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The Relationship Between Teachers' Knowledge and The Implementation of Project Based Learning at Vocational College

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Abstract

The transformation of the education system in Malaysia aims to equip students with new skills to realize the country's aspirations become high-income developed country by 2020. Project-based Learning (PBL) is seen as an innovation in education today to develop the features of 21st-century students. This pilot study aims to identify teachers' knowledge in the areas of technology pedagogy and content. In addition to determine the relationship between the variables studied and the implementation of PBL. A total of 30 respondents in the vocational program of the Malaysian Vocational Diploma program from Chenor College of Vocational (Agriculture) participated in this study. Respondents were randomly selected to answer this questionnaire. The results showed that technological knowledge (M = 3.71, SD = 0.510) and pedagogical knowledge (Min = 3.75, SD = 0.409) were at the highest level while content knowledge (M = 3.08, SD = 0.44) was at the moderate level. The findings also showed that there was a significant positive and moderate relationship between technology knowledge and PBL implementation (N = 30, r = 0.421 *, p = 0.05), a weak but non-significant relationship between pedagogical knowledge and PBL implementation (N = 30, r = 0.139, p = 0.05) and a significant negative and moderate relationship between content knowledge and PBL implementation (N = 30, r = -.410 *, p = 0.05). This finding is expected to assess the level of knowledge of teachers in the implementation of PBL to enable the stakeholders to develop the improvement efforts needed to further strengthen the PBL methodology in vocational colleges.

Introduction

Malaysia aims to become a high-income country by 2020. The demand for skilled labour today not only requires students who can master the theory but students who can master practical

skills (Kiong et al., 2016). The Ministry of Human Resources reported in 2008 that there was a shortage of skilled labour in the manufacturing, agriculture and construction industries of more than 700,000 people (Ministry of Education Malaysia, 2013). In order to secure a skilled workforce by 2020, 46% of the 3.3 million job opportunities require a vocational certificate or diploma. Thus, technical and vocational education is an institution that plays a vital role in meeting the needs of the Malaysian economy. Through the Eleventh Malaysia Plan (11th Plan) for the period 2016-2020 the government will improve the curriculum to develop 21st century learning skills among students. PBL is seen as an innovation in the field of education today towards developing holistic and integrated individual potential (Ministry of Education Malaysia, 2013). The aim is to produce individuals who are knowledgeable and, have high level thinking skills, ability to use technology and have positive work ethic values. PBL based on collaborative elements of communication, creative and critical thinking (Teacher Education Division, 2015). According to the Sabah State Educational Technology Division (2007) in the PBL Pilot Project Implementation Report in Sabah, the PBL is able to encourage students to explore new knowledge, make judgments, interpret and synthesize information in meaningful ways. To enhance the vocabulary of vocational graduates, the Ministry of Education will equip students with skills that are in line with industry requirements. These include working with industry partners, upgrading equipment and equipment and emphasizing practical pedagogy (Ministry of Education Malaysia, 2013). PBL is seen as a practical pedagogy that should be emphasized in vocational colleges as students need to produce products or services through the Final Year Project during the 3rd and 4th semester.

Problem Statement

This study aims to look at the level of technology knowledge, pedagogical knowledge and content knowledge of Malaysian Diploma Vocational program teachers. In addition, this study also identifies the relationship between technological knowledge, pedagogical knowledge and content knowledge with the implementation of PBL. Although the implementation of the PBL is long overdue, much of the research has been focused on student impact (Iwamoto, Hargis, & Vuong, 2016) and areas of education such as Physics (Mihardi, Harahap & Sani, 2013), Biology (Hassan, 2015) and Electrical Engineering (Zouganeli et al.,2014). Study on PBL is very limited among teachers. Therefore, it is appropriate to identify teachers' knowledge of implementing new curriculum such as PBL. This is because the success of the students and the effectiveness of the method depends on the teacher acting as the implementing agent.

According to Hassan (2015) even though the PBL has long been introduced to the research of teachers related to PBL at the primary and secondary level, it is still lacking and considered foreign to the national education system (Isa & Abdullah, 2013). This situation is due to the circumstances of the teacher who is still unprepared and confident to implement the method (See, 2015). A study conducted by Han et al. (2016) found that teachers felt uncomfortable with learning that emphasised active student engagement. The question is, are teachers willing to accept change? Do teachers have sufficient knowledge to implement student-centred learning such as PBL? To find the answer, it is worthwhile to conduct a study to see if teachers have sufficient knowledge to transform into learning that is important to the active involvement of students such as PBL.

Research Objective

1. Identify the level of technological knowledge among vocational college teachers.

2. Identify the level of pedagogical knowledge among vocational college teachers.
3. Identify the level of content knowledge among vocational college teachers.
4. Identify the relationship between technological knowledge, pedagogical knowledge and content knowledge with the implementation of PBL.

