PROMOTING MEANINGFUL LEARNING VIA AN ONLINE PROJECT-BASED MODULE

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ABSTRACT

This paper will discuss the use of an Online Project-based Module (m-PAT) to promote meaningful learning among students using the project-based learning approach. m-PAT was applied in a project-based learning for a topic in Physics. A mixed method case study design was employed, where the findings of quantitative data were confirmed using the findings of qualitative data. A total of 42 form four students from a secondary school in Klang Valley, Malaysia were chosen based on purposive sampling. The data were collected through questionnaire, student reflection, online discussion, and open-ended questions after each participant generated a physics-learning blog by using the m-PAT as a platform. Quantitative data were analyzed descriptively in form of mean scores and standard deviations to observe the distribution of students' feedback towards the attributes for meaningful learning during the m-PAT implementation. Thematic analysis was used for the qualitative data to produce a tabulated matrix related to the attributes of meaningful learning. The findings prove that m-PAT has a high potential as an online platform to promote a meaningful learning for students. Further research with a larger number of participants is needed to support the present findings.

Keywords: Meaningful learning, Online project-based module,

INTRODUCTION

The willingness and commitment of the Ministry of Education (MOE) in promoting the integration of Information Communication Technology (ICT) and the Internet in education (MOE, 2004, 2006, 2012) accelerated the development of the Internet network infrastructure in Malaysian schools. Students indicated that they were very interested in and adept at using online applications such as searching for information, socializing through social networking sites and producing websites and blogs (Safar & Fatimah, 2000; Musa & Narimah, 2001; Multimedia Development Corporation (MDEC), 2006; Pew Internet & American Life Project, 2007, 2011). The students seemed to be ready for the integration of ICT in Teaching and Learning (T&L) in school, although ICT integration implemented in schools was mostly focused on word processing application (MOE, 2012), information search on Internet and courseware utilization for T&L (Ashfahani, 2014). Following this, policies and frameworks for the project-based learning approach both for primary and secondary education were emphasized by MOE (MOE, 2012). However, there is still limited research on learning modules that combine the use of ICT with the project-based learning approach developed for school level that can be used as reference by educators.

Robert (2003) defines *project-based learning* as an activity framework that centers on the T&L process regarding the development of a concept rather than being an enrichment activity at the end of the learning process. As for school-based assessment, a project is defined as a method of assessment where the students need to plan, investigate and collect the data (Malaysian Examinations Syndicate (MES, 2004). The conclusion from Robert (2003) and MES's (2004) definitions indicate that project-based learning is a comprehensive T&L activity that embraces the whole process of student-centered learning while focusing on a certain concept where the outcome of the activities is evaluated as the assessment materials. Thus, it is assumed that the implementation of online project-based learning for the purpose of assessment should provide a meaningful learning experience for students. Project-based learning is also a process-oriented learning approach which is almost similar to problem-based learning and case-based learning (Quek, 2010). Research shows that such a process-oriented learning approach has resulted in meaningful learning for students (Hakkarainen et al., 2007; Keskitalo et al., 2011; Rustam, Hwang & Huang, 2015).

Meaningful learning occurs when students construct their own knowledge, and not merely transmitted from the teacher to the students (Jonassen et al., 1999). In meaningful learning, students learn from thinking about what they are doing (Hakkarainen, 2007). Thus, the teacher's role is to stimulate and guide activities that trigger thinking among learners (Bhattacharya, 2002). Previous research (Jonassen et al., 1999; Hakkarainen, 2007; Hakkarainen & Saarelainen, 2005) has posited five attributes to show that meaningful learning occurred within a learning process: (i) Active (manipulative) learning takes place when a student is actively involved in the learning process by acquiring skills and knowledge from the learning community, practicing recently acquired skills and knowledge, manipulating objects and equipment simultaneously, and observing the outcome of the manipulation process; (ii) Constructive (reflective) learning occurs when the learning process encourages students to continuously self-reflect on their learning experiences. This enables students to construct their own mental model to explain what they have learnt (Hakkarainen, 2007). Reflection involves contemplating over the meaning and knowledge before, during, and after learning activities. Effective reflection requires teachers and students to think deeply in order to draw out the learning related experiences (Chapman, 2006); (iii) Directed (intentional) learning is driven by a specific known goal (Schank, 1994). Technology- based directed learning enables students to describe results and strategies used to achieve the outcome of learning and apply it in new situations; (iv) Authenticity (complex and contextual) learning relates the topics to the real world so that the students can connect the content with reality; Finally, (v) cooperative (collaborative) meaningful learning demands group discussions among students, sharing of ideas, and assisting one another in solving a problem. Collaborative learning is considered meaningful, as it represents working inreal life situations.

