

The Role of PBL in Improving Physics Students' Creative Thinking and Its Imprint on Gender

Elnetthra Folly Eldy¹ & Fauziah Sulaiman¹

¹Physics with Electronics Programme
School of Science & Technology
University Malaysia Sabah
Kota Kinabalu Sabah, Malaysia.

e-mail: follyelnetthra@yahoo.com; fauziahs@ums.edu.my; fauziahsulaiman6@gmail.com

Phone: +6088320000 (5857); Fax: +608435324

Abstract: Creativity is one of the components in thinking skills that realized as one of a critical feature for a developing industrial country like Malaysia. The main objective of this paper is to provide details of students' score on several criteria's of creative thinking who was previously done from YanPiaw Creative-Critical test analysis and in addition of that also to present an evidence to support the previous study on the relationship between creativity and gender. The subjects of this study were 28 Physics with Electronics undergraduate students exposed to problem-based learning (PBL) for one semester (i.e., 14 weeks) during Semester 2, Session 2012/2013 academic year. The study took place at School of Science & Technology, University Malaysia Sabah. The results and comparison of the findings in this study with previous study was present, also accompanying by proper discussion.

Keyword: *Problem-based learning, creative thinking, gender.*

1. Introduction

As graduates nowadays urged to developed more on their higher order thinking as it was the most factor that are demanded by employers (Malaysian, 2012), the study on how to supported the development of students creative and critical thinking become among the element that are concerned of in teaching education. Other than critical thinking as it can be taught, creative thinking was something like a talent of each individual who requires training to be sharpened (Zhou, 2012). While problem-based learning (PBL) was seen and support by several study as the best alternative that can be help the development of creative thinking, the adaptation of this teaching in this study was something to look forward.

The purpose of this paper was to provide details of students' score on several criteria's of creative thinking who was previously done from YanPiaw Creative-Critical test analysis after implemented with PBL online approach. In addition this paper also presents an evidence to support the previous study on the importance of the relationship between creative thinking skills and gender.

2. The Understanding of Creative Thinking and Related Topic

Creative Thinking

Definition and Theory of Creative Thinking

Widely, creative thinking define as “*divergent, tries to create something news and carried on by violating accepted principle*” (Baker, 2001) or in simplest understanding specifically on university level creative thinking was about how individual able to applied imagination to solve problem (Coughlan, 2007). On the other hand, Torrance (1966) (p.6) as mentioned by Baker (2001) defined creative thinking as more operational as

“a process of becoming sensitive to a problem, deficiencies, gap in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypothesis about these deficiencies; testing and retesting these hypothesis and possibly modifying and retesting them; and finally communicating the results”

Guilford (1964) described creative thinking as divergent thinking which defined as producing a lot of varies idea about some topic in limited time (Chua, 2010), Torrance (1984) also known as “creativity man” established the 4 characteristics of creative thinking (i.e. *originality, elaboration, fluency and flexibility*) (Chua, 2004) which almost similar with what Guilford (1964) described.

Creative Thinking Ability and Gender Based

A quiet plenty studies show the culture of creative thinking between male and females was different; some shows the bias of creative thinking was more towards male than females, while some studies show females later males demonstrated the greatest creativity. Study from Stephens *et al.* (2001) which investigates the gender differences among third and fourth grade students show that the girls’ achieve higher score than the boys’; other parallel finding as show by Caroliet *al.* (2009) found girls score on creativity than boys. On the other hand, even there was no statistically significant of the results between males and females as found from Stoltzfuset *al.* (2011) but overall males show higher scored than females, parallel finding also found from Ariffinet *al.* (2011) indicate that males have a higher level of higher order thinking ability than females. Anyhow, some studies also found the non-significant differences between males and females in creativity (Babaliset *al.*, (2012); Sulaiman (2011)).

Despite the inconsistent founding on study related to creative thinking skills among different gender but the knowledge of understanding about creative thinking ability on gender based believed could helped to the advancement of individual in varies field (Poturet *al.*, 2009).

