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Improving the e-activity Design in Problem-based Learning Module in Mechanical Engineering

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Abstract The transition from the teacher-centric learning environment to the problem-based learning (PBL) environment may not be smooth due to students' expectations of getting direct support from the teacher. However, a teacher also tries to teach students the skills to be an independent learner. The aim of this study is to improve the students learning experience in the PBL environment by improving the e-tivity (online activity) design in a blended online teaching module in Mechanical Engineering (ME). A mixed research method approach helped to analyse the students' learning experience in the module. The result shows that the present design of the e-tivities does not provide students with opportunities to study effectively in the PBL environment online, and proposed an improved design of the e-tivities. It implies the need to create e-tivities by taking into consideration the students' learning styles to encourage active participation, to provide rich student-tutor interactions for prompt feedback on the students' performance and hold workshops to improve the facilitation skills of the academic staff in the PBL environment. Further study suggests evaluating the effectiveness of the designed e-tivities on the students' academic performance, and the development of the skills needed to study effectively in a PBL environment.

Keywords PBL, e-tivity, Online Activity, Blended Learning

1. BACKGROUND

The 2nd year engineering students, studying this module, are continuing the Bachelor's degree in different engineering fields such as Renewal Energy, Electronics, Mechanical, Materials, Product Design and Engineering Management at Edinburgh Napier University (ENU), Scotland. Most of the

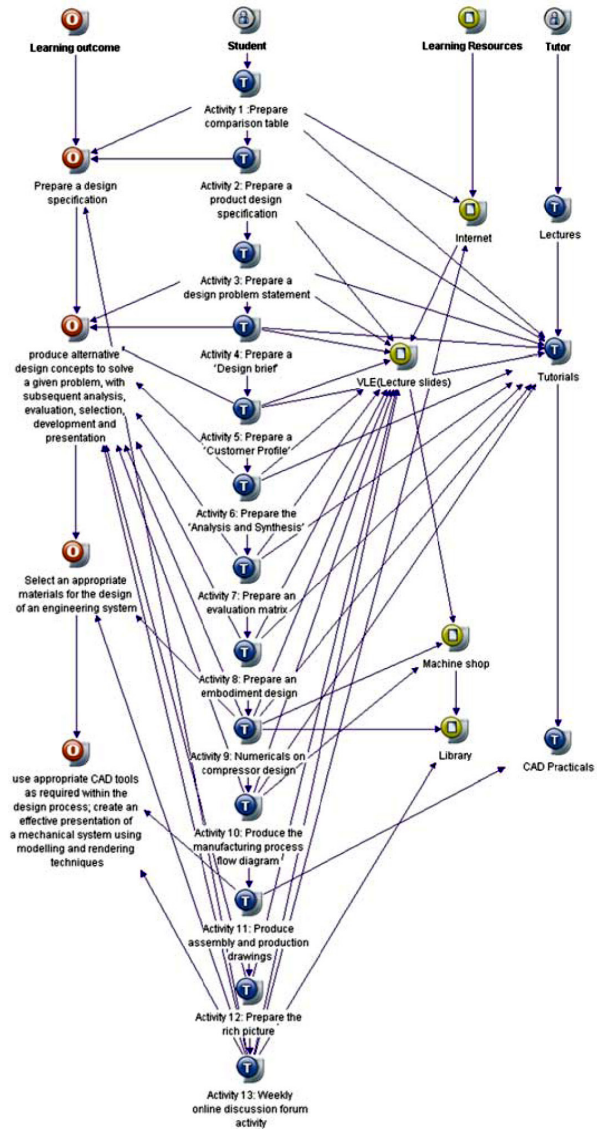

Figure 1: Teaching and learning activities in Engineering Design and CAD.

students have progressed from 1st year at ENU. The students have varied learning skills and different learning needs. The module teaches product design process, selection of the engineering materials and use of computer-aided design (CAD) software for effective presentation of a mechanical system using the modelling and presenting techniques.

The summative assessment coursework carries a weight of 50% of the overall module marks and checks the students' knowledge of the design process. Similarly, CAD coursework, evaluates the students' CAD skills, carrying the weight of 50% of the overall module marks. An online multiple choice quiz assesses the students' learning engineering design and CAD.

The design component teaching comprises of face-to-face sessions to cover the design task information and two hours of tutorial each week to do engineering design calculations. The CAD part has two hours for a practical class, where students learn 2D drafting, 3D modelling, assembly and production of engineering drawings. Besides, every week students also have to complete an online activity on the engineering design task.