Research by Hakkarainen et al. (2007) indicated that attributes of meaningful learning occur when the process-based learning approach is used. The study used digital video as a support material in the case-based learning to promote meaningful learning among students. The results showed that designing, producing and solving the case using digital video could promote active learning, contextual learning and emotional involvement in the learning process. In addition, Keskitalo et al. (2011) used case studies to explore meaningful learning in students' Second Life through problem-based learning. Second Life is defined as a 3-dimensional space in a virtual world

that is shared by students in which they can communicate synchronously using avatars (representing students). The pedagogical model used in this study is called the *Global Virtual Education (GloVEd)* using the *teaching-studying-learning process* (TSL process) approach. The results showed that the T&L process undertaken was able to create meaningful learning attributes of active, constructive, contextual, collaborative and reflective learning.

The project-based learning approach (for the purpose of school-based assessment) has been carried out widely in schools throughout Malaysia (Neo, Neo & Tan, 2012). Online project-based learning is expected to engage the students' interest towards team learning and online activities. This method is suitable because it does not only encourage students' self-directed learning, but also supports team work and peer learning. It is also easily accessible anytime and anywhere (Valjataga & Fiedler, 2009; Hung et al., 2013) and allows students to experiment learning innovatively and creatively through multimedia presentations (Poe & Stassen, 2002; Hsieh & Chen, 2012). Additionally, online project-based learning allows an in-depth study of the chosen topic (Harris & Katz, 2001). It gives more autonomic power to students in their learning process while sustaining their interest and motivation (Worthy, 2000). It also enables students to create a project that would reflect their interests and capabilities as well as present what they have learned through meaningful artefact building in the form of reports, multimedia presentations, and the like (Harel & Papert, 1991; Kafai & Resnick, 1996). Students are also capable of exploring knowledge to construct learning strategies through technology-based collaborative learning (Shukor et al., 2014; Biasutti, 2015; Wong, 2013) as well as combining contents and skills, and improving their academic and self-development (Robert, 2003). These are evidence of outcomes of project-based learning programs. However, little is known on the meaningful aspect of this learning approach especially in the Malaysian context.

The study presented in this paper was designed with the objective of evaluating whether meaningful learning environments occur when students engage in an online project-based learning approach using an online project-based module developed for the study. The design and development of the online project-based module called m-PAT (Malaysian acronym for Online Project-based Module) was intended to serve as a platform for teachers and

students to realize online project-based learning. In this research, m-PAT was used to implement one of the school-based assessment activities in the form of project-based learning for Physics. The m-PAT was designed to provide meaningful learning for students who undertook the online project under their teachers' supervision.

METHODOLOGY

The study was conducted in two phases, i) design and development of m-PAT and ii) evaluation of m-PAT to uncover the existence of a meaningful learning environment during the learning process.

