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Embracing TVET education: The effectiveness of project based learning on secondary school students' achievement

Zaharah Che Isa, Nurulwahida Azid
School of Education, Universiti Utara Malaysia, Malaysia

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ABSTRACT

Project based learning (PBL) has long been used especially in developing countries. Various results of PBL-related studies have also been found to be effective and have a positive impact on students. However, although it has been introduced in Malaysia, it is still considered foreign to students and teachers. Therefore, this study was conducted to look at the effectiveness of applying the PBL method in the topic of project design on form two students' learning process. An experimental study with mixed method approach was conducted through pre and post-tests on one control and one treatment group. A total of 60 form two students were involved, of which 30 were treatment students and another 30 were control students. Five students from the treatment group were randomly selected to go through a semi structured interview process. This interview was conducted to confirm the results of the quantitative study. The results of analysis of covariance (ANCOVA) showed that students in the PBL group performed significantly better in project design learning process than those in the contrast group. Therefore, this study demonstrated that the PBL method had a positive impact on students' learning process. Based on the interviews, all respondents agreed that PBL was an excellent approach because the learning activities were interesting and different from the normal learning environment. In addition, the interview results also showed that the respondents suggested that the PBL method should be continued and implemented in other topics and subjects.

Corresponding Author:

Nurulwahida Azid
School of Education
Universiti Utara Malaysia
06010 Sintok, Kedah, Malaysia
Email: nurulwahida@uum.edu.my

1. INTRODUCTION

At present, Technical Vocational Education and Training (TVET) is gaining more attention compared to the mainstream education. TVET education is said to be able to solve many issues such as poverty, unemployment and skills in the workplace [1], [2]. TVET is a form of education that provides students with the skills and knowledge that enable them to compete in the job market while also making them skilled workers in a field of specialization making TVET education increasingly popular [3].

The development of TVET in the education system in Malaysia is seen in line with the growth of TVET globally [4]. The education system designed and implemented in TVET can produce students who are capable of developing individuals to become quality citizens, well-behaved, responsible and able to adapt to real life situations [5], [6]. The application of different learning strategies and methods compared to other subjects has given rise to increased attention in TVET. One of the methods applied is project based learning (PBL). PBL that has been applied in many previous studies have shown positive effects on students [7], [8].

Project based learning (PBL) is a learning method that is based on the theory of constructivism through the principles of learning by doing founded by John Dewey [9]. Based on this principle, William Heard Kilpatrick further developed the idea of teaching and learning through a method known as project-based learning [10]. This method allows students to engage in learning situations through the application of ideas and the production of a project [8], [11]-[14]. The Ministry of Education Malaysia has interpreted PBL as a model of activity that differs from ordinary classroom practice and involves a broad range of disciplines [6]. In addition, PBL is said to be an active and student-centered method of learning that is believed to enable students to gain deeper knowledge through active exploration of real-world challenges and problems [15], [16]. Project based learning is a learning method that differs from ordinary classroom practice as it is a hands-on project, actively engaged student-centered, involves the process of exploring for deep knowledge and thus producing individuals with problem-solving skills as well as the challenges facing the real world.

Previous studies [17]-[21] have found that PBL methods are effective on students' achievement. Thus, the PBL method can have a positive impact on the development of the student learning process. Furthermore, project based learning method is a suitable teaching and learning practice in line with the development of education that requires skills to solve real-world problems among students. The use of a wide range of educational resources and the integration of PBL methods make teaching and learning processes interesting and effective.

2. RESEARCH BACKGROUND

The Department of Statistics Malaysia and Economic Review 2019 Ministry of Finance Malaysia found that the unemployment rate according to the level of education in 2017 among graduate students was higher than secondary, primary education and no formal education [22]. Research showed that many graduates did not have the knowledge, skills and abilities that were relevant to the industry. A study by Hanapi and Nordin [22], found that some of the causes of this problem were due to students' attitude towards the learning process and competencies of the teachers involved. This reflected the trend that students' learning processes did not have a significant relationship with the skills needed in the job market.

