

An Investigation of the Effectiveness of PBL Online on Students' Creative Thinking: A Case Study in Malaysia

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ABSTRACT : *In this paper we scrutinized the effectiveness of combining the Problem-Based Learning (PBL) approach and Online Learning medium in improving students' creative thinking particularly amongst physics students. A cohort of 61 science undergraduate physics students from the School of Science and Technology (SST), and 41 pre-service physics teachers from the School of Education and Social Development (SESD) of the University Malaysia Sabah comprised the sample. The sample was broken up into experimental and control groups, with the experimental group experiencing the PBL and online learning activities, and the control group more traditional learning conducts. Both groups were supported via an online learning environment, which acted as the main medium for learning. Participants' creativity was evaluated using a previously validated instrument, the Torrance Test of Creativity Thinking (TTCT) administered before (pre-test) and after (post-test) the intervention. Examination of these data, points to statistically significant differences between the traditional and PBL groups in creative thinking. Thus the research findings suggest that PBL and Online learning are capable in improving physics students' and pre-service science teachers' creative thinking effectively.*

KEY-WORDS: *problem-based learning; online learning; creative thinking;*

1. INTRODUCTION

Unlike the past graduation from university is no guarantee of employment. This is particularly so in the case of Malaysia, the focus of this inquiry. The fact that ca. 70 percent of the graduates from public universities in Malaysia cannot secure employment is a cause of considerable anxiety. Local commentators say that these graduates remain unemployed because they lack creativity (Nain, 2010). The President of the Malaysian Association of Creativity & Innovation (MACRI), Datuk Ghazi Sheikh Ramli, claims that the creativity of Malaysians is suppressed by the education system, and a perceived need to follow societal norms. He adds that Malaysian society generally constrain children's learning, arguing that children need space to grow, and when this space is not given, it kills their natural creativity. This is also reported in other cultures such as in Pacific Island nations (Sade & Coll, 2003; Collet al., 2006). Ghazi claims that in more open societies such as Western nations, students are encouraged to challenge the opinions of their lecturers and elders.

Creative Thinking and Learning Science : 'In the Malaysian compulsory education system, education about thinking emphasizes skills such as analysis, teaching students how to understand claims, teaching them how to follow or create a logical argument, how to figure out the answer, eliminate incorrect ideas, and focus on the 'correct' answer. This is a very traditional approach to learning science, one that suggest to students that science is a codified body of factual knowledge; a body of content that must be learned and repeated verbatim upon request (Millar, 1989). Harris (1998), however, suggests there is another kind of thinking we should foster; one that focuses on exploring ideas, generating possibilities, and looking for many right answers rather than seeking the one 'correct' answer. We suggest here that both ways of thinking are useful in working life after graduation, yet it seems the latter tends to be ignored until after college in many countries including Malaysia. According to Chua (2004), there are four main steps that we need to take in order to foster creative thinking: remove barriers to creative thinking; make students aware of the nature of the creative process; introduce and practice creative thinking strategies; and foster a creative environment. In Malaysia, efforts are now being made to encourage creativity through both curricular and co-curricular activities (see, e.g., Utusan

Malaysia (2008); Yong (1987) ; Yong (1993)). As noted recently by the Deputy Prime Minister of Malaysia, Tan Sri Muhyiddin Yassin (also the Minister of Education), Malaysian education urgently needs to be transformed if we are to enhance economic development by application of creativity and innovation (Coll & Taylor (2008); Zakaria (2010)). Thus, in Malaysia teachers are encouraged to use pedagogies to promote creativity, and students are likewise encouraged to be innovative and come up with new ideas. Students are encouraged to participate in creative activities, allowing them to become conscious of the ways in which they think and learn.

Measuring Creative Thinking : It is not obvious how one could measure such an holistic construct like creativity. Based on the literature, it seems creativity is usually measured by means of survey instruments. The main instrument reported in the literature used to measure creative thinking is Torrance Test of Creative Thinking (TTCT, Forms A& B)(Torrance, 1990). Torrance(1966, 1990) suggests that creative thinking means to generate new ideas, the student must produce more and more ideas (i.e., be fluent), and include a variety of different ideas (i.e., be flexible), ideas that are unique (i.e., original ideas), and that such ideas need to be specific, detailed and useful (i.e., they are valuable). To measure these skills, the TTCT in Form A (for pre-test) and Form B (for post-test) are used. There are no major differences between the tests since the questions in each form revolve around six activities:

Activity 1: Asking - students need to ask as many questions as possible about the activities seen in a picture that is provided;

Activity 2: Guessing the causes - students need to guess as many causes as possible, about what caused the event/occurrence shown in a picture that is provided;

Activity 3: Guessing the cause of an occurrence or an event – students need to list as many causes as possible, for the causes or outcomes of what will happen because of the event/occurrence shown in a picture that is provided;

Activity 4: Improving the product – students need to list the best and most extraordinary ways we could change a given form of a product to produce a more interesting or useful form of the product;

Activity 5: Extraordinary uses - students need to list as many possible functions or ways in which a product can be utilized in a picture that is provided;

Activity 6: Supposing – students need to list other things that might happen through, or be caused by, an occurrence that has already happened/occurred.