Problem-based Learning and Creative Thinking Skill

PBL started in Malaysia at 1981 when it first implemented in Medical Department of Universiti Sains Malaysia (Ibrahim, 2009). The operational definition of PBL also act as the process of this teaching method start as cycle with students meet the problem, identify, independent study, tutorial and end with integration of learning (Hung *et al.*, 2007; Arzuman, 2005; Barrett, 2005). PBL experienced positive development and can be seen as a trustful alternative teaching method to improved students’ thinking abilities, problem solving skills and proficiencies not only in medic, teacher and engineering education teaching even in Physics itself (Selçuket *al.*, 2010; Ali *et al.*, 2009; Hari, 2008).

Problem-based learning proved could be a trustful alternative for teaching to help the positive development on creative thinking skills among individual in various field of education as supported by study such as on Physics education by Sulaiman *et al* (2013) provided a proved of the capability of PBL improved Physics students' creative thinking skills. Few other study supported by founding a parallel finding (Mokhtaret *al.*, 2010) in calculus and (Awanget *al.*, 2010) in civil engineering.

The link between PBL and creative thinking was explored by looking into study which supported the PBL teaching method contributes positively on students' creative thinking skills.

3. Methodology

For this current study, the objective of implementing the PBL approach was to investigate the effects of the independent variable (PBL online) on dependent variable (YanPiawCreative-Critical Thinking score and Torrance Test Creative Thinking Test (TTCT)).

Subjects

This study was performed on 28 (i.e., 16 females and 12 males) of second year students from Physics with Electronics Programme who attended Thermodynamics Physics course in Semester 1 Session 2012/2013. This programme is out of ten sciences programme that administered under School of Science & Technology at University Malaysia Sabah. They had been exposed by PBL's throughout Semester I Session 2012/2013 academic year, which took 14 weeks. The course led by lecturer who had 10 years of experience in PBL.

Instruments

Data was collected by using The YanPiaw Creative Critical Thinking test developed by Chua (2004) to identify student level of thinking styles. In this particular test there were 4 level of thinking style that being stated which are: superior creative thinking, creative thinking, balanced thinking style, critical thinking style and superior critical thinking style.

The reliability of the instrument also shows positive values during the pilot test where the Cronbach's alpha coefficient for the test is .90(total score), .81(critical thinking style) and .85(creative thinking style).

Data was also gathered using Torrance Test Creative Thinking Form A (1990) to measure the students creative thinking skills after implemented with PBL. This test was divided into 4 mental characteristics; fluency, flexibility, originality and elaboration.

The Cronbach's alpha coefficient for this test .79 (fluency), .84(flexibility), .84(originality), .78 (elaboration) and .81(total score).

4. Procedure

The Online Platform

In order to implement the online activities, Facebook (FB) chat room was used. As widely known, FB is a freely accessible social network on the Internet which would work for anyone. FB which developed on 2004 by Mark Zuckerberg accessed by using either on computers or mobile phone and this makes students easy to use everywhere and anywhere (Collier, 2012). This also make student's easy to share document or photo

related to their problem anytime needed, whilst other members or facilitator can access to whatever they posted asynchronously out from their chats room's timetable (Sulaiman, 2011).

The PBL process used in this implementation was summarized as shown in Figure 1.