Teacher-centered teaching and learning is still popular and practiced by some teachers today [17], [18], [23]. Teacher-centered, explanative, demonstrative and one-way method are associated with conventional learning methods. Such learning situations make students passive and the learning environment less enjoyable [24], [25]. This approach to teaching also does not help students to actively engage in the learning process [26].

Although PBL methods have long been introduced, they are still considered foreign in the national education system especially in secondary schools [6]. Lack of exposure and promotion of the benefits of this method has led to less attention among teachers and students [16]. According to Hanapi and Nordin [22], teachers who do not mix the methods in the teaching and learning process make the students less active in their learning process. In addition, there are some teachers who are skeptical of the students' ability to explore their own knowledge and this is one of the contributing factors to the growing popularity of using a conventional approach among teachers. According to Yahya [27], the PBL approach has a positive impact on students' learning development but it has some limitations including students' perception and teacher's role.

Therefore, this study was conducted to examine the impact of project based learning (PBL) on the learning process of project design topic. Project design topic was selected in this study because it is one of the important topics that can produce global-minded individuals who understand the latest technology and are able to solve future problems [28]. In addition, this topic is also a basic topic that leads to an understanding of concepts before moving on to other topics. This study applied eight PBL elements as suggested by Larmer and Mergendoller [29] that are significant content; 21st century competencies; in-depth inquiry; driving question; voice and choice; need to know; critique and revision; and public audience. This PBL concept has characteristics of an active, student-centered, hands-on learning environment, project creation as the output, emphasizing 21st century skills and the role of teachers as mentors.

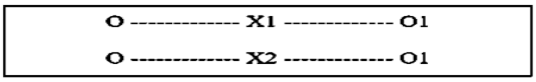
Thus, the research questions in the study are: 1) Is there any significant difference between pre and post-test in the project based learning (PBL) process for treatment and control groups? 2) What are the students' perceptions towards learning that applies the principles of project based learning in the topic of project design?

3. RESEARCH METHOD

3.1. Research design

This study was based on a quasi-experimental research design with mixed-method approach (quantitative-descriptive and inferential) and (qualitative-focus group interview). The mixed method approach in this study used explanatory sequential design implemented through two phases, which were

quantitative study in the first phase and followed by qualitative study in the second phase [30]. In this study, quantitative data were obtained through experimental studies involving project-based learning pre and post-tests while for qualitative, data were obtained through interview sessions with students and teacher involved with the treatment group. Experimental study is usually conducted to manipulate one or more independent variables and see how they affect dependent variables [31]. This quasi-experimental study involved pre and post-tests of the control and treatment groups. The design of the study is described in Figure 1.



O=Pretest; O1=Posttest; X1=Conventional learning (control group); X2=Project based learning (treatment group)

Figure 1. Pre and posttest for two groups design [32], [33]

3.2. Population and sampling

The population for this study was form two students (14 years old) in the state of Kedah, Malaysia. Form two students were selected because this study involved the topic of project design which is the topic of form two. This study involved 60 students from two classes in a rural school area who were identified through purposive convenience sampling [34]. Each class consisted of 30 students in which one class was used as the experimental class that used the PBL method and the second class as the control class that received the conventional learning method. The selection of 30 students in this experimental study was based on Cresswell [30] who suggested 15 people as the minimum size for each group. On the other hand, Gall, Gall, and Borg [35] stated that a minimum of 30 people in a group is proposed to obtain satisfactory findings. Since the number of students in a class has been set by the school from the beginning to the end of the year, the number of samples in this study depended on the number of students already in the class. The students in the existing class could not be isolated as it would interfere with their daily school activities based on the classroom system as set by the school and the Ministry of Education Malaysia [36]. Out of the 30 treatment students, five students were randomly selected to go through the interview process related to the learning process using the PBL method. A sample of five students was as suggested by Cresswell [37] stated that the number between four and ten subjects is appropriate for interview sample.