Design and Development of m-PAT

The design of an online project-based learning module is particularly important because it has been proven that there are connections between the theories of learning and the learning approaches selected for educational programs with certain learning aspects (Jou et al., 2010). In this study, the design of m-PAT included the attributes of meaningful learning using suitable learning theories and e-learning models. The constructionist learning theory that supports project-based learning (Papert, 1980; Resnick et al., 1996) was used to design the m-PAT. The constructionist learning theory originated from the constructivist learning theory by Piaget (1965). Harel and Papert (1991) suggested that both theories emphasized building knowledge structures in any learning situations. The constructionist learning theory however, adds that the building of knowledge structures will be more meaningful when a student is consciously involved in the building of a meaningful artefact (either the sand castle at seashore or Theory of Universe), which can be shared with other people collaboratively. Bers (2006) later reckoned that by building artefacts or external objects to reflect learning, students are able to develop internal knowledge simultaneously. Bers et al. (2002) identified four main characteristics of constructionist theory, namely (i) learning by actively inquiring and learning by doing; (ii) the building of artefact as a material to reflect the students' mind; (iii) collaboration to improve the outcome of the project; and (iv) self-reflection to explore students' thoughts in order to intellectually and emotionally relate

newly discovered knowledge to make learning more meaningful. These four characteristics were the basis of the m-PAT design. Artefact building in the constructionist theory encourages active, constructive, collaborative, and directed learning, which are part of meaningful learning attributes.

Online learning models or e-learning models guide educators in delivering desired e-learning outcomes(Gunter et al.,1995). The E-tivities model (Salmon, 2002) was chosen to organize the content of m-PAT, as this model favors active and interactive learning via online collaboration. The E-tivities model comprises five steps, namely (i) access and motivation; (ii) socializing online; (iii) information exchanged; (iv) knowledge building; and (v) reflection. This model was adapted to organize the sequences of modules in the m-PAT.

Moodle's Learning Management System (LMS) was used to develop the m-PAT platform. Moodle is a suitable platform, as this system was developed based on the Social Constructionist Learning Theory, thus facilitating adaption according to the suitability and requirements of the study. Furthermore, readily available modules in Moodle, such as forums, blogs, questionnaires, and tracking systems eased the monitoring of the students' activities.

The final m-PAT module comprises of five sub-modules as follows:

1. Sub-module 1 - Introduction and Access - This activity aims to train and socialize students to access the Internet using a chat room and message space.

2. Sub-module 2 - Designation of Cyber Rules - This activity aims to develop skills in searching & selecting information using Internet and participating in discussions in the online forum. At the end of the activity, students jointly determine the cyber rules for their learning community by which they should abide by while carrying out m-PAT activities. Furthermore, this activity encourages community building among learners.

3. Sub-module 3 - Development Blog (phase I) - This activity aims to develop technical skills, such as uploading photos and animations as

well as creating links. At the end of the activity, students are able to create learning spaces, which included *Introduction*, *MyProfile,* and *MyCyber Rules*.

4. Sub-module 4 - Development Blog (phase II) - This activity aims to build knowledge on the pre-determined project title (Physics Form 4). At the end of the activity, students further develop the *MyProject* space that has been pre-developed in Sub-module 3.

5. Sub-module 5 - Online collaborative discussion on the improvement of the blog (peer review). In Sub-module 5, students open their blogs for other students to view. This enables other students to express opinions and provide feedback.

6. Reflection - Students rethink the learning process based on the given questions. Reflection was carried out at the end of each m-PAT submodule (self-assessment). Students are required to write an online reflection to submit to the teacher.

In this study, m-PAT was used to implement one of the school-based assessment activities in the form of project-based learning for Physics.

The online project activities utilizing the m-PAT's five sub-modules were carried out for 6 weeks. Students completed one sub-module per week online; thus, it took 5 weeks to complete all sub-modules. The final week was allocated for the students to improve and finalize their blogs.

Before engaging each sub-module, students were divided into two groups. They were briefed and trained by their teachers at their school computer lab. A Physics teacher acted as their online mentor while four other Physics teachers from different schools acted as online observers. All the teachers were already trained to do their tasks. During the completion of the online project, students were able to communicate with their friends and teachers via chat room and forum to engage in discussion and seek guidance. Additionally, an online user manual was provided for the students, as a guide for the technical part of the m-PAT.