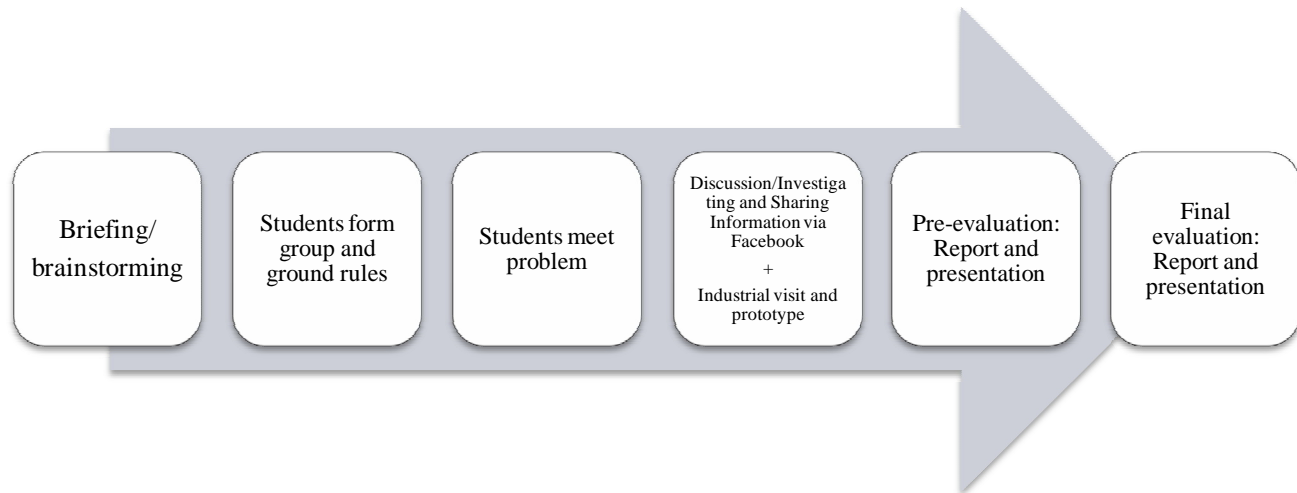


Figure 1: Summary of PBL model used

During the first and second week before the PBL implementation, students were briefly introduced about course outline. Meanwhile, students formed group (i.e., 5 to 6 people in a group) and set ground rules. Students were provided with lecture note and act as their main guideline to identify their own problem statement. After brainstorming, students decided their slot time for online chatting: 1 hour per week for every group as this online PBL implementation held almost 3/4 using online chatting.

Students identified their own problem statement or issue afterwards and facilitated by a facilitator. During discussions, students were encouraged to suggest and imply their own idea. They were also shared information they have gathered during the independent learning process took place. These activities had been monitored by a facilitator via online. Normally students were given with one week settling and deciding their problem statement and issue. Identifying the main objective is important where they will stick to it throughout the particular semester. Students usually gathered information from their surroundings, technology (internet), books and journals reading to come up with their problem statement.

The intervention process starts with students brainstorming and briefing about the problem with each other. Afterwards students were provided with they knew (i.e., prior knowledge) and what they do not know about the problem and objective of problem. Students searched relevant information including books, journals, magazines, notes, manual, internet and other kind of resources. All of this 'give and take' or sharing information and idea processed held via Facebook facilitated by a lecturer and facilitator.

Additional compulsory activity that the group need to do was to visit to any government or private agencies related to their problem respectively. This extra activity was needed as they will find more information on site that they will never find in books or any other printed material. The extra information gathered by interview and observation in a way for students to understand and gets more useful information. These extracurricular are important as it will make students understand more and get useful information. Some of

students even make a simple laboratory experiment or prototype after the visit to gain more idea and provide deeper understanding with the member group and other classmates.

To ensure the PBL was implemented effectively, after every two to three weeks of online class in chatting room (Facebook), student's compulsory meet face to face with facilitators to exchange their confusing or dilemma. On the other hand, students also need to provide pre-report and pre-presentation at week seven or eight in front of their classmates and facilitator. This pre-evaluation provide them with experience for better communication skills and presents in front of many people. Final report and presentation also held at the end of implementation in week fourteen for final evaluation