Literature Review

PBL Definition

PBL is one of the most innovative teaching methods used by teachers to develop 21st century skills in students (Teacher Education Division, 2015). PBL encourages well-planned exploration, research and project activities with the aim of expanding student mind-set (Curriculum Development Division, 2012). According to Kokotsaki and Wiggins (2016) PBL is a form of student-centred teaching characterized by student autonomy, constructive inquiry, goal setting, collaboration, communication, reflection in real situations. Meanwhile, Holm (2011) defines long-term PBL to provide students with the opportunity to select, plan, investigate and produce products.

PBL is also defined as an innovative learning process, critical strategy, student-driven, teacher-facilitated and student knowledge gained through investigative activities (Bell, 2010). Markham, Larmer and Ravitz (2003) also state that PBL is a systematic teaching method that involves active student engagement, building knowledge and skills through complex, authentic and product-oriented inquiry processes. In addition, PBL is holistic, challenging, and authentic, promotes cooperative learning and relates to the real life of students (Educational Technology Division, 2006).

PBL Elements

The essential elements of PBL are categorised into two groups, namely the essential content and skills of the 21st century (Hallermann, Larmer & Mergendoller, 2011). Essential content is made up of three elements: driving questions, in-depth research, public products, and teaching knowledge and skills. 21st Century skills include student choice and voice, the need for students to know, review and reflec, critical thinking, problem solving, collaboration, collaboration and communication. To help teachers, schools and organizations make reference to improve PBL practice, Larmer and Mergendoller (2010) from Buck Institute Education have proposed eight steps to implement PBL. Among them are Significant content, a need to know, a driving question, student voice and choice, 21st century competencies, in-depth inquiry, critique and revision and public audience.

Method of Implementing the PBL

The Education Technology Division (2006) outlined six steps to implement the PBL approach in schools. Among the steps in implementing the PBL are as follows:

a) Get Research Topics

The topic of study chosen should be based on the student's level of ability and the actual life of the student. The topic of study selected is based on the Syllabus Description.

b) Planning Activities

Pupils are given the autonomy to plan activities by engaging in stimulation. This activity is intended to support the throughout the learning process. When implementing PBL, all implementation processes will be developed by the students themselves and supervised by the facilitator.

c) Create a Schedule or Calendar of Activities

As students are actively involved in the implementation of projects in schools and are given the autonomy to plan, students need to create a timeline or an overall project schedule. The preparation of the timetable and the time limit of each activity are important to ensure the smoothness of the planned project.

d) Observation and Monitoring

Before implementing project activities, teachers should guide students in all aspects appropriate to their role as the facilitator. Teachers' guidance will help students to carry out projects in a more systematic and orderly way.

e) Assessment

PBL involves continuous assessment throughout the learning process. Therefore, rubrics are used to analyse every activity that students perform. The use of the practice rubric serves as a score guide to distinguish students' level of achievement in assessment.

f) Evaluate

Once the project is complete, an evaluation of the entire project will be carried out. In order to evaluate completed projects, individual and group reflections are carried out to make incomplete improvements. Additionally, students can share what they learned, how they learned, and why they learned.

PBL Challenge

Implementing PBL in the classroom will present specific challenges to teachers who use it. There are some challenges that teachers face in implementing PBL. Some of them are as follows

Take a Constructivist Approach

Thomas (2000) reports that an important challenge is that PBL conflicts lead to teachers' confidence in teaching and the necessary balance between student control and teacher control over activities. Teachers as the implementing agents of the new curriculum need time to move towards constructivism, sharpen their skills and shift their beliefs from traditional approaches to student-centred approaches (Grant & Hill, 2006; Rogers et al., 2011). In addition, teachers may doubt their ability to complete the required curriculum due to the time factor in implementing the project. In addition, teachers are also concerned about losing control of students' behaviour for them to work in small groups and find it difficult to implement constructive teaching approaches in the classroom.

Curriculum and Topic Selection

Another challenge facing teachers is the selection of meaningful project topics (Wurdinger et al., 2007). According to Grant and Hill (2006) teachers do not have sufficient expertise in the subjects they are teaching to conduct their investigations correctly. Therefore, when teachers hone their skills in PBL and become creative in planning related activities, they will overcome their concerns and choose the right topics (Wurdinger et al., 2007).

Evaluating Project-Based Learning

Marx et al. (1997) state that, in some cases, teachers ask students to create artefacts that do not require critical thinking and evaluate these artefacts without measuring their understanding. They also point out that assessing the quality of artefacts is difficult because of several features that need to be taken into account, such as design, organization, and accuracy. In addition, Grant and Hill (2006) argue that assessment should include a number of learning products and not just final artefacts. They propose a portfolio as a learning product where students learn through experience through the project phase. Similarly, Barron and Darling-Hammond (2008) emphasise the importance of formative assessment and suggest rubrics, review solutions, overall class discussions, performance assessments, written journals, portfolios, weekly reports, and self-assessments as other forms of assessment. Therefore, teachers need to look at assessment in PBL as a function of various functions. It targets individual and group performance, concrete and cognitive products and metacognitive skills as well as learning and social skills.