Each student individually built a learning artefact in the form of a blog regarding a topic in Physics. Rubrics were provided for the students to guide them in creating the content of the blogs. Next, students were required to share materials and collaborate with teachers and peers through online discussion in order to improvise their blogs.

Upon completion, the students had to print their blogs for school assessment purposes. Data were collected once the participants had completed all of the sub-modules. Figure 1 shows the front page screenshot of m-PAT.

Figure 1: Front Page of m-PAT (Sub-modules 1 to 5 can be accessed through the e-Project menu).

Evaluation of m-PAT

In examining the meaningful learning elements of the m-PAT module, a Triangulation Mixed Method design (Creswell, 2008) was used, whereby findings from quantitative data were confirmed by triangulating them with qualitative data findings. Quantitative data from the questionnaire on attributes of meaningful learning as perceived by students after participating in the m-PAT module study program were analyzed descriptively. Meanwhile, qualitative data collected from the same set of students were analyzed using thematic analysis to identify themes related to attributes of meaningful learning as experienced by the participants while participating in the m-PAT module. The two sets of data were then triangulated.

The participants consisted of 42 form four students from a secondary school in the Klang Valley, Malaysia, who were taking Physics. The particular school was chosen because it had comprehensive internet infrastructure with a technical assistant for the computer laboratory and had received the consent of the teachers and administrative staff on the initiative. Moreover, the participants had an internet connection at home and their parents' consent were obtained to allow them to carry out the online project using m-PAT at home. The internet connection and parental consent were important criteria because the project was to be carried out at home after school hours. Data were collected once the participants had completed all the sub-modules in the m-PAT. Five Physics teachers were also chosen as participants. A teacher from the same school acted as their online mentor while the other four teachers from different schools acted as online observers. These teachers also monitored students' online activities based on given checklists.

A questionnaire was used to collect the quantitative data. The researchers developed the questionnaire based on the definition of meaningful learning by Jonassen et al. (1999). The questionnaire, which comprised 42 items, was designed to measure the attributes of meaningful learning. The items were on active learning (8 items), constructive learning (12 items), directed learning (10 items), authentic learning (7 items) and collaborative learning (5 items). All the items were measured on a 5-point Likert scale (1= Strongly disagree; 2= Disagree, 3= Less agree; 4= Agree, 5= Strongly agree). Three experts evaluated the content of the questionnaire to ensure the validity of each constructed item. To establish the reliability of all items, a pilot test were carried out with 27 form four students from another school who were also taking Physics.

The research instrument was administered after the students completed all modules of the m-PAT program as explained in the previous section. The analysis revealed acceptable reliability of each attribute in the research instrument, as indicated by Cronbach's alpha greater than 0.75 ($\alpha \geq 0.75$) (Sekaran, 2000). The quantitative data were then analyzed descriptively to assess the mean and standard deviation of the student responses to the items on the existence of attributes associated with meaningful learning in m-PAT.

The qualitative data were obtained through the participants' reflections, online discussions, and open-ended questions and analyzed using thematic analysis to produce a matrix table of attributes associated with meaningful learning. Three other experts reviewed the theme coding to ensure the validity of the themes that emerged from the qualitative analysis. Cohen's Kappa value K for each relevant theme was greater than 0.70 ($K \geq 0.70$) which indicated that the interpretation was within in the substantial range of reliability index (Landis & Koch, 1977). This shows that the qualitative data for this study had a high reliability index based on the value of K. The themes that emerged from the respondents' qualitative data were triangulated with data from the teachers' observation checklists associated with the respondents' activities in m-PAT.

RESULTS

The data from the questionnaire were analyzed descriptively to observe the distribution of feedback from students regarding the existence of attributes for meaningful learning during the implementation of m-PAT. Table 1 below shows the classification of the mean scores used to interpret the level of participants' agreement on the m-PAT assessment.