Each answer in this instrument is scored using the following criteria (i) fluency, (ii) flexibility, (iii) originality, and (iv) elaboration. Juremi (2003)reported good construct and criterion validity, for both versions of the TTCT in the Malaysian context, suggesting they would likely to be suitable for use in the present inquiry (see below for validation of instruments). Additionally, work by Ghouse (1996), supports the construct validity of the TTCT for two cohorts of students, who were taught how to think creatively, compared with a group taught traditionally.

II. PROBLEM-BASED LEARNING

Problem-based learning (PBL) is a pedagogical approach to science education that focuses on helping students develop self-directed learning skills(Barrows & Tamblyn, 1980;Boud & Feletti, 1991). PBL has its origins in the Medical School of McMaster University (Rideout & Carpio, 2001), but has since been used in a variety of other contexts. It derives from the idea that learning is a process in which the learner actively constructs new knowledge on the basis of current knowledge. Unlike traditional teaching practices in higher education, where the emphasis is on the transmission of factual knowledge, PBL consists providing students with a set of problems that are carefully sequenced to ensure the students are taken through the curriculum in a measured fashion. The students encounter problem-solving situations in small groups guided by a tutor, who facilitates the learning process by asking questions and monitoring the problem-solving process. The ability to solve problems here is more than just accumulating knowledge and rules; it is the development of flexible, cognitive strategies that help analyse unanticipated, ‘ill-structured’ situations with an end result of producing meaningful solutions. Even though many of today's complex issues are within reach of student understanding, according to the literature the skills needed to tackle these problems are often missing in our pedagogical approaches (Hitchcock, 2000; Hmelo-Silver & Xiu, 2000).Works done by Osman, Samsudin and Halim [41]at secondary level, PBL approach are capable in creating a better learning atmosphere which in return reflects culture of science in classroom.PBL appears, to at least in part, address concerns about other educational methods noted in the literature, such as how to enhance creative and critical thinking (Wards & Lee, 2002). According to Meier, Hovde, and Meier (1996), students taught within a teacher-dominated, lecture-based system

are not able to solve problems that require them to make connections and use relationships between concepts and content.

Only emerging scientists who are trained and taught to think creatively are likely to be able to solve real life problems. The literature thus suggests if we want our future scientists to be capable of solving some of the problems facing society, then we need to find ways to develop creative thinking skills in our students. The research reported in this inquiry seeks to investigate the effectiveness of PBL in enhancing students' creativity skills in Malaysia, and at to see whether or not there is any positive impact on students' critical thinking.

III. PBL AND ONLINE LEARNING

There is now a substantial literature on how PBL and online learning can be combined(see, e.g., Candela et al., 2009; Cheany & Ingebritsen, 2005;Jeannings, 2006; Lee, 2006; Lim, 2005; Savin-Baden & Gibbon, 2006), a combination that is often called PBL online. The argument in favour of this combination is that PBL online is capable of promoting both the development of problem-solving, and students' ability to use information technology; emphasizing the advantages of PBL as a promoter of process, as opposed to content(Watson, 2002). At first, technology was only used by teachers for administrative purposes, or for information dissemination (Lim, 2005), but as teachers became more familiar with such technologies, they sought to explore the potential of ICT in delivering collaborative inquiry through online forums (Lim, 2005). Some authors report integrating constructivist-based education of practical work such as PBL with online learning (Lim, 2005).

Integrating PBL with online learning consists of merging the pedagogy (in this case PBL) and delivering the content partly, or entirely, online via the Web. A key feature of PBL online is the online collaboration that occurs as part of the learning activities(Saven-Baden &Wilkie, 2006), and this focuses on team-oriented knowledge-building discourse, and reduced teacher-centred learning (Saven-Baden, 2006). Savin-Baden also note that PBL online involves students working collaboratively in real time, or asynchronously, and collaboration tools such as shared whiteboards, video conferencing, group browsing, e-mail, and forum rooms are important for the effective use of PBL online. Students can learn through the use of Web-based materials such as text, simulations, videos, and demonstrations (Savin-Baden & Gibbon, 2006). In some cases, no print materials are provided, and students only can access materials directly from the course website(Yong, Leong & Jaime, 2003). In other cases there is a focus on a particular website, through which students are guided by the use of strategy problems, online material and specific links to core material, rather than delivery of PBL solely online (e.g., Savin-Baden & Gibbon, 2006). In both cases, use of websites is mostly student led/driven, and the materials provided support the learning undertaken in face-to-face PBL groups. An example of such a site is that for the SONIC project (Student Online in Nursing Integrated Curricula) (Savin-Baden & Gibbon, 2006) which used PBL in an interactive environment using FlashPlayer-based physiology resources in order to improve students expertise in nursing. Savin-Baden and Gibbon in an investigation of the interrelationship of PBL and interactive media, report that the assessment of PBL combined with interactive media to date has not fully considered the difficulties of combining these two approaches. There is little in the literature about integrating PBL online and creative thinking in non-Western settings such as Malaysia. Thus, this study seeks to contribute to the literature by considering how we might foster creative thinking amongst science students and pre-service science teachers' using PBL online for physics.

