lecturer served as an instructor to guide the students in learning rather than playing the centre role for knowledge and information delivery. Remote learning PBL fostered students to actively search for information and learning materials to solve the problem posed by the lecturer. Moallem and Igoe (2018) employed Top Hat as the web-based PBL approach to developed the instructional materials. They incorporated scaffolds in Top Hat modules to developed a series of hard scaffolds in the form of consecutive questions that assist students in problem identification and analysis processes. They found that PBL using remote learning instructions encouraged students to think deeper and students were more actively engaged in searching for learning materials.

Methodology

Current research employed both quantitative and qualitative approaches to answer the research questions. Quantitative assessment used the 5-Points Likert scale to measure the students' critical thinking and problem-solving skills before and after the remote learning PBL module. To measure critical thinking skills, the questionnaire items were adapted from Al-Mazrooa (2017). On the other hand, to measure problem-solving, the questionnaire items were adapted from Chis, Moldovan, Murphy, Pathak, and Muntean (2018). The
questionnaire items of critical thinking and problem-solving skills were set in the Google Form for the students to answer before the start of the remote learning PBL module (pre-test), and after completing the remote learning PBL module sessions (post-test). Statistical analysis for comparing the pre- and post-test score is Paired Student’s T-Test.

Qualitative assessment was conducted to determine the remote learning PBL module’s impact on the student's feelings and attitudes. In this study, open questions were designed and set in the Google Form (together with the post-test) to the target respondents in this study. The open questions were related to the students’ perception towards remote learning PBL (pre-, during, and post-). Data gathered in this study used thematic analysis approach based on six-steps introduced by Braun and Clarke (2006) as following figure.

![Thematic Analysis Steps](image)

**Figure 2. Thematic Analysis Steps**

The target respondents were the undergraduate students from the Public Management Program in UUM, which enrolled in the three credit hours course that taught by the lecturer for semester A192. There were a total of 34 students involved as respondents in this study. This study employed a single module to examine the student’s experience in remote learning PBL and its impact in improving their critical thinking and problem-solving skills. There was only one problem scenario for the students as the central component of the module in this study. The research was conducted for three remote learning meetings. To make the subject matter and PBL more relevant, the modules designed in this research were based on the topics outlined in the course syllabus. The lecturer designed ill-structured problems using real-world scenario from news, government reports or other related reports that showed the problem that related to the subject matter. In the module, ill-structured problem were provided in the first meeting; students formed groups of four to five and were requested to solved the PBL module in the second meeting; and students wrote their reflections in the third meeting. In essence, following table illustrates the implementation process of Remote Learning PBL module instructions.

| Table 1. Remote Learning PBL Module Instructions |
|-------------------|-------------------|
| **Duration**      | **Instructions**   |
| First Meeting     | • Students need to answer the questionnaire that assess their pre-critical thinking and problem-solving skills in Google Form. |

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**Lecturer provided video of the designed open-ended real-life problem and related learning materials to students via UUM-OL. Students required to watch the video and read the related materials, then prepare questions to be asked in the next meeting.**

**Second Meeting**
- The lecturer served as the facilitator to guide the discussion and provide guidelines and feedback.
- Students formed groups of four to five and work in group to produce their findings and solutions to solve the given problem.
- Students were given the opportunity to ask questions during the meeting and try to work out the problem in their respective group.
- Students completed the PBL task.

**Third Meeting**
- Students presented their findings.
- Students were asked spontaneously by the lecturer in the Webex meeting on their learning outcome evaluation and suggestions for future learning.
- Students need to answer the questionnaire that assess their post-critical thinking and problem-solving skills and provide their reflections of the learning by answering the open questions given by the lecturer in Google Form.

During the pandemic time, the first session was conducted using Webex for the virtual meeting between lecturer and students. According to the remote learning PBL module design suggested by Duncan, Smith and Cook (2013), the warm-up activities were needed when the students were new to both PBL and remote learning. Following the suggestions, the first meeting was emphasized on module introduction and the related warm-up activity. At the beginning of the meeting, students were requested to complete the questionnaire that assessed their pre-critical thinking and problem-solving skills in Google Form. After all have submitted the questionnaire, students were asked to download and read the learning materials uploaded to UUM-OL platform by lecturer. The learning materials included YouTube videos on ways to solve ill-structured problems.