Table 1: Interpretation of Mean Scores

Mean score	Interpretation of mean score
1.00 – 1.79	Very low
1.80 – 2.59	Low
2.60 – 3.39	Medium
3.40 – 4.19	High
4.20 – 5.00	Very high

(Source: Educational Planning and Research Division (EPRD), MOE, 2006)

The existence of meaningful learning attributes was evaluated based on the attributes of meaningful learning, as stated by Jonassen et al. (1999), which were active, constructive, directed, authentic, and collaborative learning. Tables 2, 3, 4, 5 and 6 show mean scores, standard deviations (SD), and mean score interpretations of the participants' agreement on the existence of meaningful learning attributes during the m-PAT session.

The evaluation of the existence of active learning during the implementation of m-PAT (Table 2) showed that the highest level of agreement was obtained for item 3 (mean score=4.67, SD=0.53). Meanwhile, the lowest level of agreement was obtained for item 1 (mean score=3.90, SD=0.73). 4 out of 8 items showed mean score values with Very High level of agreement while the remaining 4 items showed mean score values of High level of agreement. Overall, the findings of the study showed that the participants gave Very High level of agreement (mean score=4.28, SD=0.32) on the existence of active learning during the implementation of m-PAT.

Table 2: Participants' Agreement toward the Existence of Active Learning

Item		Students (n=42)		
		Mean score	**SD**	**Interpretation**
1	m-PAT activities give students a chance to ask teachers questions at any time.	3.90	0.73	High
2	m-PAT activities give students a chance to learn from their peers.	4.45	0.55	Very high
3	m-PAT activities give students a chance to seek various information and materials from the internet.	4.67	0.53	Very high
4	m-PAT activities give students a chance to develop a learning blog according to their own preference.	4.57	0.70	Very high
5	m-PAT requires students to be involved actively throughout the learning process.	4.00	0.58	High
6	m-PAT activities (*MyProject* blog) allows students to do in-depth exploration of the Physics concept.	4.07	0.75	High
7	m-PAT activities enable students to share knowledge with their peers.	4.12	0.83	High
8	m-PAT activities allow students to share ICT skills among their peers.	4.43	0.59	Very High
Overall mean and SD		**4.28**	**0.32**	**Very high**

For the evaluation of the existence of constructive learning, (Table 3), item 9 showed the highest level of agreement (mean=4.67, SD=0.53) while item 20 showed the lowest level of agreement (mean score=3.71, SD=0.83). A total of 4 out of 12 items had mean scores that represented a Very High level of agreement and the remaining 8 items had the mean scores that represented a High level of agreement. Overall, the results showed that participants in the study reported a High level of agreement (mean=4.16, SD=0.35) on the existence of constructive learning during the m-PAT session.

Assessment of the existence of directed learning during the implementation of m-PAT (Table 4) showed the highest level of agreement with item 30 (mean score=4.60, SD=0.63) and the lowest level of agreement with item 25 (mean score=3.98, SD=0.84). A total of 4 out of 10 items had mean score values indicating a Very High degree of consensus, while the other 6 items had the mean score values indicating a High level of agreement. Overall, the results showed that participants reported a High level of agreement (mean score=4.18, SD=0.30) on the existence of directed learning during the implementation of m-PAT.

Table 3: Participants' Agreement toward the Existence of Constructive Learning (Skills and Knowledge)

Item		Students (n=42)		
		Mean score	SD	interpretation
9	m-PAT activities increased the student's skills in seeking online information.	4.67	0.53	Very High
10	m-PAT activities increased the student's skills in using forum as a platform for discussion.	4.19	0.71	High
11	m-PAT activities increased the student's skills in using forum to give feedback on peers' blogs.	4.29	0.60	Very High
12	m-PAT activities increased the student's skills in constructing a learning blog.	4.50	0.59	Very High
13	Forum discussions raised awareness among students on cyber regulations.	4.45	0.59	Very High