Face-to-face Discussion

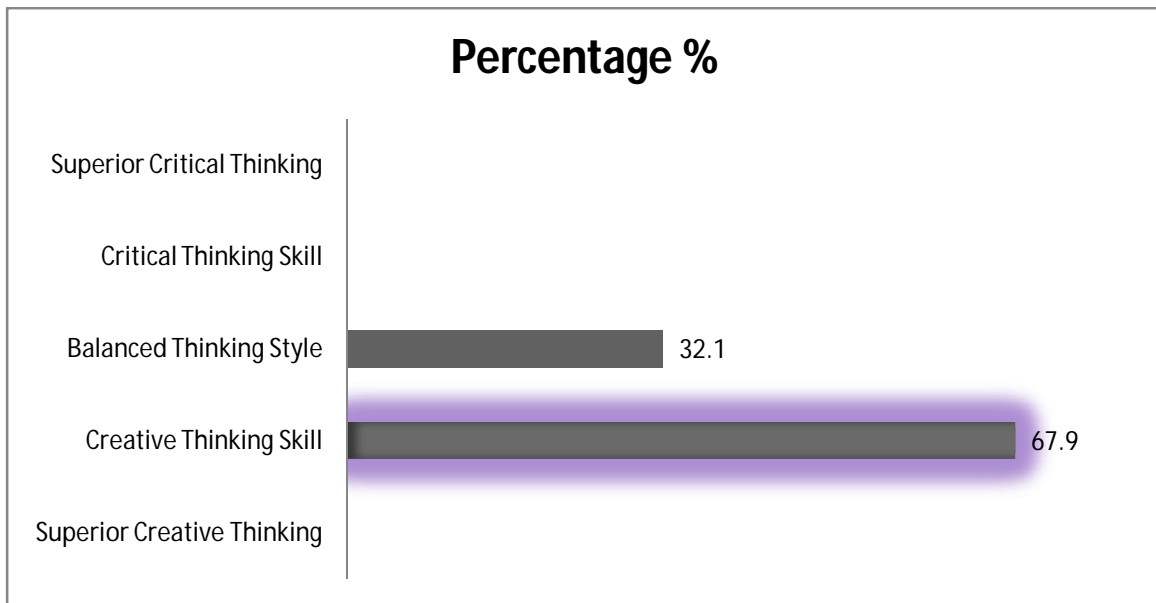
Face-to-face discussion in this study held as normal lecture, sit in a class for 1 to 2 hours and facilitator discuss the progress of each group in term of their solution. This discussion held about 2 or 3 weeks after online class. This is important as to provide students with a solid discussion in every chat and they had time to ask facilitator question they found hard to explain during the online chat class. This discussion also provide time between facilitator and students to be little closer and realize the role of facilitator in their online chat class as guide which help students to be more open to ask, share their opinion and widen their rationale during online chat. In addition, this discussion also helps each member to solve their misunderstanding and misinterpretation between each other's.

At the end of every face-to-face discussion, facilitator provides some feedback to almost every group member regarding to their level of participations, contributions of opinion or comment and alternative of solving the problem. This was important in helping the students to be to more confidence with the information that they want to share.

5. Results and Discussion

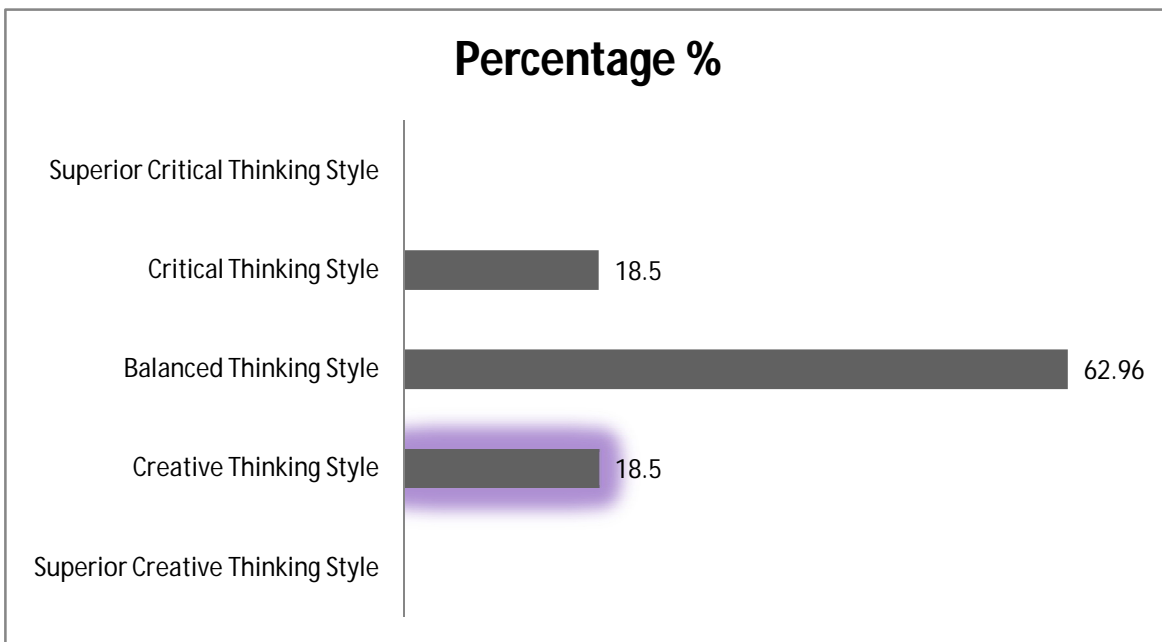
The distribution of students thinking styles from previous YanPiaw Creative Critical Thinking test showed on Table 1 and Table 2 as followed. Table 1 showed the distribution of student thinking style before implemented by PBL online approach while Table 2 showed the distribution after 14 weeks exposed with the same approach.