In the second meeting, students were first split into a group of four to five. Then, the lecturer presented the guidelines on the PBL module and explained to students of the steps to solve the ill-structure problem. On the other hand, students could ask questions to clarify the context during the meeting. Thereafter, in group, they were requested by the lecturer to solve the assigned problem and present their findings in the next meeting.

In the third meeting, groups presented final findings and solutions to the class via Webex. During this meeting, the lecturer engaged in collective reflections with the entire class on the final meeting of the module. Also, students were requested to complete and submit the Google Form that included (1) post-critical thinking and problem-solving skills assessment questionnaire and (2) reflections of the learning by answering the open questions given by the lecturer.

### 3. Results, Findings and Discussion

There were a total of 34 returned responses from the students. Before the research instruments were used to test the hypothesis, it has been tested on the validity and reliability. The instruments were validated using content validity, and the reliability of instruments was calculated using Cronbach’s Alpha. The validation results for both problem solving and critical thinking variables indicated the items design were valid by two subject matter experts. The Cronbach’s Alpha test showed that the items of problem-solving skills have a reliability coefficient.
of 0.852, whereas critical thinking items was 0.794. These results indicated that the instruments for both variables were valid and reliable.

Descriptive analysis indicated that critical thinking skills possessed greater variance and standard deviation compared to problem-solving skills. Intensively, pre-test critical thinking recorded 11.08 variance, 3.33 standard deviation, while the post-test critical thinking recorded 10.27 variance and 3.20 standard deviation. On the other hand, pre-test problem-solving recorded 3.34 variance and 1.83 standard deviations, while during post-test problem-solving recorded 3.35 variance and 1.83 standard deviation.

Before running paired sample T-Test, the basic assumptions of paired sample T-Test were tested and the subjects were assumed to be approximately normal. The normality was conducted using skewness and kurtosis values. In this study, specific statistical test such as a Shapiro-Wilks test was not used because the statistical test was less useful in small samples (Hair et al., 2010). Based on the SPSS output, the skewness and the kurtosis value for pre- and post- critical thinking and problem-solving skills were within the range of ±2. In other words, they were considered acceptable to proved the normal distribution (George & Mallery, 2010).

The research objectives of this study was to test the effects of remote learning PBL in improving students’ critical thinking and problem-solving skills. The hypothesis were tested using paired sample T-Test to determine the presence or absence of the differences in students’ critical thinking and problem-solving skills before and after the remote learning PBL module. Table 2 illustrates the results of the study.

Table 2. Paired Sample T-Test Results

<table>
<thead>
<tr>
<th>Paired Samples Statistics</th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem-Solving Skills</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>11.588</td>
<td>34</td>
<td>1.828</td>
<td>0.313</td>
</tr>
<tr>
<td>Post-test</td>
<td>12.471</td>
<td>34</td>
<td>1.930</td>
<td>0.331</td>
</tr>
<tr>
<td>Critical Thinking Skills</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>23.882</td>
<td>34</td>
<td>3.328</td>
<td>0.571</td>
</tr>
<tr>
<td>Post-test</td>
<td>25.088</td>
<td>34</td>
<td>3.204</td>
<td>0.549</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Paired Samples Correlations</th>
<th>N</th>
<th>Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem-Solving Skills</td>
<td>34</td>
<td>0.467</td>
<td>0.005</td>
</tr>
<tr>
<td>Critical Thinking Skills</td>
<td>34</td>
<td>0.572</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Paired Samples T-Test</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>t</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem-Solving Skills</td>
<td>1.887</td>
<td>0.324</td>
<td>-2.726</td>
<td>33</td>
<td>0.010</td>
</tr>
<tr>
<td>Critical Thinking Skills</td>
<td>3.022</td>
<td>0.518</td>
<td>-2.326</td>
<td>33</td>
<td>0.026</td>
</tr>
</tbody>
</table>
The statistical result showed there was a significant difference in the scores of pre-test-problem solving skills (M=11.588, SD=1.828) and post-test-problem solving skills (M=12.471, SD=1.930) with t(33)=-2.726, p<0.01. As a result, H1 was accepted and indicated there was a difference of students’ problem-solving skills between pre-remote learning PBL and post-remote learning PBL. On the other hand, there was a significant difference in the scores of pre-test critical thinking skills (M=23.882, SD=3.328) and post-test critical thinking skills (M=25.088, SD=3.204) with t(33)=-2.326, p<0.05. The result showed that there was a difference in students’ critical thinking skills between pre-remote learning PBL and post-remote learning PBL, and H2 was accepted.

