THE EVALUATION OF PROJECT-BASED LEARNING: A CASE STUDY AT MECHANICAL ENGINEERING DEPARTMENT AT A POLYTECHNIC IN MALAYSIA

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ABSTRACT

The purpose of this case study was to evaluate the Project-Based Learning that was implemented at the Mechanical Engineering Department in a polytechnic in Malaysia. Project-Based Learning is a different approach than the traditional learning in the sense that it is a student-centered learning approach based on the principles of constructivism. This study employed CIPP model because it is a comprehensive model for evaluation. However, the context dimension was dropped because the present study did not focus on the needs analysis. The input dimension assesses the module and supervisor's readiness. The process dimension evaluates the project activities and the product dimension assesses the quality of the product. This study involved a random sample of 118 students and 43 supervisors in the Mechanical Engineering Department. The study found that both the students and supervisors agreed that Project-Based Learning approach is appropriate for the final project course J5012. In addition, both groups of respondents believed that the supervisors possesed adequate technical knowledge and implemented supervisory duties effectively. Nevertheless, students perceived the module content was hard to understand. In terms of finding ideas, both students and supervisors agreed that students were encouraged to assess the real problem by their supervisors. However, the supervisors were uncertain whether the students went to the library to get the ideas for their project. In addition, the supervisors were barely agreed about the creativity of the students in finding the project ideas. However, students and their supervisors believed that critical thinking and creativity were needed in the Project-Based Learning. The respondents also believed that e-SOLMS helped the students to work in group to complete the project. In terms of project duration, the students were uncertain regarding the sufficiency of the time to complete the project. The students barely agreed that the machines and equipments at the polytechnic were appropriate for the project. In terms of product, both students and supervisors believed that the students' products were marketable because they have good design and aesthetic values. Finally, the present study puts forward a new framework for Project-Based Learning.

PENILAIAN TERHADAP PEMBELAJARAN BERASASKAN PROJEK: SATU KAJIAN KES DI JABATAN KEJURUTERAAN MEKANIKAL DI SEBUAH POLITEKNIK DI MALAYSIA

ABSTRAK

Kajian kes ini bertujuan untuk menilai Pembelajaran Berasaskan Projek yang telah dilaksanakan di Jabatan Kejuruteraan Mekanikal di Politeknik di Malaysia. Pembelajaran Berasaskan Projek ialah pendekatan yang berbeza daripada pembelajaran tradisional iaitu ia adalah pembelajaran yang berpusat kepada pelajar berdasarkan prinsip konstruktivism. Kajian ini menggunakan model Penilaian CIPP kerana ia merupakan model yang komprehensif untuk penilaian. Dimensi konteks digugurkan kerana kajian ini tidak memberi tumpuan kepada analisis keperluan. Dimensi input menilai modul dan kesediaan penyelia. Dimensi proses pula menilai aktiviti kemajuan projek manakala dimensi produk menilai kualiti produk. Kajian ini melibatkan 118 orang pelajar dan 43 penyelia di Jabatan Kejuruteraan Mekanikal. Dapatan kajian ini menunjukkan bahawa pelajar dan penyelia bersetuju bahawa Pendekatan Pembelajaran Berasaskan Projek adalah sesuai untuk kursus projek akhir J5012. Responden juga yakin bahawa penyelia mempunyai kemahiran teknikal dan menjalankan proses penyeliaan dengan efektif tetapi pelajar berpendapat kandungan modul adalah sukar untuk difahami. Dari segi mencari idea, pelajar dan penyelia bersetuju bahawa pelajar digalakkan oleh penyelia mereka untuk mencari idea dengan melihat permasalahan sebenar. Namun, penyelia tidak pasti sama ada idea projek didapati dari pencarian literatur yang dilakukan oleh pelajar di perpustakaan. Penyelia juga tidak pasti sama ada pelajar adalah kreatif dalam mencari idea untuk projek. Pelajar dan penyelia amat bersetuju bahawa pemikiran kritikal dan kreatif diperlukan dalam Pembelajaran Berasaskan Projek. Responden juga yakin bahawa e-SOLMS telah membantu pelajar bekerja secara pasukan khususnya dalam menyelesaikan projek. Dari segi masa, pelajar tidak pasti sama ada masa yang diperuntukkan adalah mencukupi untuk menjalankan projek. Pelajar juga kurang bersetuju bahawa peralatan dan mesin di politeknik tersebut adalah mencukupi untuk projek. Dari segi produk, pelajar dan penyelia percaya bahawa produk mereka berguna kerana produk itu memiliki reka bentuk yang baik dan mempunyai nilai estetika. Akhir sekali, kajian ini mengemukakan satu kerangka baharu untuk pelaksanaan Pembelajaran Berasaskan Projek.