IV. METHODOLOGY

The study was conducted in Semester II during the 2008/2009 academic year at the University Malaysia Sabah (UMS), Malaysia. A cohort of 61 science physics students from the Physics and Electronics Program in the School of Science and Technology (SST), and a second cohort of 41 pre-service science teachers from the Science With Education Program from the School of Education and Social Development (SESD) were involved. The student cohorts were separated into experimental and control groups. The experimental group pursued all the PBL learning activities (i.e., collaborative learning, independent learning, self-directed learning, and reflective learning), while the control group were taught in a traditional lecture based learning manner. Both groups were provided with an online learning environment (i.e., using the same learning management system - Moodle). For the PBL group, the students were divided into 10 groups of 4-6 students. Whilst for the traditional group, there were no groups involved, and they studied individually (Table 1).

Table 1. Sample used for the study

Group	Problem-Based Learning	Traditional
Science Physics Students (SST)	30 students (6 groups)	31 students
Pre-Service Science Teachers (SESD)	20 Students (4 groups)	21 Students

The intervention was conducted over 16 weeks. The TTCT instrument was administered one week before classes as a pre-test, and one week after the intervention as a post-test. During the intervention, all the teaching and learning assessment was delivered using the learning management system (LMS) organized by the Educational Technology and Multimedia Unit (ETMU) of the Universiti Malaysia Sabah. The LMS was developed in 2007, and the first author and lead researcher prepared the LMS following PBL and traditional approaches. For the PBL groups the learning activities started with problems. After they were introduced to the problem, the students had to find their own sources of information in order to develop an appropriate solution. They could find solutions via the Internet, from interviews with their lectures or tutors, from textbooks, observations, or any method they felt would provide relevant information to help them solve their problems. The students in the PBL group also had to access to the LMS to engage in chat rooms at least once in a week –this was monitored by a facilitator. In these chat rooms they could argue, share thoughts, and start to construct solutions to the problems posed. They also could enter a forum room to post any inquiries or any ideas asynchronously. Additionally, some linkages, sources and lecture notes were uploaded by the facilitator to ensure the students did not lose their way when trying to find suitable solutions. They were given two weeks to solve each problem, and they had to solve five problems over the semester. In PBL online approach, students separated into 10 groups (6 groups from SST; 4 groups from SESD) as it consist of 4-6 members. Before they started with the intervention they had been given with a series of daily life situation problems that related to the Modern Physics’s syllabus. In the first week they distributed the task among group members. Before go on to their further research, they discussed about their hypothesis and prior knowledge about the issues either online or by conventional method. The following task is the individually independent research to find any related information, ideas, knowledge, or notes to support their explanations about the issue. The following weeks they meet up again via online to discuss, analyse and synthesize their information whether it will be the best solution. If not, they will do the same process in finding the information individually and will come up ones again in a group discussion through online and continue discussing on their matter. The process will continue until the group come up with the best solution for each daily live problem given.

For the traditional group, no major differences were made in terms of their learning activities compared with their usual face-to-face traditional teaching approach. The students in both cohorts were familiar with the LMS, where they already had experience in downloading and reading lecture notes online, accessing tutorial questions and assignments. They were required to submit all answers to tutorial problems and assignments via the LMS, but received no additional learning activities. This use of the LMS, Moodle2007, followed the suggestion of Jayasundara et al. (2007) that PBL online is easier if it is incorporated into existing learning management systems such as Moodle and Blackboard. In summary, in this inquiry the intention was to improve students’ creative thinking via a PBL online intervention. The data were collected through a creative thinking test - the Torrance Test of Creative Thinking, which as noted above contains four criteria used to evaluate creative thinking. There were two versions of the creative thinking test employed, a pre-test (Form A) and post-test (Form B). The purpose of conducting the pre-test was to make sure the students from the two cohorts were comparable in term of their creative thinking, and the post-test are intended to see if there were any significant differences in creative thinking after the intervention. The tests were administered in Week 1 and Week 16 of the semester.