3.3. Instruments

The instruments used in this study were pre and post-test PBL process inventory and student interview protocol. The PBL instrument was developed by Biggs, Kember and Leung [38], contained 20 items to measure students' perceptions of the project-based learning process. This instrument has been translated using the back-translation method as suggested by Brislin [39] and adapted to local values and culture. The process of translation had been carried out by a university lecturer in the field of language together with the researcher. PBL instrument has gone through the process of translation, face and content validity by four experts in assessing the Malay language sentence structure, improvement of language and comprehension. Next, reliability test was conducted on 50 form two students in Baling, Kedah, Malaysia. For the overall reliability of the instrument, the analysis showed that the PBL inventory obtained an alpha value of .86. The value of reliability of this instrument was considered high and very satisfactory [40] and applicable for Malaysian students.

The student interview protocol instrument was developed by the researchers to support the findings of quantitative data. Therefore, four interview protocol items were developed based on the research problems, research questions and research variables. The type of interview that has been used in this study was a semi-structured interview. Semi-structured interview means that the researcher has prepared the questions in advance and would ask the same questions to the study samples during the interview sessions. At the same time additional questions and columns were provided which would be added according to the appropriateness of the information received from the study samples [30]. Figure 2 shows the summary of two instruments that the researchers used in the study.

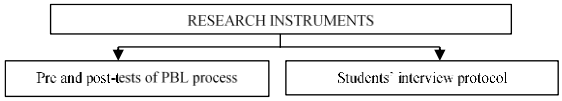


Figure 2. Research instruments

4. RESULTS

In this section, the result findings are presented and at the same time comprehensive discussion is provided. Results are presented in figures, graphs, tables and others that make the reader understand easily [2], [5]. The discussion is made in several sub-chapters.

4.1. Homogeneity of variances test result

Homogeneity of Variance is also one of the conditions that must be met in order to qualify for the ANCOVA test. In this case the variance value of the dependent variable across all groups in the independent variable should be the same. This can be done using Levene's test. A non-significant result in the Levene's test indicated that the study data were qualified for the ANCOVA test. Table 1 show the result of the Levene's test on the homogeneity of variances for PBL process test. Based on Table 1, the result of the Levene's test for the dependent variables of the learning process [F (1, 58)=.09, p>.05] was not significant. Therefore, the variance values for each group for the dependent variable were not different and the study data complied with the ANCOVA test conditions [31], [41].

Table 1. Levene's test on the homogeneity of variances for PBL process

F	df1	df2	Sig.
.090	1	58	.765

4.2. ANCOVA test result on PBL process

Table 2 reveals the mean value for the treatment group following the PBL approach was higher than the mean value for the control group (mean post-test-treatment group=15.37 and mean post-test-control group=9.97). This indicated that the mean post-test for treatment group was better than for the control group.

Table 3 shows the result of ANCOVA test analysis of PBL process test results. The result showed that there was a significant effect of sample group independent variables on PBL process post-test variables [F (1, 57)=52.147, p<.05]. In addition, there was a significant effect of PBL pre-test control variables on the post-process PBL test variables [F (1, 57)=31.39, p<.05]. In this study, pre-test of PBL process was used as a covariate to reduce experimental errors or reduce the effects caused by control variables. This is because pre-test is an external variable of which is a variable that is not studied but is considered as a variable that can affect the dependent variable [39].

Based on this result, the researchers rejected the null hypothesis of the study. The result of this analysis confirmed that there was a significant effect of independent variables (sample group) on post–test learning process dependent variables after controlling the PBL pre-test control variables. This showed that the PBL post-test test scores of the treatment group (PBL approach) outperformed the control group (conventional learning approach) significantly. The result suggested that the implementation of learning through the PBL approach has a more positive and significant impact on the PBL process among students.

Table 2. Descriptive statistical analysis of PBL process

Group	Mean	Standard deviation	N
Treatment	15.37	2.83	30
Control	9.97	4.11	30
Total	12.67	4.43	60

Table 3. ANCOVA test analysis of PBL process

Source	Type III Sum of squares	Df	Mean square	F	Sig.
Corrected model	693.755a	2	346.877	42.468	.000
Intercept	287.973	1	287.973	35.256	.000
Pretest of PBL process	256.355	1	256.355	31.385	.000
Sample group	425.938	1	425.938	52.147	.000
Error	465.579	57	8.168		
Total	10786.000	60			
Corrected total	1159.333	59			

a.R Squared=.598 (Adjusted R squared=.584)

4.3. Interview findings

Interviews conducted with five of the 30 treatment students were randomly selected. The purpose of the interview was to gain feedback and perceptions of students on the implementation of PBL activities that they have undergone during the five sessions of learning the topic of project design. In general, there were

several themes that were gained through interview analysis. The following are the extracts of students' responses (R).