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ABBREVIATIONS

ANCOVA	Analysis of Covariance
BIE	Buck Institute for Education
CBA	Competency Based Assessment
CDIO	Conceive, Design, Implement, and Operate
CIPP	Context, Input, Process and Product
CMC	Computer-Mediated Communication
COE	Center of Excellence
COT	Center of Technology
CPR	Calibrated Peer Review
DAD	Diploma in Automotive Mechanical Engineering
DEM	Diploma in General Mechanical Engineering
DPT	Diploma in Agriculture Mechanical Engineering
e-SOLMS	Electronic Students Oriented Learning Management System
ETP	Economic Transformation Program
GNI	Gross National Income
GTP	Government Transformation Program
JPP	Jabatan Pengajian Politeknik
KPT	Kementerian Pengajian Tinggi
KPIs	Key Performance Indicators
MIT	Massachusetts Institute of Technology
NEAC	National Economic Advisory Council
NKEAs	National Key Economic Areas
OECD	Organisation for Economic Co-operation and Development
PBL	Problem-Based Learning
PjBL	Project-Based Learning
PICS	Productivity and Investment Climate Survey
R&D	Research and Development

SDL	Self Directed Learning
SET	Students Evaluation of Teaching
SPSS	Software Package for Statistical Analysis
STEM	Science, Technology, Engineering and Mathematic
TVE	Technical and Vocational Education
UniSA	University of South Australia
TVET	Technical and Vocational Education and Training

CHAPTER 1

INTRODUCTION

1.1. Introduction

Malaysian Government Transformation Program (GTP) and Economic Transformation Program (ETP) were launched in 2010 to achieve the high-income status. The ETP builds upon the 10th Malaysia Plan (2011-2015) which focuses on the 12 National Key Economic Areas (NKEAs). The four largest NKEAs (Oil, Gas and Energy, Financial Services, Palm Oil, and Wholesale and Retail) are projected to generate over 60 percent of the future GNI growth. ETP was designed to transform Malaysia into a high-income economy with a GNI of MYR 1.7 trillion (USD 0.53 trillion) in 2020 compared to MYR 660 billion (USD 206 billion) in 2009. This means

that the GNI per capita will have to rise from MYR 23,700 (USD 7,406) in 2009 to MYR 48,000 (USD 15,000) by 2020 (http://etp.pemandu.gov.my). This level of GNI per capita would correspond to that of a high-income economy as currently defined by the World Bank.

The Malaysia's transformation programs were propelled by the aspiration to stand equal with other developed nations by 2020 and to become a stalwart of education hub, especially in the Asian region. The core thrust of the transformation agenda is the development of high quality human capital. And a nation's competitivenesslies in its human capital and the strength of its workforce is dependent on the quality of its education (Douglass & Edelstein, 2009; Ramlee&Norhasni, 2008). Thus, education is an important catalyst in developing talented, relevant, skillful and innovative human resources. Education continues to play a vital role in developing and transforming Malaysia for the next decade.

Malaysia aims to become the education hub in the regionby 2015. Strategic policies have been geared toward encouraging foreign universities to set up branches or offshore campuses in Malaysia. Currently, there are about a million students enrolled at Malaysian higher educational institutions (www.thestar.com.my). Higher education sector is at the forefront in driving the nation's progress and development. This sector plays a key role in shifting Malaysia's position tobecome a high income economy by 2020. The Ministry of Higher Education has deployed critical strategies to strengthen its quality human resources in order to achieve the transformation's goals. The development of human capital is carried out by collaborative efforts using

innovative methods, particularly in the context of teaching and learning (Khaled, 2013).

The Ministry of Higher Education through its dynamic efforts and collaboration with institutions of higher learning and various agencies has laid a strong foundation to supply quality graduates for Malaysian workforce (Khaled, 2013). In terms of Higher Education Institutionsas of October 2011, there are 20 public universities, 26 private universities, 23 private university colleges, 28 polytechnics, 74 comunity colleges, 434 private colleges and several branch campuses of foreign universities (www.moe.gov.my/).