Researcher's Statement on Project-Based Learning

According to Casey and Hawson (1993), cognitive approaches focus on the process of thinking, rather than on the accuracy of student-generated responses. In line with the concept of PBL, student-centred learning assumes that students have the ability to "learn by doing" and recognize that they play an active role in learning (Barron et al., 1998). PBL encourages students to use problem solving skills, critical thinking and content knowledge on problems in real-world situations. Students take on greater responsibility than conventional approaches because they need to find information to solve the problems given and thus encourage self-learning among students. In general, all PBL approaches share six core features as described by Barrows (1996):

a) Learning is student-centred
b) Learning takes place in small group tutorials
c) Teachers are facilitators or guides
d) Problems form the focus and stimulus for learning
e) New information is gained through self-learning

PBL represents a constructivist theory in which knowledge is constructed individually and socially constructed from interactions with the environment (Hung, Jonassen & Liu, 2008). Constructive learning approaches emphasize learning and how to think and understand. Constructivist learning involves learning activities in a real-world context where students learn how to question something and promote their natural curiosity to the world. As a result, constructivism promotes higher retention because students seek meaning for themselves rather than meaning built by their teachers (Hmelo & Evensen, 2000).

PBL was introduced in the context of Malaysian education, especially in health science, in the early 1970s (Achike & Nain, 2005), but its growth was slow and almost undocumented. However, by the 1990s, more and more medical and non-medical schools began to introduce PBL. For example, Universiti Teknologi Malaysia (UTM), a public technology-based university is implementing a PBL in engineering. The aim is to produce more high quality graduates, where it is said that an engineering graduate should be equipped with skills in communication, teamwork, and problem solving (Mohd-Yusof et al., 2005). Said et al. (2005) also demonstrated the need for electrical engineering graduates equipped with analytical skills, critical thinking, technical skills, team work and time management. Overall, the PBB in Malaysian higher education is more integrated into engineering and medical schools than in other subject areas including teacher education.

Research Methodology

Correlative descriptive quantitative methods are used to determine the relationship between technological knowledge, pedagogical knowledge and content knowledge with the implementation of PBL. In addition, the study also aimed at determining the technological knowledge level, pedagogical knowledge level and teacher content knowledge level. This study involved 30 teachers teaching at Chenor Vocational College (Agriculture), Pahang. In conducting this study, researchers used questionnaires to obtain data from respondents. In this study, researchers used questionnaire instruments adapted from Schmidt et al. (2009), Pamuk et al. (2015) and Hixson, Ravitz and Whisman (2012) to achieve research objective. Before the instrument was distributed to the respondents, verification by three experts was carried out immediately after the translation process. Researchers have made improvements to the instrument based on feedback received from these three experts. There were five questionnaires used to measure each of the study variables. Part A focuses on respondents' background which includes gender, educational background and diploma or certificate of proficiency held by respondents. In addition to teaching experience, subjects are taught and have teachers attend PBL courses. Respondents were asked to indicate the appropriate answer from the proposed answer. Part B contains 7 question items to test the pedagogical knowledge of teachers. Section C and Section D, meanwhile, contain 8 questions about pedagogical knowledge and content knowledge. In Section E, there are 52 question items to test the implementation of PBL in terms of the practice of teaching and learning in the 21st century. The Likert-5 points scale is used in Sections B, C and E while the Likert-4 points are used in Section D.

Data Analysis

To make the data collected more meaningful, the researchers conducted data analysis. All data obtained through the questionnaire were processed and analysed using Statistical Package for the Social Sciences (SPSS) software version 23. Descriptive statistics and inference statistics were used to identify the technological knowledge level, pedagogical knowledge level and content knowledge level of the Malaysian Diploma Vocational program. In addition, it is also to identify the relationship between technological knowledge, pedagogical knowledge and content knowledge with the implementation of PBL. To determine the level of technological knowledge and teachers' pedagogical knowledge of PBL implementation, the mean scores were interpreted based on a 5-point Likert Scale adapted from Moidunny (2009) as shown in Table 1.

Table 1
Interpretation of Mean Scores

Mean score	Interpretation of Mean
1.00-1.80	Very Low
1.90-2.60	Low
2.70- 3.40	Moderate
3.50-4.20	High
4.30-5.00	Very High

Furthermore, to determine the level of knowledge of Malaysian Diploma Vocational teachers' content, the mean scores were interpreted based on a 4-point Likert Scale adapted from Riduwan (2012). Table 2 shows the mean interpretation of the 4-point Likert Scale.

Table 2
Interpretation of Mean Scores

Mean Score	Interpretation of Mean
1.00-1.50	Weak
1.51- 2.50	Low
2.51- 3.50	Moderate
3.51-4.00	High

In addition, to identify the relationship between technological knowledge, pedagogical knowledge and content knowledge, researchers used Pearson correlations. The Pearson 'r' correlation was used to examine the relationship between these three knowledge and the implementation of the PBL. The value of 'r' represents the strength of either the strong or weak correlation studied. Table 3 shows the value of the 'r' coefficient and the strength of the relationship as outlined by Cohen (1988).