4.3.1. Increase enthusiasm and interest in the subject content/topic

All five students interviewed said that learning activities through the PBL approach generated a great deal of enthusiasm and interest in the content of the lessons they were and would be studying. They said that every activity was fulfilling because they have to be actively involved and also each activity was a hands-on process that needed to be completed individually. Some of the statements regarding interest and enthusiasm gained through the interview are as:

> *"...previously, I did not really like to go to the workshop, but now I love it and I have gained a lot of interest in the project design topic."* (R1)
> *"I like learning using the PBL concept. Maybe can be used in other subjects too."* (R2)
> *"This way of learning made me like to learn this topic. Previously, I found this topic to be difficult and I did not understand what the teacher has taught me. Now that we have to do a project, I cannot wait for the next lesson to come."* (R4)

4.3.2. Gain new experience

All respondents stated that during the PBL session of project design topic, they gained new experiences that were not previously available in other classes. One example was that students gained new experience through the use of previously unused hand tools such as riveter or drill machines. After participating in the PBL, they gained experience using all the tools available in the workshop in the process of completing the project for the project design topic. In addition, new experiences were also gained as teachers gave students full freedom to express their opinions in order to obtain the best learning outcomes. Some of the extracts from the interviews related to new experiences are as:

> *"... got to feel a whole new experience ... got to hold and use the tools in workshops like ... riveter, drill, saw."* (R1)
> *"... I got many new experiences especially during class discussions. The teacher let us speak as long as it was not out of topic. Sometimes the class was noisy but the teacher said as long as our chatting was about the content, it was okay."* (R2)
> *... I got new experience that before this I could only look at. It was fun to handle things like hammer, file, paint, sandpaper."* (R5)

4.3.3. Application of 21st century skills

All respondents stated that through the PBL, they could indirectly apply 21st century skills. In addition, these skills also gave a positive effect when engaging with other subjects that have PBL elements such as in science where they have to do experiments. Thinking skills in various different ways, problem solving skills, interpersonal skills, team work skills and communication skills were among the skills acquired when students were involved with PBL. Some of the responses related to 21st Century skills that were extracted from student interviews are as:

> *Yes ... because in project design learning sessions ... thinking skills, problem solving and decision making were always a must because every time we have to think, and solve problems related to the project we wanted to create."* (R1)
> *"Yes ... I feel more confident because my communication skills are getting better because teacher always conducted discussion sessions and teacher always encouraged me to talk and give my opinions."* (R2)
> *"I think PBL can really improve interpersonal skills because before this ... I did not talk much but when I wanted to do a project, I have to ask a friend and ask teacher. In addition to that ... I have to think hard to solve problems for example, to choose what or which tools to use for this activity."* (R5)

4.3.4. Positive perception towards PBL

Based on the interviews, all respondents agreed that PBL was an excellent approach because the learning activities were interesting and different from the normal learning environment. With PBL, students were more engaged in learning activities than teachers. In addition, students also found that this approach could help discipline them in terms of managing study time, keeping up with class time and safety precautions while carrying out activities in the workshop. All respondents also agreed that this approach be

extended to students from other classes and applied to other subjects as well. Among the interview extracts with the student are as:

> *"Yes ... because when I learned through PBL, I did not get bored and were always excited every time it was project design lesson."* (R2)
> *"Yes ... because learning this through PBL was exciting, we did not only have the teacher explain but we did everything we wanted to do until the project was completed."* (R3)
> *"Yes ... because when we did the project, we could be self-disciplined such as went into workshops early because of the passion for the project, and learned to be disciplined such as after completing the project task of the day, we cleared and tidied the working area."* (R5)

5. DISCUSSION

Based on the significant ANCOVA test, it meant that there was a significant effect on the learning process post-test. This indicated that the treatment process on the PBL learning group affected the learning process post-test. Therefore, the study proved that the PBL approach can enhance the learning process of students in mastering the project design topic. The learning process becomes more effective when integrating appropriate methods such as applying project-based learning elements that include various skills in line with the current situation and needs of the students. The concept of learning by doing by Dewey, reinforces this statement that learning becomes a meaningful process when teachers can provide a learning environment through the active engagement of students themselves in their learning process [42]. Students were not only mastering the topic theoretically but were often required to engage themselves in the learning process and do hands on work to complete the project. The results of this study were in line with many previous studies.