Economic competitiveness of a country is based on the skills of its workforce. The skills and competencies of the workforce are dependent on the quality of the country's education and training system. Technical and Vocational Education (TVE) is one of the various disciplines of education that can generate economic growth of a country (Ramlee & Abu, 2004). TVE was designed to provide opportunities for students who have the tendency toward vocational fields and technology to fulfill the technical workforce. It is perceived as one of the crucial elements in enhancing economics of productivity (Min, 1995; Ramlee & Greenan, 2002). Since 1969 when the first polytechnics, Ungku Omar was established, the polytechnics system in Malaysia has evolved. With 60,840 students in 2009 to 87,440 in 2012 (Sahul Hamed et al., 2010), the polytechnics have expanded to become Malaysia's largest public tertiary TVE provider in this country. In 2010, Polytechnics Transformation Plan was launched with these goals (Department of Polytechnics Education, 2010):

(1) Enhance the polytechnics as a leading institution in the field of technical training in the semi-professional sector

(2) Strengthen the relevance and responsiveness of polytechnics programs to the needs of the national economic development

(3) Steer the niche techonology areas to produce quality and competitive graduates

(4) Build excellent reputation and brand, and

(5) Diversify and expand its programs

The demand for knowledge and skilled workers is growing due to the economic reality in 2020. High productivity and innovation are created by highly knowledgable and innovative workforce – as evident in advanced countries such as the United States of America, Finland, Germany, South Korea and Japan. Generating human capital for high income economy requires the polytechnics system to transform itself ready for an innovation-led economy by advancing its graduates to higher levels of education and training. Thus, Project-Based Learning was introduced in the Malaysian polytechnics curriculum in order to produce creative and innovative graduates. It is believed that students using Project-Based Learning are actively involved in authentic inquiry, knowledge construction, autonomous learning, scaffolding, and proposing creative solutions (Chambers et al., 2007). In addition, upgrading a premier polytechnics into a polytechnic university is another option to boost the techo-creativity reservoir among polytechnic graduates. A combination of intellectual and technical prowess will produce world-class knowledge workers that will bring Malaysia into a greater height.

Nevertheless, the present challenges facing polytechnics such as lack of innovative leadership, heavily centralized system, lack of PhD-qualified lecturers, poor R&D facilities, traditional pedagogies, heavy teaching workload, weak industrial linkages, inadequate funding and poor incentives (as compared to universities) may slow down the transformation pace. In addition, the issue of time frame to achieve all the 56 KPIs in the *Premier Polytechnics Strategic Plan (2010)* is viewed as unreasonable by the academic staff and the Heads of Department (SahulHamed et al., 2010).

As mentioned earlier, transformation will not materialize without quality graduates. Creativity and innovationof a student can be assessed based on his or her design, product, and solution. In vocational and engineering fields, quality graduates are able to design and produce quality products. The implementation of Project-Based Learning specifically in engineering program is not new. Since the 16thcentury, Project-Based Learning has been implemented in the architectural field and has shown considerable success (Knoll, 1997). In general, Project-Based Learning is considered as a non-traditional pedagogical model that emphasizes student-centered learning by embarking on complex, real-world projects through which the learners develop higher-order competencies. Based on socio-constructivist theory (Vygotsky, 1978), Project-Based Learning stresses on knowledge construction derived from previous knowledge, experience, and interaction with the social environment. In addition, advocates assert that Project-Based Learning prepares students for the independent, critical thinking and effective teamwork skills as required in the real workplace (David, 2008). In the nutshell, Project-Based Learning was introduced because of the ineffectiveness of the traditional lecture method.

The traditional teaching method, however, is still preferred by the majority of teachers in the exam-oriented system including in Malaysia. According to Diaz and Cartnal (1999), substantial number of teachers thought that traditional teaching method was more suitable than the student-centered method when the focus is on the examination and the class size is large. In addition, Trumbull and Slack (1991) assert that many teachers fail to adopt constructivism in their classrooms because they have experienced "success" with the teacher-centered approach. Nevertheless, the major weakness of the traditional teaching method was the failure (of the students) to make connection between new information and what they had already known and between what they learnt and the real life situation.