Based on the mean value of critical thinking and problem-solving skills shown in Table 2, it indicated that the change was the increased of the scores for both critical thinking and problem-solving skills after implementing remote learning PBL module. Moreover, the negative t-value indicated that the post-test scores for problem-solving skills and critical thinking skills are greater compared to pre-test scores. Particularly, t-value was calculated as (M1 (pre-test) - M2 (post-test))/standard deviation, thus, the negative value obtained when M2 value is greater than M1 value. As a result, it could be concluded that the hypothesis testing results were parallel to past studies that indicated that remote learning PBL helped to improved students’ problem-solving skills and critical thinking skills (Blackburn, 2017; Cheaney & Ingebritsen, 2005; Chen, 2016; Duncan et al., 2013; Moallem & Lgoe, 2018).

Cohen test used to determine the magnitude of difference between two groups by calculating the mean difference between the groups and dividing the result by the pooled standard deviation and the effect size formula is Cohen’s $d = (M_2 - M_1)/SD_{pooled}$. Based on the calculation, the effect size of pre- and post- problem-solving skills test was 0.469, whereas the effect size for pre- and post- critical thinking skills test was 0.369. According to Cohen (1998), effect size greater than 0.2 and less than 0.5 was considered as small effect. In other words, it could be concluded that there was a small change in problem-solving skills and critical thinking skills after implementing the remote learning PBL module.

The third objective of the research was to assess the impact of remote learning PBL based on the qualitative assessment on an open question. Based on the thematic analysis for the collected feedback from pre-session of remote learning PBL, the first theme was 19 respondents stated that they have no ideas on PBL. Intensively, respondents stated that they did not have knowledge on the steps, approaches or methods used to solve the given ill-structured problems. These responses suggested that the students did not have exposure to the PBL learning method before, and it followed that they were unclear on the remote learning PBL module.

In addition, respondent number 30 stated that they could not catch up on the module and respondent number 33 responded that the noise from the environment that interrupted his attention in the session. During the remote learning, communication barriers such as physical noise tend to interrupt the decoded messages, and this affected the effectiveness of learning. Likewise, Berge (2013) indicated that communication barriers were the challenges in remote learning. This barrier included technical, psychological, social, contextual, and cultural challenges in remote education teaching and learning. The lecturer in remote learning required to realised these challenges and
tried to find the solutions to reduced communication barriers occurred in remote learning environment.

The second theme was no confidence to deliver the ideas. There were four respondents grouped in this theme. Basically, they felt not confidence to do the problem-based analysis, not confidence in the proposed ideas, and felt that the proposed solutions might not be accepted for the final decision. Apart from the negative feedback, there were some positive feedbacks by respondents.

The third theme was ready to be engaged positively in remote learning PBL. Seven respondents were grouped under this theme. Although they were not exposed to PBL lesson before, they mentioned that they tried to understand the given topic. On the other hand, there were five respondents seeking PBL as an interesting learning mechanism, and they felt excited to participate in remote learning PBL. Integration of technology such as interactive videos attracted the interests of students to engage in active learning.

Based on the thematic analysis for the collected feedback from during-session of remote learning PBL, students gradually make clear on PBL learning mechanism and learned to draw connections among the ideas to general solutions. First theme was PBL helped students to triggered higher thinking level and promoted greater problem-solving skills. Basically, there were seven respondents stated that that they have learned the problem-solving steps and able to implement the steps in problem solving process. Based on Bloom’s taxonomy, PBL helped to triggered higher thinking level and this was true in this study. The feedback from the respondents implied that they have learned to find the suitable information which relevant to the topic and able to use the information and draw the connections among the ideas to generate possible solutions.