Table 3
Cohen's Correlation Strengths (1988)

'r' value	Relationship Interpretation
0.50-1.00	Large Correlation
0.30- 0.49	Moderate Correlation
0.10-0.29	Small Correlation

Research Finding

The data obtained through the questionnaire were processed and analysed based on the objectives of the study using SPSS software version 23. Explanation of instrument reliability, data normality, technology knowledge level, pedagogical knowledge level, content knowledge level and relationship between technological knowledge, pedagogical knowledge and knowledge content with PBL is as follows:

Instrument Reliability

To determine the Cronbach Alpha value, the obtained data were analysed using Statistical Package for Social Science (SPSS) version 23. The purpose was to determine the reliability of the instrument. Instrument trust is very important for testing the stability and consistency of data. Reliability refers to the consistency, accuracy or accuracy of the measurements made

(Ghafar, 1997). According to Creswell (2008) the Cronbach Alpha coefficient value greater than 0.6 is an acceptable instrument and 0.72 is better and more suitable for use in the study. Table 5 shows the results of the confidence tests conducted to see the actual consistency of the instrument.

Table 4
Cronbach Alpha Reliability Index for Knowledge and Implementation PBL

Items	Number of Items	Total of Items	Cronbach Alpha value	Amount of Values Cronbach Alpha
Technology Knowledge	B1-B7	7	0.899	
Pedagogy Knowledge	C1-C8	8	0.884	
Content Knowledge	D1-D8	8	0.865	
Implementation PBL	E1-E52	52	0.931	
Dimension				
Critical Thinking Skills	E1-E7	7	0.831	
Collaboration Skills	E8-E13	6	0.869	
Communication skills	E14-E19	6	0.881	
Creativity and Innovation Skills	E20-E25	6	0.746	
Self-esteem Skills	E26-E32	7	0.892	
Global Networking Skills	E33-E39	4	0.403	
Local Networking Skills	E40-E44	5	0.503	
Technology Use Skills	E45-E52	8	0.912	
TOTAL				**0.917**

The results of the reliability test conducted on the whole respondents data showed that Cronbach Alpha obtained was 0.917. It shows the instrument is in good working condition with high degree of consistency. Table 5 shows the interpretation of Cronbach Alpha scores by Bond and Fox (2015).

Table 5
Interpretation of Cronbach Alpha Score

Cronbach Alpha Score	Reliability
0.8 - 1.0	Very good, effective at a high level of consistency
0.7 - 0.8	Good and acceptable
0.6 - 0.7	Acceptable
<0.6	The Item needs to be refined
<0.5	The Item needs to be dropped

Referring to the table above, the reliability values obtained during the pilot study for all constructs ranged from 0.403 to 0.912. Overall it was found that all variables had a reliability

value of greater than 0.70 except for two constructs in the PBL implementation dimension: Global Network and Local Network with Cronbach Alpha values less than 0.6. For Global Network Dimensions, Cronbach Alpha's total value is 0.403 while for Global Network dimensions Cronbach Alpha's value is 0.503. According to Bond and Fox (2015) items with only Cronbach Alpha 0.6 to 0.7 were acceptable for further study. After the two dimensions were eliminated, the researchers re-analysed the construct. It is found that the Cronbach Alpha value of the PBL implementation dimension increased from 0.931 to 0.946. Table 6 shows the two constructs eliminated based on the PBL implementation dimensions.

Table 6
Items Removed by Construction

Construct	Dimension	Item	Cronbach Alpha value	Amount of Values Cronbach Alpha
Implementation PBL	Global Skills	Networking		0.403
		E33	0.318	
		E34	0.302	
		E35	0.428	
		E36	0.282	
		E37	0.493	
		E38	0.251	
		E39	0.476	
	Local Skills	Networking		0.503
		E40	0.523	
		E41	0.405	
		E42	0.305	
		E43	0.503	
		E44	0.477	

Referring to the table above, all of the items found in Global Network constructs show a Cronbach Alpha coefficient of less than 0.5. This indicates that all of these items need to be dropped (Bond & Fox, 2015). Items dropped are as follows E33 (0.318), E34 (0.302), E35 (0.428), E36 (0.282), E37 (0.493), E38 (0.251) and E39 (0.476). Meanwhile, Bond and Fox (2015) also stated that only trust values of 0.6 to 0.7 could be accepted for further studies. Therefore, the Local Network constructions of E40 (0.523), E41 (0.405), E42 (0.305), E43 (0.503) and E44 (0.477) were also removed.

It was found that all study variables showed trust values above 0.70 and were in good and effective condition with high degree of consistency (Bond & Fox, 2015) except for implementation study variables for the Global Network and Local Network dimensions of less than 0.6. These values indicate that all variables are suitable for actual study except for the two dimensions in the implementation of the PBL that have been eliminated.