2. INTRODUCTION

In the current ME module, the design coursework evaluates the student's engineering design skills. The module adopted PBL approach and used both face to face and online instructions. Besides face-to-face tutorial sessions, students complete a weekly online activity on the discussion forum related to the coursework. Since the students have studied in a teacher-centric learning environment in the 1st year, the feedback showed that students are experiencing difficulty in understanding and completing online activities in the module. Winter et al. (2011) research finding states that the issue in developing e-learning expertise is the ability of the students to manage the combination of learning and non-learning activities online. Therefore, while designing online activities, it will be useful to take into consideration the students' learning style and their familiarity with the education technology. Kenny et al. (2006) studies inferred that PBL fostered problem-solving behaviour in learners and suggested to avoid linking PBL problems to specifically marked assignments and, instead, base course assessment on other measures of knowledge and skills gained through the PBL process. Also, the learner's control of the environment with active communication providing feedback increases interactivity (Sim & Radloff, 2008). Savery & Duffy (1995) studies provided assumptions of constructivist learning in PBL as follows 1) Learning should engage the learner. 2) Learning should be authentic or based on real-world situations. 3) Learning should be collaborative. 4) Learning should involve the construction of knowledge. 5) Learning should promote self-directed learning (SDL)/ self-regulated learning (SRL). English & Kitsantas (2013) research on the relationship between PBL-SRL inferred that many students' with underdeveloped SRL skills. Therefore, the PBL learning environment design must foster SRL critical skills for PBL such as 1) taking responsibility for the learning process by setting goals,

2) reflecting, 3) monitoring, and 4) sustaining their motivation. Capdeferro & Romero (2012) research findings state that for an active collaborative learning in an online education, provide students with information about the learning models, online activities, interest and objectives of computer-supported collaborative learning activities.Online instructors need to purposefully encourage and continue learners' Wiki activities (writing, reviewing, revising, and editing) throughout the learning process to make students familiar to Wiki's consistent and dynamic collaboration (Huang, 2010). Pisutova-Gerber & Malovicova (2009) research on encouraging critical thinking in threaded online discussion settled that sufficient critical thinking opportunities need space, time and facilitation on purpose and not on frequency. Robertson (2008) finding states that design and functionality of Wiki are consistent with characteristics such as communication, collaboration and knowledge building that promotes adoption in PBL. Therefore, a tutor also needs to adopt strategies to help students use the education technology effectively.

In the present study, students can upload their e-tivities work each week on VLE and can interact with peers on the discussion forum. The use of VLE helps in providing uniform learning opportunities to students in large-sized classes ranging from 50 to 100 students. The aim of the study is to improve the design of e-tivities, to provide students with opportunities to study in an online PBL environment effectively. In particular, the current study has four objectives (1) to evaluate the effectiveness of the current e-tivities in an online PBL environment. (2) to identify the areas of improvement in the current e-tivities. 3) determine the actions to be performed by the students in the PBL environment. 4) propose a design of the e-tivities.

3. RESEARCH METHOD

Anonymous students feedback questionnaire helped in gathering data on their module learning experience. The feedback survey comprised nine quantitative and three qualitative questions. The study sample consisted of the ME mentioned above module with 91 students. Descriptive statistics helped to analyse the data by presenting the data summary in a tabular form using the statistical software SPSS 20.0 (academic version). First, the mapping of the five-stage framework of the e-tivity design (Salmon,2002) with the assumptions of constructivist learning in PBL environment (Savery & Duffy,1995) ensures the use of the e-tivity design framework for creating e-tivities for the PBL environment. Second, the mapping of the module's e-tivities with the five-stage framework for e-tivities helped to find the area for improvement of the design of current e-tivity. Finally, the mapping of the students' role in the

e-tivity with the student part mentioned in the hybrid learning model (HLM) table (University of Ulster, 2009) helped to improve the e-tivity design.

3.1 Research Design

The research work presented in this paper used mixed research method approach with one quantitative and one qualitative research question (RQ). The combination of the quantitative and qualitative methods provides a better understanding of the research problem than either approach alone. The results helped to improve the design of the module's e-tivities in the PBL environment. The research questions are as follows:

RQ1. Did the e-tivities on the VLE provided students with opportunities to effectively study in an online PBL 3environment?