14	The *MyProject* blog activity helped students better understand Physics concepts related to the project title.	4.05	0.73	High
15	Reflection questions helped students to rethink what they had learned in more depth.	3.88	0.89	High
16	Reflection questions helped students to recall all that they had learned in every activity.	3.90	0.66	High
17	Reflection questions helped students to recall all learning processes they went through.	4.02	0.64	High
18	The Reflection activity helped students to recall how they solved problems encountered while completing the project.	4.19	0.67	High
19	The Reflection activity encouraged students to be more aware (sensitive) towards what they had learned.	4.02	0.87	High
20	The Reflection activity helped students to achieve long-term memory in recalling what they had learned.	3.71	0.83	High
Overall mean and SD		**4.16**	**0.35**	**High**

Table 4: Participants' Agreement toward the Existence of Directed Learning

Regarding the existence of authentic learning (Table 5), item 37 exhibited the highest level of agreement (mean score=4:48, SD=0.55), while item 36 showed the lowest level of agreement (mean score=3.93, SD=0.84).

Item		**Students (n=42)**		
		Mean score	SD	interpretation
21	The scope of the project was clearly stated (on the front page of the m-PAT).	4.00	0.49	High
22	Learning objectives in each module of m-PAT (Sub-module 1 – Sub-module 5) were clearly stated.	4.19	0.74	High

23	Activities in each module were designed to meet the learning objectives.	4.07	0.60	High
24	Activities in each module were designed to assist students in completing the project.	4.31	0.60	Very High
25	Questions for the *MyProject* blog were clearly stated and easily understood.	3.98	0.84	High
26	Link references supplied were relevant and appropriate in helping students obtain information.	4.21	0.52	Very High
27	The User Manual helped students carry out activities in Sub-module 1 – Sub-module 5.	4.29	0.77	Very High
28	An example of a blog in the m-PAT helped provide ideas for students to develop their blog.	4.12	0.92	High
29	The Rubrics provided in the m-PAT helped students create projects that met the criteria for scoring.	4.00	0.58	High
30	Spaces for forum and chat room helped students to communicate with teachers and peers for assistance.	4.60	0.63	Very High
Overall mean and SD		**4.18**	**0.30**	High

Only 1 out of 7 items had the mean score indicating a Very High level of agreement while other items had mean scores indicating a High level of agreement. Overall, the results showed that participants reported a High level of agreement (mean score = 4.16, SD = 0:39) on the existence of authentic learning during the implementation of m-PAT.

Table 5: Participants' Agreement toward the Existence of Authentic Learning

Item		Students (n=42)		
		Mean score	SD	interpretation
31	The Project title was related to the real-world situation.	4.19	0.67	High
32	The *MyProject* title enabled students to relate Physics with the real-world situation.	4.17	0.58	High

33	The *MyProject* title enabled students to realize that what they learned in Physics was applicable in real life.	4.17	0.62	High
34	The *MyProject* title that was related to the real world made learning more meaningful.	4.00	0.80	High
35	The *MyProject* title that was related to the real world made learning easier to comprehend.	4.19	0.63	High
36	The *MyProject* title that was related to the real world made learning easier to memorize.	3.93	0.84	High
37	Discussions via forum and chat room helped students to solve problems they encountered while completing the project.	4.48	0.55	Very High
Overall mean and SD		4.16	0.39	High

The assessment of the existence of collaborative learning during the implementation of m-PAT (Table 6) showed that the highest level of agreement was obtained for item 42 (mean score=4.64, SD=0.48) and the lowest level for item 38 (mean score=4.10, SD=0.66). A total of 4 of 5 items had the mean score indicating a Very High level of agreement while only one item had the mean score indicating a High level of agreement. Overall, the results showed that participants reported a Very High level of agreement (mean score=4:40, SD=0.40) on the existence of collaborative learning during the implementation of m-PAT.