Table 1 TheYanPiaw Creative-Critical Thinking Test Analysis (Form A)



*Number of students for each percentage (32.1%, N=8; 67.9%, N=20)

Table 2 TheYanPiaw Creative-Critical Thinking Test Analysis (Form B)



*Number of students for each percentage (18.5%, N=5; 62.96%, N=17; 18.5%, N=5)

Table 1 showed around 68% (N=19) of students fall on creative thinking style whilst only 19% (N=5) on Table 2. As shown on Table 1 and Table 2, there is a decreasing on the percentage of creative thinking styles of students before and after implemented by PBL as students balanced thinking style (i.e., Creative-Critical thinking) increase.

Meanwhile as the purpose of this paper was to provide details of students' score on criteria of creative thinking based on previous result of YanPiaw Creative Critical Thinking test, Table 3 show the report mean mark of each criteria for creative thinking based on TTCT test.

Table 3 Report of TTCT mean mark for creative thinking by criterion

Creative thinking criterion	PBL Online N=(27) Mean (SD)
Fluency	29.15 (10.64)
Flexibility	19.15 (5.49)
Originality	2.59 (1.80)
Elaboration	7.48 (5.98)

Note: This was an open-ended test, and so there are no maximum or minimum score

The finding shows in Table 3 indicate that overall creativity of students is characterized mainly by two component of abilities name *fluency* and *flexibility*. The highest mean score was on *fluency* (29.15), this show that students are more capable in producing a large number of idea or response in problem-solving situation. The lowest mean score was on *originality* (2.59) which shows that students still lack with the ability to produce new or unique extraordinary idea or response.

As the results in Table 3 compared with Sulaiman (2011), there is similarity in term of students strength in each criteria pattern as her work shows the same criterion, where students get higher mean mark after being exposed with the PBL online which is *fluency* and *flexibility*. Contrary with the other two criteria's; *originality* and *elaboration*, Sulaiman (2011) reports the inversely findings when mean mark for *originality* was higher than *elaboration*.

Table 4 Report of TTCT mean marks for creative thinking by gender by criterion

Creative thinking criterion		Gender			Independent samples test t-test for equality of means		
		Male N=10	Female N=17	Total N=27	T df=	Mean difference	Sig (2-tailed)
Fluency	Mean	35.40	25.47	29.15	-2.59	-9.93	.02*
	SD	12.27	7.78	10.64			
Flexibility	Mean	22.10	17.41	19.15	-2.32	-4.69	.03*
	SD	6.40	4.15	5.49			
Originality	Mean	3.40	2.12	2.59	-1.87	-1.28	.07
	SD	1.36	1.90	1.80			

Elaboration	Mean	9.70	6.18	7.48	-1.51	-3.52	.14
	SD	6.60	5.37	5.99			
Overall	Mean	70.60	51.27	58.37			
	SD	26.62	19.20	23.92			

Note: *Statistically significant differences between Male and Female. This was an open-ended test, and so there are no maximum or minimum scores.

Table 4 shows the report of TTCT mean marks by gender criterion. From the table it shows that male has the higher mean mark for overall mean score and also dominated for each of four criterions in this test. The report shows male and female both has the highest mean score on *fluency* (35.40) and (25.47) respectively and lowest mean score on *originality* (3.40) and (2.12) for respectively.