The aim of this RQ is to find whether the students had all the needed information and adequate opportunities to interact with the module content and peers. As a result, data analysis of the quantitative students' feedback on their module learning experience, helped to answer this RQ.

RQ2. Do the qualitative feedback on the students' learning experience and the evaluation of their learning suggest the availability of the opportunities to effectively study in an online PBL environment?

The aim of the RQ is to find whether students learnt the skills on how to effectively study in a PBL environment online. As a result, data analysis of the students' qualitative feedback on three questions on their reflection and evaluation of the learning experience, helped to answer this RQ.

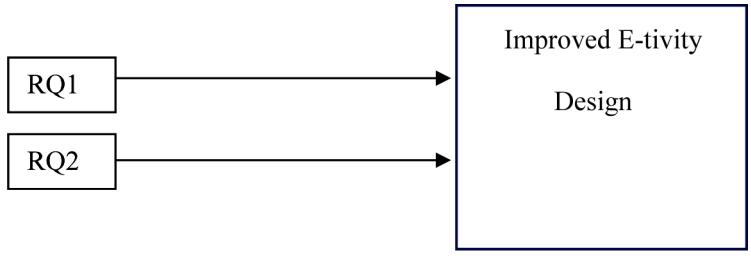

Figure 2: Research design diagram.

3.2 Reliability

The reliability coefficient of Cronbach's alpha contributed to analysing the reliability of the quantitative students' feedback questionnaire. The reliability

Table1: Reliability Statistics.

Cronbach's Alpha	Number of Items
0.983	9

test result shows Cronbach's alpha coefficient value of 0.983. The lower limit of the Cronbach's alpha of 0.70 is acceptable. Therefore, the reliability analysis shows a right consistency of the measuring instrument. Therefore, it is a valid measuring tool (Gupta & Kapoor, 2007).

3.3 Content validity

The present feedback questionnaire checks the students' learning experience in blended online teaching, their reflection and evaluation of the learning experience. There is an adequate number of feedback questions which includes all the variables needed to find out the effectiveness of the present e-tivity in providing students with an opportunity to study effectively in a PBL environment online. The feedback questionnaire includes all the questions related to students' overall learning experience in the module and the open-ended questions to provide students with an opportunity to reflect and evaluate their learning experience.

4. DATA ANALYSIS

4.1 RQ1. Did the e-tivities on the VLE provided students with opportunities to effectively study in an online PBL environment?

The quantitative students' feedback data is presented in the tabular form in Table 2 below.

Table 2: Students' feedback data.

Question No.	Question	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)	Not Applicable (%)
1	Q & A online forum encouraged detailed study	20.69	58.62	10.34	10.34	0	0
2	Learned from others Q & A posts	24.14	56.9	17.24	17.2	0	0

3	Machine shop visit improved my understanding of the machine time calculations	15.52	29.31	34.48	13.79	3.45	3.45
4	Moodle information supported learning	34.48	53.45	8.62	1.72	1.72	0
5	Videos improved learning	32.76	41.38	18.97	6.9	0	0
6	Information on assessment requirements was clear	3.45	36.21	31.03	8.62	18.97	1.72
7	Assessment criteria for marking have been made clear tome	8.62	36.21	36.21	15.52	1.72	1.72
8	Provided adequate study support for CAD	30.69	41.38	18.97	12.07	5.17	1.72
9	Provided adequate study support for design assignment	20.69	41.38	20.69	13.79	3.45	0

Table 2 shows that students can access the information through VLE. Lectures are the source of motivation to take part in an online activity, and there are no motivational messages on the VLE for the e-tivities to explain what they are learning, why is this way, what they have to do to take part in the e-tivities. Question number 3 shows that the machine shop visit did not help students in understanding the machining time calculations. Second, information provided on the assessment needs was not clear to the students. Third, the information given on the evaluation criteria for marking was also not clear to them. The overall feedback for questions 1, 2, 4, 5, 8 and 9 is a positive learning experience, as the percentage of 'Strongly Agree' and 'Agree' responses is greater than 50%. The result shows that students found the present e-tivities

useful in their studies. At the moment, it's hard to say with certainty whether the e-tivity design provided students with opportunities to study successfully in an online PBL environment. Mapping of the five-stage framework of e-tivity design (Salmon, 2002) with the assumptions of the constructivist learning in PBL environment (Savery & Duffy, 1995) helped to make sure that it fulfils the wants of an e-tivity design for an online PBL environment. See Table 3.