The new idea generations were, in fact, spur through ideas sharing in a group, and these differing opinions lead to the exposure of different problem-solving ways. For instance, respondent number 2 able to see things differently, respondent number 19 listed the problem and solutions, respondent number 8 related the problem with learning objectives and respondent number 1 able to use the information to draw a connection to the problem and the topic of study. In addition, during the problem-solving process, respondents learned to evaluate the solutions and able to justify the stand or decisions to select a suitable solution. Respondent number 2 and 27 stated that they were able to select the suitable solution for the problem and respondent number 21 indicated that he was able to think rationally to select the best solution.

Interestingly, the thematic analysis results showed that discussions with group members and the lecturer played an important role in problem-solving. There were seven respondents’ feedbacks grouped in this theme. Discussion with group members spurred the brainstorming process and aids in generating possible solutions. In addition, idea sharing in a group promoted active learning and created curiosity and fun in the problem-solving process. Lecturer facilitated the problem-solving process reinforced the understanding of students regarding the problem-solving steps. Moreover, lecturer shared extra information regarding the topic and facilitated students to think from different perspectives.
During the implementation of the problem-solving session, there were two respondents reported that they faced difficulty to understand the topic and confused on the steps to solve the problem. The result suggested hazard in conducting remote learning PBL where the challenges of the lecturer to guide the students’ understanding on PBL. Cheaney and Ingebritsen (2005) stated that the remote learning was more difficult to be conducted because the lecturer did not have face-to-face contact with the students and students were searching to developed their answers largely by their own. This resulted in some of the students found difficulty in the learning module and they were struggling in the remote learning environment that they were not familiar with.

Finally, the thematic analysis under post-session of remote learning PBL indicated that majority of the students improved in their understanding, critical thinking skills and problem-solving skills. There were a total of 20 respondents indicated that PBL helped to improved their understanding, critical thinking skills and problem-solving skills. Specifically, there were ten respondents highlighted that they had achieved a basic understanding of problem-solving steps, or the human resource-related knowledge based on the learning topic. Ten respondents reported that they achieved greater critical thinking. Intensively, PBL improved student’s ability to summarize and identified the problem, determined the good or bad of the proposed solutions, and to find the best solution for the problem. Moreover, the experience in PBL also helped the students to improved their knowledge and application skills in other related aspects. For instance, respondent number 22 annotated that she implemented the problem-solving skills in other related disciplines such as marketing problem in an organization, and respondent number 5 indicated that she applied problem-solving steps in other individual assignments. On the other hand, the result showed that students had more confidence to handle remote learning session. This suggested that the students’ acceptance of remote learning PBL were hinged on the understanding of the method.

Conclusion

Problem-based learning helps students to learn through the experience of solving problems. This enhances students’ thinking and problem-solving skills by constructing the problem scenario and resembling the situations that are connected to the learning objectives. The current study found that PBL can be implemented in a remote learning environment and the hypothesis testing results indicated that remote learning PBL improved students’ critical thinking and problem-solving skills, albeit the effect size was not that ample. The results proved that PBL enhances the subsequent retrieval and reinforces the understanding of students on the subject matter, and hence, triggers them to higher thinking level in Bloom’s Taxonomy. Moreover, PBL in remote learning setting motivates the students’ active learning and participation in the learning process.

PBL in a remote learning setting still exists great challenges compared to face-to-face PBL (Cheaney & Ingebritsen, 2005). Although students’ reactions to the remote learning PBL are positive, some reservations occurred especially about the environmental disruptions and the challenges such as difficulties to catch up with the course syllabus. Therefore, lecturers need to look at their students' feedback from time to time to improve the learning mechanism and to create better learning environment. For instance, lecturers need to take active steps to minimize distractions in remote learning PBL and assist students in managing additional cognitive demands.
imposed by remote learning platform. Since the PBL in remote learning creates positive impacts on students’ thinking and problem-solving skills, future study should take a step further to impose remote learning PBL in other courses rather than the selected course in this study, and implement several PBL modules in order to maximize the impact on students’ overall learning.

Acknowledgement

This is to acknowledge that this research was funded under the SoTL Grant, bearing the SO Code 14512, from Universiti Utara Malaysia, Malaysia.

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