Normality Test

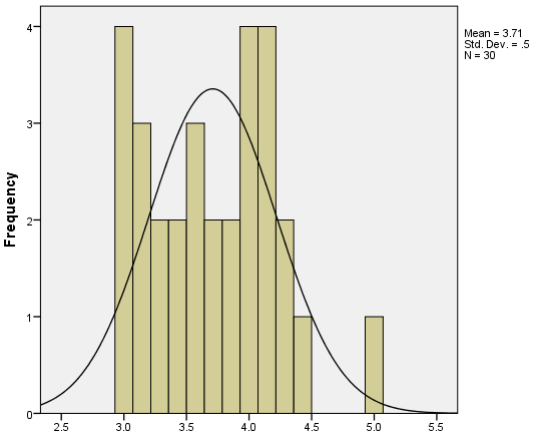
Normality tests are important to determine whether the data obtained is normal or abnormal. In the Pearson correlation test and regression various respondents' data were collected to be

normalized to meet the basic requirements for performing inference analysis. To identify data validity, researchers used two methods such as viewing the histogram curve and Normal Probability Plot (Q-Q plots).

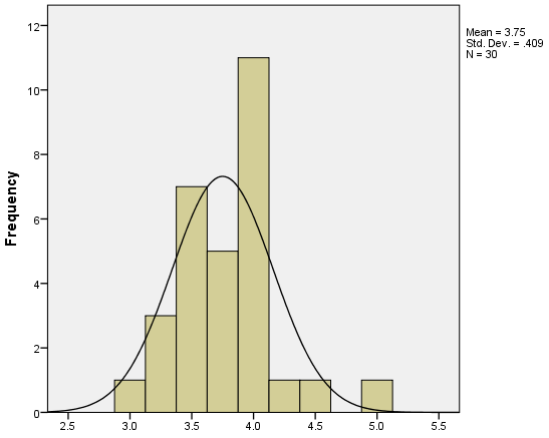
Histogram

The study involved variables namely technological knowledge, pedagogical knowledge, content knowledge and PBL implementation. Visual analysis by histogram shows a histogram shaped to resemble a bell shape. According to Darusalam and Hussin (2016) it is said that normal distribution occurs when the population distribution is within a moderate range. Figure 1 shows the histogram illustration of all the variables studied.

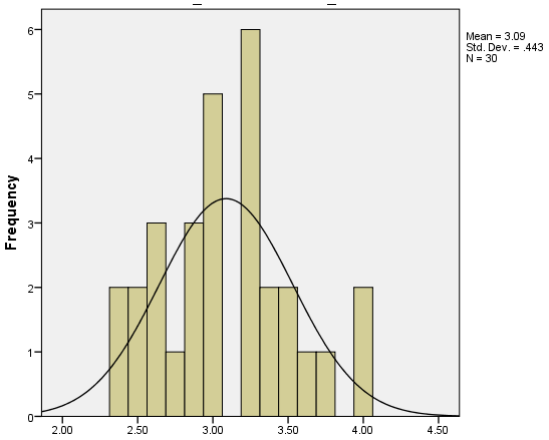
(a) Technology Knowledge



(b) Pedagogy Knowledge



(c) Content Knowledge



(d) Implementation PBL

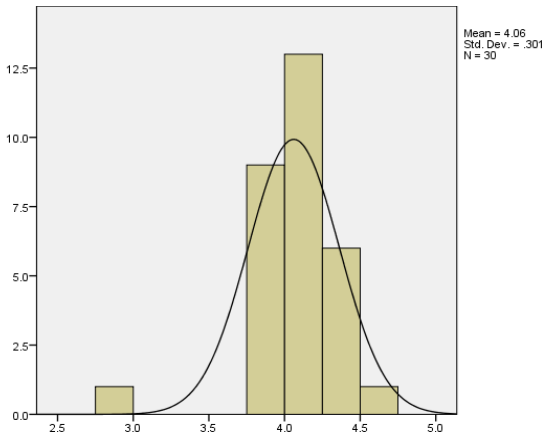


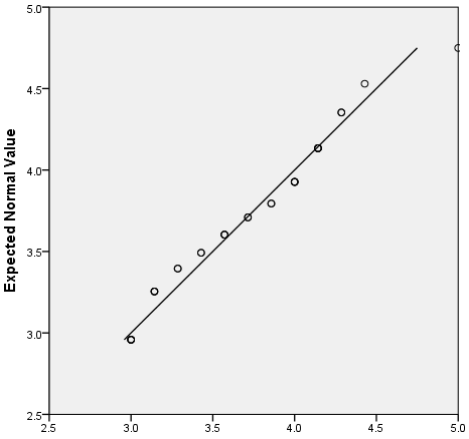
Figure 1: Histogram of All Study Variables

Based on Figure 1, the shape of the histogram curve is “bell shape” and this shows normal scattering data for all study variables.

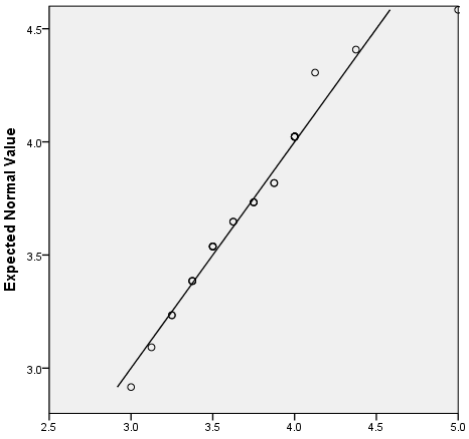
Normal Probability Plots (Q-Q plots)

Data is normally distributed if the data collected is close to a straight line (Pallant, 2007). Figure 2 shows a graph of the Normal Probability Plot (Q-Q plots) of all the variables studied.