Table 3: Mapping the Salmon's (2002) five-stage framework with the Savery & Duffy (1995) assumptions of constructivist learning in PBL.

Five stage framework of e-tivity design (Salmon, 2002)			Assumptions of constructivist learning in PBL (Savery & Duffy, 1995)
Stage	Student	e-moderator	
1	Stage 1: Access and motivation	Welcoming and encouraging	Learning should engage learners
2	Stage 2: Online socialization	Familiarising and providing bridges between cultural, social and learning environments	
3	Stage 3: Information exchange	Facilitating tasks and supporting use of learning material	
4	Stage 4: Knowledge construction	Facilitating process	Learning should be based on authentic or real-world situations
			Learning should be collaborative
			Learning involves construction of knowledge
5	Stage 5: Development	Supporting and responding	Learning should promote self directed learning

The result shows the usefulness of the Salmon's five-stage framework for e-tivity design for creating online activities for the PBL environment. Therefore, mapping of the module's online activities of the design part with the five-stage framework of the e-tivity design helped to find any scope for further improvement as shown in Table 4.

Table 4: Mapping of the present VLE instructions with the Salmon's (2002) five stages of e-tivity.

Activity	Stage 1		Stage 2	Stage 3		Stage 4	Stage 5	Action
	Access	Motivation	Online socialisation	Information Exchange		Knowledge construction	Development	
				Content	Participants			
A1	Yes	No	No	Yes	No	No	No	Prepare
A2	Yes	No	No	Yes	No	No	No	Prepare
A3	Yes	No	No	Yes	No	No	No	Prepare
A4	Yes	No	No	Yes	No	No	No	Prepare
A5	Yes	No	No	Yes	No	No	No	Prepare
A6	Yes	No	No	Yes	No	No	No	Prepare
A7	Yes	No	No	Yes	No	No	No	Prepare
A8	Yes	No	No	Yes	No	No	No	Prepare
A9	Yes	No	No	Yes	No	No	No	Perform
A10	Yes	No	No	Yes	No	No	No	Produce
A11	Yes	No	No	Yes	No	No	No	Produce
A12	Yes	No	No	Yes	No	No	No	Prepare
A13	Yes	No	No	Yes	No	No	No	Post online

Table 4 indicates that students can access the information and exchange content information on VLE, lack of motivation to actively engage in e-tivities and no opportunities for online socialisation, collaborative knowledge construction and development of reflective and metacognitive skills. Besides, the students performed limited actions such as prepare, perform, produce and posting online. Therefore, e-tivities did not provide students with adequate opportunities to effectively study in the PBL environment online.

4.2 RQ2. *Do the qualitative feedback from students on their learning experience and the evaluation of their learning show the availability of the opportunities to effectively study in an online PBL environment?*

The analysis of the qualitative feedback data on three open-ended questions helped to answer this RQ. The data analysis involved the careful reading of the students' feedback responses to identify the main themes. Secondly, the assembly of information around the specific themes and grouping information in specific terms. As a result, from the data analysis, two main themes emerged: 1) self-study and 2) collaborative study.

The students' evaluation of the learning experience says that the learning activities in the module helped students in understanding the importance of self-study and taking responsibility for their learning. It also tells that students can access the information online and had information on how to actively engage in the learning activities. As one of the students wrote:

"I have learnt that I am capable of managing my time effectively to fit in my Moodle activity every week and spreading my time effectively to work on my Design Report."

Similarly, students' feedback suggests the provision of an opportunity to learn collaboratively. As one student gave the comment:

"*I can work better as a team player, receiving help from others and giving help when needed"*.

The feedback also suggests that students have realised the importance of group study, group discussions and how a particular group can manage successfully, as a student wrote:

"I have learnt from other students that study groups are effective when each member has a unique role, and everyone contributes. These groups also increased everyone's understanding of the module content."

The absence of the students' feedback on the peer's interaction, knowledge construction in groups and development by reflection and evaluation, are the areas for further improvement of learning activities in the online PBL environment. Therefore, students had inadequate opportunities to study effectively in an online PBL environment.