Content validity in this administration was checked by a lecturer in the area of creative thinking (at another university form that where the survey administration occurred) who checked the instrument for suitability in evaluating creative thinking skills, and an English language teacher checked the instrument for clarity of English language. The instruments for the present study also validated from a pilot study, where a group of students answered the questions and gave feedbacks. This resulted in minor linguistic modifications for clarity. Creative thinking was evaluated using the four elements that form the basis of the instrument described above; viz., fluency (i.e., students give as many answer as they can), flexibility (i.e., students give as many

themes of answers as they can), originality (i.e., students give authentic answers that are different from others), and elaboration (i.e., students give cause and effect for each answer).

V. RESEARCH FINDINGS

Table 2 shows a comparison of creative thinking for the experimental, and traditional (control) groups. Differences were evaluated using a variety of statistical tools. According to Coakes (2005), it is best to employ the independent samples t-test if the data is of a normal distribution, and the Mann Whitney U-test if the distribution is not normal(or is a small sample). In this study the data were analysed using both approaches. It appears that overall there are statistically significant differences between the traditional and PBL group for the both Mann-Whitney U test ($z = -2.95$, asymp. sig (2 tailed) = $0.01^* < 0.05$) and the Independent Sample t-Test (sig. 2 tailed, $t = -2.78$, $p = 0.01^* < 0.05$) in the post-test. These findings were based on flexibility, originality and elaboration criterion, where the PBL group achieved higher mean marks - again for both analyses (Mann-Whitney U test $z = -3.16$, asymp. sig (2 tailed) = $0.00^* < 0.05$; $z = -3.86$, asymp. sig (2 tailed) = $0.00^* < 0.05$; $z = -3.16$, asymp. sig (2 tailed) = $0.00^* < 0.05$; and Independent Sample t-Test, $t = -3.16$, $p = 0.00^* < 0.05$; $t = -3.97$, $p = 0.00^* < 0.05$; $t = -4.57$, $p = 0.00^* < 0.05$; respectively). No statistically significant differences were noted for fluency.

Table 2.Comparison between the traditional and PBL group

Creative Thinking Criterion	Mann-Whitney U-Test		Independent Sample t-Test	
	Z	Asymp. Sig	t	p
Fluency	-0.77	0.44	3.22	0.75
Flexibility	-3.16	0.00*	-3.16	0.00*
Originality	-3.86	0.00*	-4.57	0.00*
Elaboration	-3.16	0.00*	-3.97	0.00*

VI. DISCUSSIONAND CONCLUSION

The research findings reported in this study suggest that students' creativity as measured by the Torrance Creative Thinking Test (TCTT) was enhanced when they engaged with PBL online compared with their counterparts who were taught more traditionally. The overall means show statistically significant differences for the combined SST and SESD students in favour the PBL online group. In particular, it seems that the PBL online students did better for three scales of flexibility, originality and elaboration. This is consistent with the features that are captured in flexibility, originality and elaboration elements of creative thinking in the Torrance Test. These findings are similar to work reported by Tan (2000) and Juremi (2003), who say that PBL online increases students' creative thinking. Furthermore, through online learning, the students in the present work also saw PBL online as a new way of learning, that they felt gave them a number of benefits, and they felt that the benefits of demonstrated learning effectiveness, justify the extra resourcing, consistent with work by King (2008) where PBL online students reported high satisfaction even with an increased workload. Mandic, Dzinovic and Samardzic(2012) also suggest that the cutting edge technologies (i.e., Internet technologies, Web portals and multimedia software) have positive impact to implementation of cooperative work of students, more interactivity and experience of teaching and learning process. Additionally, Kaewkuekool(2013) adds that lesson via ICT was thoroughly accepted and Rahmat works shows that learning via online were capable to facilitate students to gain latest relevance information in more collaborative learning atmosphere (Rahmat, 2013).

This study provides some evidence of the positive effects of using PBL online on students' creative thinking. Although some scholars suggest creative thinking is a process involving phases and skills that cannot be learnt in a short time (Chua, 2004).It appears that PBL online has the potential to improve undergraduate of science physic students' and pre-service science teachers' creative thinking. In conclusion, through PBL online, students were engaged in a holistic form of learning process which was quite different to their traditional experiences. Although at the beginning students were a bit overwhelmed by the workload, the outcomes from this study suggests that PBL online can be useful for undergraduate science students and pre-service science teachers to nurture creative thinking. Thus this suggests that teachers, curriculum designers and Ministry officials' should consider the implementation of PBL online at the tertiary level since it seems it may enhanced

students' creative thinking something local commentators say we need to do if we are to help Malaysia achieve the goals specified in Vision 2020.

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