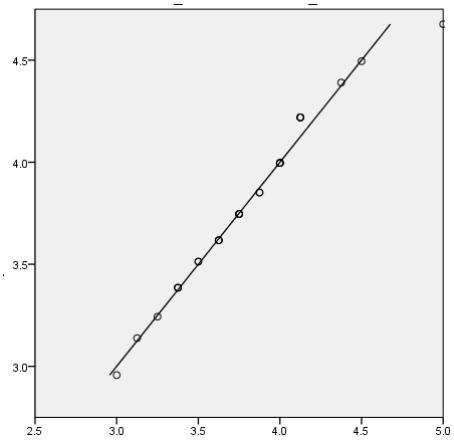
(b) Technology Knowledge



(b) Pedagogy Knowledge



(c) Content Knowledge



(d) Implementation PBL

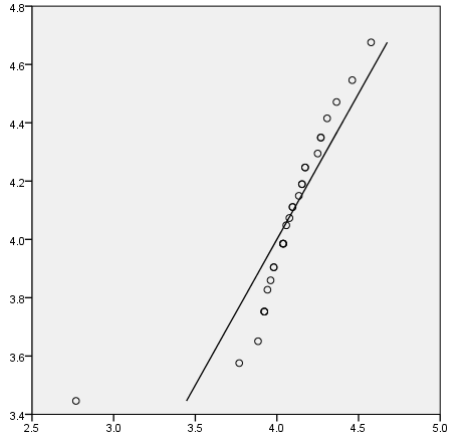


Figure 2: Normal Probability Plot (Q-Q plots) for All Study Variables

Based on Figure 2, the data of all the study variables are close to the straight line. This indicates that the data are normally distributed for each variable studied.

Overall, histogram shape and Normal Probability Plots (Q-Q plots) indicate that the data are normally distributed for all study variables. Therefore, the researchers used Pearson's correlation analysis to look at the relationship between technological knowledge, pedagogical knowledge and content knowledge with the implementation of PBL.

Level of Knowledge in Technology for the implementation of the PBL

Table 7
Mean distribution and Standard Deviation for Technology Knowledge

	Item	Mean	SD	Level	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
B1	I know how to solve my own technical problems.	3.67	0.606	High			12 40%	16 53.3%	2 6.7%
B2	I can learn technology easily.	3.60	0.621	High			14 46.7%	14 46.7%	2 6.7%
B3	I keep up with important new technologies.	3.77	0.568	High			9 30%	19 63.3%	2 6.7%
B4	I frequently play around with the technology.	3.67	0.606	High			12 40%	16 53.3%	2 6.7%
B5	I know about a lot of different technologies.	3.77	0.679	High			11 36.7%	15 50%	4 13.3%
B6	I have the technical skills I need to use technology.	3.77	0.728	High			12 40%	13 43.3%	5 16.7%
B7	I have had sufficient opportunities to work with different technologies.	3.73	0.691	High			12 40%	14 46.7%	4 13.3%
	Overall Mean	**3.71**	**0.51**	**High**					

Level of knowledge technology: 1.00 – 1.50= Weak, 1.51-2.50= Low, 2.51-3.50=Moderate, 3.51-4.00=High

Table 7 shows the mean and standard deviation of all items in the technology knowledge. Findings indicate that the mean of technological knowledge ranges from 3.60 to 3.77. This indicates that respondents have the knowledge of technology to implement PBL in the classroom. The highest meanings in technology knowledge items were knowledge of new technology (M = 3.77, SD= 0.568), knowledge of different technologies (M = 3.77, SD= 0.679) and knowledge of technical skills required to apply technology (M = 3.77, SD= 0.728). Items knowledge the new technology found that 19 (63.3%) agreed and 2 (6.7%) strongly agreed with this statement. Meanwhile, 4 people (13.3%) strongly agreed and 15 (50%) agreed to be knowledgeable in using different technologies. Knowledgeable items in the technical skills

required to use the technology also recorded the highest mean value of which 60% (18) of respondents strongly agreed with this statement. At the same time, the lowest mean refers to item B2 easy to learn new technology (M = 3.60, SD= 0.621). The analysis showed that 53.4% (16 people) of the respondents strongly agreed with this statement. Overall, technological knowledge was high (M = 3.71, SD= 0.51). This shows that respondents are highly skilled in the knowledge of technology for implementing PBL in the classroom.