5. INTERPRETATION OF THE RESULTS

Both RQ1 and RQ2 result shows that e-tivities did not provide students with enough opportunities to study effectively in the online PBL environment. The comparison of the findings of RQ1 and RQ2 with Salmon's (2002) five-stage framework of e-tivity design suggests that at stage 1 of the e-tivity layout, although students can access the module material on VLE. The e-tivities did not provide students with the information on how to actively take part in online learning. Secondly, according to the Expectancy Theory (Feather, N., 1982) (Biggs, J., 1999), students need extrinsic motivation to enable them to become involved and contribute and develop skills for themselves. Whereas, at the moment, there is a lack of information such as 1) why they are learning, 2) Why in this way, 3) What they have to do to take part in the e-tivity. This finding suggests that e-tivities should include information on how to actively engage in learning, the purpose of learning, how it will be useful for the participant to take an active part in the learning process and feedback to the students on how their learning is progressing. Previous studies by Mantri, Dutt, Gupta & Chitkara (2008) also suggested that one of the factors for the success of the PBL course was that throughout the learning process, students were guided and corrected by the roving facilitator. The facilitator would guide students as

they meet difficulties and help them draw conclusions so as to find the wanted results.

At stage 2 of the e-tivity design, the RQ1 and RQ2 findings state that e-tivities did not provide an opportunity to start building the bridges between the students in an online learning environment. Backed by this finding, it can be said that although it blended the online course and the lecturer's needs to promote webs of trust in e-tivity that do not depend on physical meetings. Specific instructional strategies should be used to carry out the active participation of students and adoption of deep learning approach in their studies to create effective collaboration learning groups in an online environment (Brindley, Walti, & Blaschke, 2009).

At stage 3 of the e-tivity design, the RQ1 and RQ2 findings state that e-tivities provided students with opportunities to find information and exchange the information through the discussion board. On the other hand, students do not get opportunity familiarise themselves with the education technology used in their studies. Also, students are also not provided with information on group dynamics and how their particular group can perform successfully. Backed by this finding, it can be said that students must have, 1) knowledge of task needs for modes of learning, 2) understanding of how to use technology tools effectively, 3) knowledge and responsibilities for individual to self and others in the construction of knowledge (Solvie & Kloek, 2007). To improve the group dynamics, students may be provided interpersonal skills for a successful team in the PBL environment such as 1) consensual decision making, 2) dialogue and discussion, 3) team maintenance, 4) conflict management, 5) team leadership (Peteron, 1997).

At stage 4 of the e-tivity design, the RQ1 and RQ2 findings show that e-tivities did not provide students with opportunities to take control of their knowledge constructions in a new way by critical thinking, creative thinking or by practical thinking. Backed by this finding, it can be said that e-tivities should provide students with opportunities to compose new knowledge by completing a joint outcome and by completing an independent collaborative e-tivity. Teaching tools such as multimedia may also be used in the PBL online environment to encourage students to actively take part in the learning process to effectively work in teams and to be able to think critically (Neo & Neo, 2001). Also, while using technology in the constructivist learning environment to support the fitting and effectual use of technology-enhanced learning experience that is useful for all students, it is helpful to help students see how a particular tool that helps in the construction of knowledge is necessary (Solvie & Kloek, 2007).

Table 6: Mapping of the Salmon's (2002) five stages of e-tivity with the HLM learning events.

Salmon's (2002) five stages	HLM Learning Events	Learner action
Stage 1: Self-directed learning	Receives, Explores	Access, Apply, Explore
Stage 2: Collaborative learning	Debates	Discuss
Stage 3: Online socialisation	Debates	Present
Stage 4:Knowledge construction in groups and individually	Creates, Meta-learns	Evaluate, Refine, Create
Stage 5: Reflection	Meta-learns	Analyse, Assess, Critique, Reflect

At stage 5 of e-tivity design, RQ1 and RQ2 result shows that e-tivities did not provide students with opportunities to develop self-reflective and meta-cognitive skills. Backed by this finding, it can be said that students should be provided with opportunities to become responsible for their learning and their group learning too. Students can be encouraged to develop these skills by providing them opportunities such as asking them a reflective question at crucial times on individual and collective experiences.

The HLM tools' eight categories of the students' role are used in conjunction with Salmon's (2002) five stages of the e-tivity design framework to define the participants' actions for active participation in the e-tivity, shown in Table 6.

An improved design of activity 1 is shown in Table 7 below,

Table 7: Proposed improved design of activity 1 for an online PBL environment.

Activity 1	
1. Name of e-tivity	Preparation of comparison table for the design specifications of at least three air brush compressors available in the market and provide the list of resources such as library books, website links, online video links.
2. Purpose	This e-tivity is aimed at helping students to get an estimate of the different design parameters required for designing an air brush compressor.