A study by English and Kitsantas [18] found that students were better able to engage in learning activities through the PBL approach than the conventional learning approach. In addition, the findings of this study are also in line with previous studies [21], [43]. The results showed positive impacts on the students in the experimental group, such as could increase self-confidence, be more active and communicate better, compared to the control group.

A study by Aral, *et al.* [44] on two groups of six-year-old preschoolers also showed similar results with this study. Studies on children basic development through PBL have found that child development is more effective through PBL. However, it is different from the study by Solihatin and Syahrial [19] who also used kindergarten children as a sample group. The results of the study although have positively impacted the students, the researchers found that this method took a long time to be implemented. The effect would be better if the time allotted for the learning process through PBL was extended. However, through careful planning such as the preparation of daily lesson plans with steps and activities appropriate to the students' level, at least the problem of time constraints could be solved such as in this study.

Based on the results of the interview analysis, all respondents generally agreed that the PBL learning experiences in the topic of design: 1) Gave a positive impact on their enthusiasm and interest in the project design topic; 2) Provided them with a new experience such as using different tools in the workshop; 3) Provided them with the application of 21st century skills such as thinking skills and problem solving skills; and 4) Gave them a positive attitude towards learning such as enthusiastic and always excited, self-disciplined and the passion to complete the project. These included students expressing their growing interest in the subject, enhancing their sense of accomplishment, doing things more diligently, focusing more on the contents and learning activities, appreciating time, and being responsible in what they did. The findings are supported by previous studies [8], [12], [13], [20] which stated that PBL is capable of enhancing student interest, motivation and maintaining student focus on learning activities.

In addition, the findings showed students' different perceptions towards their learning and how they think after the experience of PBL learning. Most of the students interviewed also stated that through their PBL activities, they were able to develop some skills related to 21st century skills such as interpersonal skills, decision making, communication skills and thinking skills. This is because PBL activities, through its eight principles of significant content; 21st century competencies; in-depth inquiry; driving question; voice and choice; need to know; critique and revision; and public audience, really need such skills in its every learning activity. Indirectly, students became active and have developed certain skills in the early learning process and eventually developed these skills naturally after completing all five learning sessions through PBL activities. This is because the learning feature of the PBL itself emphasizes student-centered learning so that they can become active learners. This is in line with previous study [8] showing that active learning enhances students' thinking and responses at the end of the learning process. In addition, the results of this interview also suggested that learning through a PBL-based approach was very effective especially in the attitude and perception of students in the topic of project design for Form Two level (14 years old).

6. CONCLUSION

The study found that the PBL approach has proven to positively influence the learning process of students. Students can easily master the topics taught and at the same time, have a positive impact on the learning process, especially in improving their learning achievement and learning perception through PBL. The hands-on skills in producing something were not only needed in the classroom but more importantly the students can apply the skills outside the classroom. This in turn can definitely have a positive effect on students when they are in real life situations. The quantitative results have confirmed it statistically. In addition, the qualitative findings through students' interview have identified a number of important factors in the students' learning process such as: 1) Increasing interest; 2) Passion to complete the project; and 3) Acquisition of 21st century skills which are much needed today.

Therefore, this learning method is proposed to be utilized on students in other districts as well as to different levels of students and topics. It is also suggested that project-based learning methods are developed by providing additional application of multimedia-based constructivist learning concepts. The development of multimedia applications that integrate project-based learning and multimedia constructivism learning for this topic is also proposed to be implemented in the future in line with current technological developments, especially in the current COVID-19 pandemic situation.

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