Level of Knowledge in Pedagogy for the implementation of the PBL

Table 8
Mean distribution and Standard Deviation for Pedagogy Knowledge

	Item	Mean	SD	Level	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
C1	I know how to assess student performance in a classroom.	3.77	0.504	High			8 26.7%	21 70%	1 3.3%
C2	I can adapt my teaching based upon what students currently understand or do not understand.	3.87	0.507	High			6 20%	22 73.3%	2 6.7%
C3	I can adapt my teaching style to different learners.	3.67	0.606	High			12 40%	16 53.3%	2 6.7%
C4	I can assess student learning in multiple ways.	3.80	0.610	High			9 30%	18 60%	3 10%
C5	I can use a wide range of teaching approaches in a classroom setting.	3.67	0.606	High			12 40%	16 53.3%	2 6.7%
C6	I am familiar with common student understandings.	3.60	0.563	High			13 43.3%	16 53.3%	1 3.3%
C7	I am familiar with common student misconceptions.	3.70	0.596	High			11 36.6%	17 56.6%	2 6.7%
C8	I know how to maintain classroom management.	3.93	0.365	High			3 10%	26 86.7%	1 3.3%

Overall Mean	**3.75**	**0.409**	**High**

Level of knowledge pedagogy: 1.00 – 1.50= Weak, 1.51-2.50= Low, 2.51-3.50=Moderate, 3.51-4.00=High

Table 8 shows the mean and standard deviation of all items in pedagogical knowledge. Findings indicate that the mean of pedagogical knowledge ranges from 3.93 to 3.60. This indicates that respondents have a high level of pedagogical knowledge in implementing PBL in the classroom. The highest mean value was for items knowing how to maintain classroom management (M = 3.93, SD= 0.365). A total of 26 people (86.7%) agreed and only one (3.3%) strongly agreed with the statement. Subsequently, the lowest mean was an item sensitive to students' understanding of a matter (M = 3.60, SD= 0.563). The item found that 16 (53.3%) agreed and only one (3.3%) strongly agreed with this statement. Overall, the mean of pedagogical knowledge was 3.75 (SD = 0.409). This shows that pedagogical knowledge is at a high level. This finding suggests that respondents were highly skilled in pedagogical knowledge in implementing PBL.

Level of Knowledge in Content for the implementation of the PBL

Table 9

Mean distribution and Standard Deviation for Content Knowledge

	Item	Mean	SD	Level	Strongly Disagree	Disagree	Agree	Strongly Agree
D1	I have sufficient knowledge in my field to implement PBL.	3.30	0.535	Moderate		1 3.3%	19 63.3%	10 33.3%
D2	I know basic concepts such as formulas and definitions in my field to implement PBL.	3.00	0.695	Moderate	1 3.3%	4 13.3%	19 63.3%	6 20%
D3	I understand the content of the lessons I teach to implement PBL.	3.03	0.556	Moderate		4 13.3%	21 70%	5 16.7%
D4	I can present the same subject matter at different levels.	3.00	0.587	Moderate		5 16.7%	20 66.7%	5 16.7%
D5	I can explain background details of concepts, formulas and definitions in my field to implement PBL.	3.20	0.551	Moderate		2 6.7%	20 66.7%	8 26.7%

D6	I have adequate knowledge in explaining relations among different concept on the subject matter in the implementation of PBL.	3.03	0.615	Moderate	5 16.7%	19 63.3%	6 20%
D7	I can explain why specific topic in important.	3.03	0.669	Moderate	6 20%	17 56.7%	7 23.3%
D8	I can make connections with content I teach and daily life.	3.10	0.712	Moderate	6 20%	15 50%	9 30%
	Overall Mean	**3.08**	**0.44**	**Moderate**			

Level of knowledge content: 1.00 – 1.50= Weak, 1.51-2.50= Low, 2.51-3.50=Moderate, 3.51-4.00=High

Table 9 shows the mean and standard deviation of all items in content knowledge. Findings indicate the mean of content knowledge is between 3.30 and 3.00. This indicates that respondents have content knowledge to implement PBL in the classroom. Items with sufficient knowledge in my field to implement the PBL had a mean value of 3.30 with a standard deviation of 0.535. The analysis showed that 96.6% (29 people) of the respondents strongly agreed with this statement.

Next, there were the two lowest levels of knowledge of the concepts and definitions in my field for implementing PBL (M = 3.00, SD= 0.695) and knowledgeable for presenting the same teaching content at different levels of student ability (M = 3.00, SD= 0.587). Knowledgeable items on the concepts and definitions in my field for implementing PBL found that 6 (20%) strongly agreed and 19 (63.3%) agreed with this statement. Meanwhile, 16.7% (5 people) strongly agreed and 66.7% (20 people) agreed knowledgeable to present the same teaching content at different levels of student ability.

The mean content knowledge was 3.08 with a standard deviation of 0.44. This indicates that the level of content knowledge is at a moderate level where respondents only master content knowledge in the areas taught to implement PBL.

The relationship between technological knowledge, pedagogical knowledge and content knowledge with PBL implementation

The objective of the latter study was to determine the relationship between technological knowledge, pedagogical knowledge and content knowledge with the implementation of PBL. Statistical analysis of Pearson correlation was applied to the variables studied with the implementation of the PBL. The relationship between technological knowledge, pedagogical knowledge and content knowledge with the implementation of the PBL refers to Table 10.