3. Spark	*Stage 1*: Students' are required to search online and/ or in the manufacturer's catalogue for at least three airbrush compressors currently sold in the market and note down their design parameters such as power, voltage, RPM, discharge pressure (maximum pressure), discharge volume. *Stage 2*: Students are allowed to collaborate with each other and should post comparison table as much as possible. *Stage 3*: Students should post the table along with the source links on the online discussion forum on Moodle (VLE). *Stage 4*: Students can work in small group of 4-5 members to create a list of the important design parameters required for designing an air brush compressor and post their group findings on the discussion forum. *Stage 5*: Students should post a message in a discussion forum on their individual learning experience and on their group learning experience.
4. How many participants	91
5. Structure	Individual responses, Group responses
6. E-lapsed time needed	1 week (7 days)
7. E- moderator time	2-3 hrs
8. Participant time	1-2 hrs
9. Participant actions	1. Search online/manufacturer's catalogue and collaborate with peers to prepare the comparison table of at least three air brush compressors. 2. Post the table on the discussion forum. 3. Participate in the respective group discussion to create a list of important design parameters required to design an air brush compressor. 4. Post the group document on the discussion forum. 5. Post a message on the individual and the collaborative learning experience.
10. How evaluated?	1. Comparison table (2.5 marks) 2. Sources (2.5 marks) 3. Group participation post (2.5 marks) 4. Post on individual and the collaborative learning experience. (2.5 marks)

An improved design of all the e-tivities of this module is proposed and is shown in Table 8 below:

Table 8: Proposed improved design of all the module's learning activities in an online PBL environment.

Activity	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
1. Name of e-tivity	Name of the individual learning activity as shown in figure 1.											
2. Purpose	Name of the individual learning activity as shown in figure 1.											
3. Spark	1. Self directed learning 2. Collaborative learning 3. Online socialization 4. Knowledge construction in groups and individually 5. Reflect on the learning experience											
4. How many participants	Name of the individual learning activity as shown in figure 1.											
5. Structure	Name of the individual learning activity as shown in figure 1.											
6. E-lapsed time needed	7 days	7 days	7 days	7 days	7 days	7 days	7 days	7 days	7 days	7 days	7 days	7 days
7. E-moderator time	2-3 hrs	2-3 hrs	2-3 hrs	2-3 hrs	2-3 hrs	2-3 hrs	2-3 hrs	2-3 hrs	2-3 hrs	2-3 hrs	2-3 hrs	2-3 hrs
8. Participant time	1-2 hrs	1-2 hrs	1-2 hrs	1-2 hrs	1-2 hrs	1-2 hrs	1-2 hrs	1-2 hrs	1-2 hrs	1-2 hrs	1-2 hrs	1-2 hrs
9. Participant actions	Stage 1: Access, Apply, Explore											
	Stage 2: Discuss											
	Stage 3: Present											
	Stage 4: Evaluate, Refine, Create											
	Stage 5: Analyse, Assess, Critique, Reflect											
10. How evaluated	1. Activity completition (2.5 Marks)											
	2. Sources (2.5 marks)											
	3. Group participation post (2.5 marks)											
	4. Post on individual and the collaborative learning experience (2.5 marks)											

It implies that to create an e-tivity for an online PBL environment efficiently; the lecturer may provide the learning activities that exploit the students' unique learning styles to encourage them to participate in learning actively and to study collaboratively. The PBL learning environment may provide productive tutor-student interactions for prompt feedback on the students' performance. The learning activities may empower the students to have some role in the assessment to adopt a deep approach to learning and provide students with opportunities to take the responsibility of their education. To teach effectively

in the PBL environment, the lecturers may develop skills of facilitation to provide frequent feedback, question and probe the students' reasoning process, encourage critical appraisal of information, facilitate and support healthy interpersonal relationships in the group. The educational institutions may hold development workshops for the academic staff to help the tutor in developing the facilitation skills in the PBL environment.

6. CONCLUSIONS

The aim of the study is to improve the design of e-tivities to provide students with opportunities to effectively study in an online PBL environment based on the constructivist approach to learning. In particular, the current study has four objectives (1) to evaluate the effectiveness of the current e-tivities in an online PBL environment. (2) to identify the areas of improvement in the current e-tivities. 3) determine the actions to be performed by the students in the PBL environment. 4) propose a design of the e-tivities. The study has found that the present e-tivities did not provide students with opportunities to study effectively in an online PBL environment.