Table 6: Participants' Agreement toward the Existence of Collaborative Learning

Item		Students (n=42)		
		Mean score	SD	interpretation
38	Activities provided in the m-PAT promote cooperative learning to facilitate students to complete the project	4.10	0.66	High
39	Chat room and forum facilitated students' communication with peers and teachers	4.50	0.67	Very High

40	Forum and chat room facilitated discussion between students and teachers	4.50	0.67	Very High
41	Discussions with friends and teachers helped students to gain additional information	4.26	0.70	Very High
42	The construction of blogs can be improvised through feedback from peers and teachers.	4.64	0.48	Very High
Overall mean and SD		4.40	0.40	Very high

During the implementation of m-PAT, the participants were obliged to write a self-reflection at the end of each module. Participants were also required to engage in discussions with teachers and peers through chat room and forums. Self-reflection texts, online discussion texts, and open-ended questions were analyzed using thematic analysis to produce a matrix table associated with the attributes of meaningful learning. Three experts confirmed the coding themes constructed in the thematic analyses. The findings from the thematic analyses were used as a triangulation to confirm the findings from a descriptive analysis of questionnaire data. Table 7 shows sample responses reflecting different attributes of meaningful learning in the analysis of the theme.

Table 7: Participants' responses on the Existence of Meaningful Learning

Meaningful learning attributes		Examples of responses
1	**Act** – active learning - Students were actively involved in manipulating the resources, tools and learning environment provided in the m-PAT to enable them to gain information and solve problems in developing the learning artefacts (blog)	"...I was facing a problem with the content and formatting of the blog needed for 'Car Safety'. I found the solution by referring to the e-project menu and by inquiring my teacher in the forum..." (R4/e4/S10) "...I was having difficulties in incorporating links. I used the forum space as a platform for discussing the problem. Finally, I found the solution how to incorporate the links..." (R4/e4/S7)

2	**Cst** – constructive learning - Students develop meaningful skills and knowledge through the process of learning and self reflection which then applied in the development of learning artefacts (blog)	"...I am more knowledgeable in applying my knowledge into the blog..." (R3/e4/S21) "... Activities in the Sub-module 3 were really helpful in helping me become more proficient in the technical aspects such as incorporating animation, graphics, links and so forth in building a blog..."(R3/e5/S40)
3	**Dir** – directed learning - Student-directed activities and discussions to achieve the learning objectives in each learning module	"... Sub-module 1 helped me to understand better about the m-PAT and helped me to proceed to the next module ..." (R1/e5/S40) "... The manual gave me a clear instruction. I am sure this manual also help other users as well ... "(R5/e4/S19)
4	**Aut** – authentic learning - the learning that revolved around the reality of the real world so that students can relate the approach to learning and learning content with real life	"...in my opinion, m-PAT is suitable to be use during the implementation of Physic PEKA project as it is related to the real world, which is the vast usage of the internet..."(OEQ/S9) "...the *MyProject* activity in m-PAT is related to the applications of Physic in real life..."(OEQ/S28)
5	**Col** – collaborative learning - Students collaborated in group discussions using forums and chat rooms in searching for solutions to learning problems	"...they helped me by stating what I need to do in this project and helped amend my mistakes (in my blog)..."(R4/e4/S17) "...my teacher and my friends were really helpful. Furthermore, the discussion in the chat room and forum simplify the construction of this blog..."(R5/e4/S11)

Note. R= Online Reflection; e= e-project (m- PAT) platform; S= Student; OEQ= open ended question

DISCUSSION

The study shows that meaningful learning environments occur when students engage in online project-based learning using m-PAT. In the quantitative data findings, the participants reported a high level of consensus on the existence of meaningful learning attributes during the implementation of

m-PAT. Qualitative data further confirmed the findings, showing the presence of meaningful learning attributes in related themes.

The presence of meaningful learning attributes was closely related to the activities that were designed in m-PAT. Participants' active learning occurred in the form of information seeking, blogging, and consulting with peers and teachers through the forum or chat room. Learning by actively inquiring & learning by doing is one of the characteristics of the Constructionist learning theory that underlies the design of the m-PAT. This finding is in line with the results of a study by Bers et al. (2002) on active learning using computer games for the purpose of integration of Information Technology in the learning process.