In the traditional paradigm, teachers act as a source of knowledge. Thus, it is different from Project-Based Learning, where teachers act as a facilitator of learning. Project-Based Learning is an approach that transforms teaching from "teachers telling" to "students doing" (El Kamoun et al., 2011). Students become active problem-solvers and meaning-makers. Further, the students collaborate or cooperate forming groups, organize their learning activities, conduct research, synthesize information, organize time and reflect their learning. In Project-Based Learning, a teacher is not "sage on the stage"; but rather a "guide on the side" and assumes the role of cognitive and meta-cognitive coach (by asking, monitoring, probing, managing, group relating, keep moving) rather than knowledge-holder and disseminator (Schneider, 2005).

An effective teacher should be able to apply varied teaching techniques to ensure his or her class is appealing and meaningful. Project-Based Learning approach

has its root in the constructivist theory (Blank, 1997). Thus, Project-Based Learning is a student-centered learning approach which is more interactive, fun and innovative than the lecture mode. Solving meaningful real-life problems is the basic principle of the Project-Based Learning. According to David (2008), Project-Based Learning aims to engage learners in realistic, thought-provoking problems. Project-Based Learning has almost the "same" concept as that of Problem-Based Learning because both were the offshoot of constructivism. However, there are slight differences between the two methods. In Problem-Based Learning, it uses "problem" as a stimulus to students, but Project-Based Learning uses "project" as a stimulus (Major & Palmer, 2001). In other words, Project-Based Learning envisions the end product while Problem-Based Learning focuses on the process. Thus, Project-Based Learning is more encompassing than Problem-Based Learning (Moursund, 2002).

The philosophy of active learning, student-centered and group dynamics is embedded in Project-Based Learning. Project-Based Learning involves mind and hands. In Project-Based Learning, students are given a real problem or actual situation in which they are asked to find the solutions by gathering various inputs from books, journals, handbooks, manuals, brochures, Internet and so on. Teachers only act as guides or catalysts to the students. In addition, a number of researchers believe that technology enhances Project-Based Learning (Moursund, 2002). Technology plays a dynamic role in making the knowledge construction process explicit, thereby helping learners to become aware of that process (Jonassen et al., 1999). Krajcik et al. (1994) argue that technology makes the environment more authentic to students, because among others the computer provides access to data and information and expands interaction and collaboration with others via networks.

Technology-based learning environments are designed to support advanced knowledge acquisition. And that can be done by providing environments and thinking tools that engage constructivist conception of learning (Kommers,Jonassen, & Mayes, 1992). Thinking tools are technology systems or applications that extend the intellectual functionality of the learner by engaging the learner to tasks that facilitate knowledge construction. Even a simple Internet tools can add critical and valuable dimensions to enhance Project-Based Learning. Another advantage of the Internet is that the access of information of other projects is open to wider audiences. More specifically, students have the opportunity to examine, review and browse other similar projects–thus, giving them myriad of ideas to embark on their own project.

In the Malaysian polytechnics system, e-Students Learning Management System (e-SOLMS) is used in tandem with Project-Based Learning. The system was designed by Universiti Sains Malaysia (Md. Baharuddin, 2011). Most importantly, the web can be used as a communication and collaboration medium to build ongoing dialogues between the project participants and their supervisor. These "students-mentor" dialogues can be planned and organized to facilitate learnings and trouble-shootings. A networked project typically involves students in distant locations cooperating to research, exchange information, and learn from one another, although the distant partners may include experts. Students may conduct research, perform experiments in their own community, and report their findings. They may pose questions to experts or exchange information with their peers.

However, Project-Based Learning is relatively challenging to plan and implement due to its complexity. The other disadvantages of Project-Based Learning

are the high cost and time-consuming. Subjectivity in the assessment of Project-Based Learning is another delicate issue. Thus, the real effectiveness of the method is questionable. However, few studies have been conducted to evaluate the effectiveness of this learning system. Thus, this study was designed to evaluate the effectiveness of Project-Based Learning in one of the polytechnics in Malaysia by using the CIPP (Context, Input, Process and Product) model.

1.2. Background of the Study

Historically, Project-Based Learning couldbe associated with “Learning by Doing” philosophy. The ancient proponents of learning by doing such as Confucius and Aristotle have had such a great impact on experiential learning theory. Later scholars such as John Dewey and David Kolb have refined the experiential learning theory that was grounded in experience and driven by student interest. For them, basically, experiential learning is the process of making meaning from direct experience, i.e., learning from experience (Itin, 1999). Dewey challenged the traditional view of the student as a passive recipient of knowledge and the teacher as the transmitter of a static body of facts (Boss, 2011). He argued instead for active experience that prepare students for the real world (Dewey, 1938). As Dewey pointed out, "Education is not preparation for life; education is life itself."