The main findings, therefore, are that according to Salmon's (2002) five-stage framework for the e-tivity design, at stage 1 of the e-tivity layout, students may be provided knowledge on how to actively take part in online learning and purpose of learning. Information may also be provided on how it will be useful for the participant to take an active role in the learning process and feedback to the students on how their learning is progressing. At stage 2 of the e-tivity design, the learning activities may provide opportunities to build bridges between the students in an online PBL environment. Although, it is a blended online course, and the lecturers need to promote webs of trust in e-tivities that do not depend on physical meetings. Specific instructional strategies can accomplish active students' participation and adoption of deep learning approach in their studies to create effective collaboration learning groups in an online environment. At stage 3 of the e-tivity design, students must have 1) knowledge of task requirements for modes of learning, 2) knowledge of how to use technology tools effectively, 3) knowledge and responsibilities of self and others in the construction of knowledge. To improve the group dynamics, students may be provided with interpersonal skills for a successful team in a PBL environment such as 1) consensual decision-making, 2) dialogue and discussion, 3) team maintenance, 4) conflict management, 5) team leadership. At stage 4 of the e-tivity design, e-tivities should provide students with opportunities to develop new knowledge by completing a joint outcome and by completing an independent collaborative

e-tivity. Use of multimedia teaching tools in the PBL online environment can help to encourage students to actively participate in the learning process to effectively work in teams and to be able to think critically. Also, while using technology in a constructivist learning environment to support the appropriate and effectual use of technology-enhanced learning experience that is beneficial for all students, it is useful to help students see how a particular tool that helps in the construction of knowledge is necessary. At stage 5 of the e-tivity design, students should be provided with opportunities to become responsible for their learning and of their group learning too. Encourage students to develop these skills by providing them opportunities such as asking them a reflective question at crucial times on individual and collective experiences.

The results implied the necessity to design the learning activities by taking into consideration the different learning styles to encourage students to participate actively and to study collaboratively in learning. The PBL learning environment may provide productive tutor-student interactions for prompt feedback on the students' performance. The learning activities may empower the students to have some role in the assessment to adopt a deep approach to learning and provide students with opportunities to take the responsibility of their education. To teach effectively in the PBL environment, lecturers may develop skills of facilitation to provide frequent feedbacks, question and probe the students' reasoning process, encourage critical appraisal of information, facilitate and support healthy interpersonal relationships in the group. The educational institutions may provide academic staff development workshops to help the tutors in developing the facilitation skills in the PBL environment. A suggestion for further study is to evaluate the effectiveness of the proposed e-tivities design on the students' academic performance, and the development of the skills required to study effectively in a PBL environment.

APPENDIX 1: QUESTIONNAIRE

(1) Activity of posting a question and answer on the forums on Moodle encouraged me to study the lectures topics in more detail.
Strongly Agree b) Agree c) Neutral d) Disagree e) Strongly Disagree

(2) I have been able to learn from the other's posts on the Q & A Forums.
Strongly Agree b) Agree c) Neutral d) Disagree e) Strongly Disagree

(3) The Machine Shop visit improved my understanding of the machining time calculations.
Strongly Agree b) Agree c) Neutral d) Disagree e) Strongly Disagree

(4) The information available to me on Moodle supported my module learning.

Strongly Agree b) Agree c) Neutral d) Disagree e) Strongly Disagree

(5) Use of videos during the lecture and on course wiki improved my learning experience.
Strongly Agree b) Agree c) Neutral d) Disagree e) Strongly Disagree

(6) The information I have received about assessment requirements was clear.
Strongly Agree b) Agree c) Neutral d) Disagree e) Strongly Disagree

(7) The assessment criteria for marking have been made clear to me.
Strongly Agree b) Agree c) Neutral d) Disagree e) Strongly Disagree

(8) I have been provided adequate study support by the module staff for the CAD.
Strongly Agree b) Agree c) Neutral d) Disagree e) Strongly Disagree

(9) I have been provided adequate study support by the module staff for the Design assignment.
Strongly Agree b) Agree c) Neutral d) Disagree e) Strongly Disagree

(10) As a result of this class, what is something you learned about yourself?

(11) As a result of this class, what is something you learned from other students?

(12) What would you do differently in this course if you had a chance to do it all over again?

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