Table 10
Pearson Correlation Analysis for Technological Knowledge, Pedagogical Knowledge and Content Knowledge with The implementation of the PBL

	Mean for PBL Implementation	Interpretation of Relationships
Mean for Technology Knowledge	.421*	Moderate Correlation
Mean for Pedagogy Knowledge	.139	Small Correlation
Mean for Content Knowledge	-.410*	Moderate Correlation

Pearson correlation analysis showed that there was a significant positive and moderate relationship between technology knowledge and PBL implementation (N = 30, r = 0.421 *, p = 0.05), weak positive relationship but did not reach a significant level of pedagogical knowledge and implementation of PBL (N = 30, r = 0.139, p = 0.05) and a significant negative and moderate relationship between content knowledge and PBL implementation (N = 30, r = -.410 *, p = 0.05).

Conclusion and Recommendations Required

This study aims to identify the level of technological knowledge, pedagogical knowledge and content knowledge among vocational college teachers. This study also looked at the relationship between the study variables and the implementation of PBL. It was found that the level of technological knowledge (M = 3.71, SD = 0.51) was high. This shows that teachers are knowledgeable about technology for implementing PBL. The findings also reflect technology-related courses and workshops organized by the Vocational Technical Education Division and vocational colleges have successfully improved the ability to integrate technology into teaching. In addition, products and services through e-commerce platforms also help teachers gain new knowledge to implement teaching more effectively. This provides an opportunity for teachers to continually improve their technological knowledge in order to assist in the successful implementation of PBL. The findings of this study are in line with the findings of Apau (2017). However, the findings of this study are contrary to the study conducted by Ab Majid and Ismail (2018) where teachers' technological knowledge is at a relatively high level.

The study found that pedagogical knowledge was also high (M = 3.75, SD = 0.409). This shows that teachers are knowledgeable about pedagogy when implementing PBL in the classroom. Researchers found that respondents had knowledge of classroom management, approaches, teaching methods and techniques, and assessments used to assess student performance. In addition, the combination of technological knowledge that is part of today's pedagogy also contributes to the increase in teacher pedagogical knowledge. The findings of this study are in line with previous studies by Bahador, Othman and Saidon (2017) where pedagogical knowledge is at a high level. However, the findings of this study are not in line with the findings of Mahamod and Hassan (2018) which show that pedagogical knowledge is at a low level.

Meanwhile, research findings on content knowledge have come to different conclusions where content knowledge level is at a moderate level (M = 3.08, SD = 0.44). This shows that teachers are only knowledgeable in the areas taught to implement PBL. Therefore, ongoing training through workshops and courses to enhance the content knowledge of the areas taught should be implemented. According to Tamuri, Ismail and Jasmi (2012) knowledge sharing sessions such as discussions can help in enhancing teachers' knowledge of the areas

taught. In addition, discussions and forums through various social media applications and websites such as Telegram and Blog have become an effective new training medium for improving teachers' content knowledge.

Pearson correlation analysis showed that there was a significant relationship between technological knowledge and PBL implementation (N = 30, r = 0.421 *, p = 0.05). Both are positively related and the strength of the relationship between the two is moderate. This shows that the level of technological knowledge that teachers have does not significantly influence the implementation of PBL. This means that there are other components that teachers need to master in order to implement PBL. Therefore, the Ministry of Education Malaysia should provide teachers with training in various aspects such as content knowledge, pedagogical knowledge, technology knowledge and other relevant aspects and not just focus on one aspect.

However, it was found that there was a weak positive relationship but did not reach a significant level of pedagogical knowledge and PBL implementation (N = 30, r = 0.139, p = 0.05). This is due to factors such as the demography of respondents where the majority of respondents comprise of novice teachers by 66.6%, lack the knowledge and experience in managing the PBL. Therefore, teachers need examples to follow or guidance to be conduct PBL. Therefore, it is recommended that schooling programs be conducted at school level in order to guide teachers in implementing PBL. In addition, vocational colleges can design Professional Learning Communities to help teachers understand and understand the essence of PBL, the skills and techniques for implementing PBL.

The study also found that there was a significant negative and moderate relationship between content knowledge and PBL implementation (N = 30, r = -.410 *, p = 0.05). This indicates that the higher the knowledge of the content that the teacher has, the lower the implementation of PBL. The findings of this study enable the vocational colleges to conduct regular and ongoing monitoring to identify the active involvement of students in the implementation of PBL. Active participation of students in the implementation of PBL should be a practice of teachers when teaching in the classroom. This effort indirectly supports the learning of 21st century students in conducting project teaching at vocational colleges.

Overall research on PBL implementation and the relationship between technological knowledge, pedagogical knowledge and content knowledge with PBL implementation have opened the way for other researchers to conduct research. Further qualitative studies can be applied to gain more information on technological knowledge, pedagogical knowledge and content knowledge on PBL implementation. Given that the survey was conducted using the questionnaire to collect data, the finding of the information was only focused on the questions in the questionnaire. Therefore, using a qualitative approach, it is hoped that the results will be analysed from different perspectives. In addition, researchers can look at the implementation of the PBL in a broader sense.

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