From a different perspective, according to Knoll (1997), Project-Based Learning grew out of the architecture field that began in Italy during the late 16th century. To be elevated to a profession, architecture had to develop a theoretical

foundation in order to establish the art of building as a unique discipline. Since this need was also shared by sculptors and painters, the architects forged an allicance with sculptors and painters to establish an art academy – the Academy di San Luca in Romein 1577 (Hager & Munshower). It has contributed to recognize architecture as an independent profession that challenged architects to become creative artists. The development of the artistic creativity was one of the goals of the Project-Based Learning. However, this approach was not unique to architecture. By the end of the 18th century, the engineering profession had establish universities, technical colleges and polytechnics began to adopt Project-Based Learning in their engineering curricula.

According to Boss (2011), a number of trends have contributed to the adoption of Project-Based Learning as a 21st-century strategy for education. First, cognitive scientists have advanced our understanding of how people learn, how people develop expertise, and how people begin to think at a higher level. Fields ranging from neuroscience to social psychology have contributed to human understanding of what conditions create the conducive environment for learning. Second, culture, context, and the social nature of learning all have a role in shaping the learner's experience. These critical domains have to be taken in account when introducing Project-Based Learning for diverse learners. Third, Project-Based Learning applies across disciplines, it consistently emphasizes active, student-directed learning. Fourth, the evolving definition of literacy. Basic literacy is no longer adequate. Today's students must be able to navigate and evaluate a vast repertoire of knowledge and information. This requires higher-order thinking, fluency in technology along with creative talents.

To respond to the complex demands of the 21st century, a growing number of teachers, learning institutions and even countries have adopted Project-Based Learning.

In education, Project-Based Learning has evolved as a method of instruction that addresses core content through rigorous, relevant, hands-on learning. Projects tend to be more open-ended than problem-based learning, giving students more choices when it comes to demonstrating what they know (Donnelly & Fitzmaurice, 2005). Unlike projects that are tacked on at the end real learning, the projects in Project-Based Learning are the centerpiece of the lesson. Students are expected to solve the problem as professionals do–to communicate, collaborate, conduct research, analyze, create solution, and publish their own work for authentic audiences (Boss, 2011). Project-Based Learning method is appealling to educators due to its rejection of rote learning and memorization to providing more challenging, high-order thinking, and complex interdisciplinary cooperative learning (Railsback, 2002). This method is becoming even more meaningful in today's society as educators are having diverse learners in their classrooms; students with different learning styles and abilities. Furthermore, Project-Based Learning builds on students' individual strengths and allows them to be creative and innovative in solving the problem.

The underlying theory of Project-Based Learning is constructivism. Constructivism views learning as the result of mental construction; that is, individuals learn by constructing new ideas or concepts based on their current and previous knowledge (Karlin & Vianni, 2001). Thus, projects provide learners with a real-world context or "authentic" task for learning, creating a strong "need to discover." By design, projects are open-ended. This means students need to consider and evaluate

multiple options and solutions and, perhaps the creative ones. All these activities engage higher-order thinking skills.

However, Project-Based Learning is full of challenges. Many teachers are not formally trained to handle Project-Based Learning. Especially for teachers who have never experienced Project-Based Learning before, projects require planning, management, and supervisory strategies that they may be unfamiliar. They would have problem in implementing Project-Based Learning if they do not renew information from textbook, journals or internet (Supratomo and Baso,2007). Most teachers use traditional teaching method. The traditional teaching method is still preferred by the majority of teachers in the exam-oriented system (Ramlee et al., 2014). Project-Based Learning puts teachers in the role of facilitator rather than classroom expert. And not all teachers are effective facilitators. In addition, available resources in the learning institutions might be limited for Project-Based Learning that the students may have to make extra efforts to obtain additional resources from outside of their institutions. Teamwork could also pose a challenge to some students. The project could also take a sizable amount of time and may require advance scientific knowledge in order to complete the project (Blumenfeld et al., 1991; Scott, 1994). Hence, some students may take longer time to reach the sophistication and mastery level than others. The incoming problem is that the students could not link what they learn and use their knowledge (Susriyati et al., nd).

One of the goals of Project-Based Learning is to enhance the creativity and innovativeness of the students. However, literature has shown that, in general, Asian