Constructive learning occurred when the participants utilized the knowledge and skills they acquired in the early stages of the m-PAT module (knowledge in virtual rules, information seeking skills and online technical skills) in constructing a learning blog. This study found that the probability of directed learning took place due to certain features of the module in m-PAT which was systematically organized based on e-tivities model. Apart from the e-tivities model, directed learning also occurred with the help of the user manual and project rubrics. m-PAT learning occurred authentically because the project topic was related to real life, that is the usage of internet during blogging, and communicating online with peers regarding the project, all of which represented the authenticity of utilizing the internet in daily life. Collaborative learning occurred via chat room and forum, where the participants carried out discussions on improvising the outcome of their project (blog). The study by Salmon (2002) on designing an online module called e-moderating using e-tivities model for the purpose of teaching and learning, also revealed similar positive results.

LMS Moodle, the platform for m-PAT, provided the facility for the teacher to observe and supervise students' activities. The tracking system available in Moodle was used to observe and supervise students' activity logs. This system allowed the teacher (online mentor) to track students who exhibited tardiness in initiating the project and who failed to carry out the activity or were inactive during the discussion. With this system, the teacher was able to reprimand students from the early stage of the project. Apart from that, the teacher was able to view all discussions and blogs that were

constructed by the students in order to rectify usage of improper language and unethical online discussion as well as remind students to conform to cyber rules (for example, not giving proper credit when using a picture or information from certain websites). The teacher also provided guidance if the content of the project was deemed inaccurate.

Findings of this study are comparable with many studies on the effectiveness of the ICT integration in the teaching and learning process. These findings confirm that m-PAT is designed using suitable pedagogical approaches such as the Constructionist Learning Theory (Papert, 1980; Resnick et al., 1996), e-tivities e-Learning Model (Salmon, 2002), Technology-enabled active learning (TEAL) (Shieh et al., 2011) and the use of LMS Moodle and Open source software Moodle (Nordin et al., 2012) as a platform to promote meaningful learning. Thus, the m-PAT can be used as a platform for teachers and students to realize online project-based learning for school-based assessment activities to promote meaningful learning.

Additionally, m-PAT is designed to educate students on information management ethics and internet security when communicating online. It also enables students to channel their interest and skills in ICT in meaningful and guided ways. The fully ICT-integrated m-PAT also offers an alternative to the implementation of school-based assessment that promotes meaningful learning.

To support the findings of the present research, future studies on the application of m-PAT are needed. A larger number of students as participants and diverse subjects need to be used to obtain more proof on the viability of this approach.

CONCLUSION

The paper concludes that m-PAT has great potential as an online module/ platform for the implementation of meaningful project-based learning. Active, constructive, directed, authentic and collaborative learning are able to improve students' competency in seeking information, socializing online, and improving their technical skills. Teachers' consultancy and supervision during m-PAT activities help students use the Internet in positive ways and

prevent them from being a cyber victim. The knowledge of online ethics would encourage the students to use the Internet in ways that are more beneficial by developing blogs and websites that offer academic value in their field of interest.

The implications of m-PAT implementation in school have the potential to increase teachers' and students' competency in using ICT, promoting the use of open source software in education and literacy in ethics and virtual security. Apart from that, m-PAT also increases learning resources related to the integration of ICT in online learning which is popular among students. Efforts by MOE to upgrade the Malaysian SchoolNet network to 1BestariNet will help address the Internet infrastructure issue that might be faced by m-PAT implementation in the future. Besides, the introduction to web-based learning systems (Frog Virtual Learning Environment) in Malaysian schools will allow the wider use of m-PAT as a reference for the implementation of the online project-based learning approach, in line with strategies planned by MOE which emphasize the use of the project-based learning approach in the new curriculum standards for primary and secondary schools (MOE, 2012). In addition, the implementation of m-PAT can be done in collaboration between schools to motivate and increase the student learning participation.

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