As the mean difference in Table 4 compared with previous study by Sulaiman (2011) in term of students development on thinking style pattern by gender, it shows a parallel findings specifically on *fluency* and *elaboration* when there is no any significant difference between both findings. This also can conclude that science students focally Physics students did not have a big difference for both of these criteria in term of gender.

Differently when both of this findings; Table 4 and Sulaiman (2011) compared specifically on each gender separately, the other way round of findings was found, as Sulaiman (2011) reports that all off the four criteria's in this test was dominated by female which was very different with what shows in Table 4. This finding shows that the difference on creativity among male and female on Physics students was not bias in any particular gender. This might cause by some factor such as number of male students (N=10) in this study was smaller than number of female students (N=17), while as Sulaiman's (2011) study the number of students for both gender was same (i.e N=15).

This finding also might affect by how the PBL process implemented to subjects (students) where in this study almost everything starting from finding the main problem statement until the end of cycle process of PBL was depended on students themselves. As mention in part of the methodology in this paper, the problem that students will learn and solved throughout semester was decided by students with guide from facilitator while as understand from Sulaiman (2011) integrated methodology, the problem statement was provided. In addition of that an innovation to the PBL implementation throughout this study which after every two or three week of chat room, face to face class (normal lecture) was handled contributed on the difference finding on both study.

6. Conclusion

The present study show the details of students' score on criteria of creative thinking on previous finding from YanPiaw Creative-Critical thinking test analysis after implemented with PBL online. The result yield that *fluency* placed high with 29.15 mean score while *originality* where students required to provide an original and new idea placed lowest with just 2.59 mean score. There some dissonance on two criterias(i.e. *originality* and *elaboration*) of the present result when it compared with previous study of Sulaiman (2011). This study also shows that there was a significance difference between overall mean score of males and females. The same pattern found on each criterion for each gender as male leading all four main criteria (i.e. *fluency*, *flexibility*, *originality*, *elaboration*) in TTCT.

REFERENCES

- Ali A.H., Rubiah S.N.K. 2009. *Student-Centered Learning: An Approach in Physics Learning Style Using Problem-Based Learning (PBL) Method*. University TunHussienOnn Malaysia.
- Ariffin S.R., Daud F., Ariffin R., Rashid N.A., Badib A. 2011. *Profile of Creativity and Innovation Among Higher Learning Institution Students in Malaysia*. World AppliedSciences Journal 15 (Innovation and Pedagogy for Lifelong Learning): 36-41.
- Arzuman H.2005. Education Guide for Faculty Members:Problem-Based Learning. Kota Bharu. University Sains Malaysia.
- Awang H., Ramly I. 2010. Creative Thinking Skill Approach Through Problem-Based Learning: Pedagogy and Practice in the Engineering Classroom. International Journal of Human and Social Sciences.3:1.
- Babalıs T., Xanthakou Y., Kaila M., Stavrou N. 2012. *Research attitude and innovative-creative thinking: Differences between undergraduate male and female students*. International Conference on Education and Educational Psychology (ICEEPSY 2012).69:1452 1461.
- Baker M., Rudd R. 2001.*Relationship between Critical and Creative Thinking*.Journal of Southern Agricultural Education Research.Vol 51, No1, pp. 173-188.
- Barret T. 2005. What is Problem-Based Learning? Handbook of Enquiry & Problem Based Learning. Dublin. University College Dublin.
- Caroli M.E.D., Sagone E. 2009. *Creative Thinking and Big Five Factors of Personality Measured in Italian School Children*.Faculty of Educational Science. University of Catania, Italy.
- Chua Y.P.2004. *Creative and Critical Thinking Styles*.Serdang: Universiti Putra Malaysia Press.
- Chua Y.P.2010. *Building a test to assess creative and critical thinking simultaneously*.Procedia Social and Behavioral Sciences. 2:551-559.
- Collier A., Magid L. 2012. A Parent's Guide to Facebook. <http://www.connectsafely.org/pdfs/fbparents.pdf>. Retrieved on 13 March 2013.

- Coughlan A. 2007-2008. *LEARNING TO LEARN: Creative Thinking and Critical Thinking*. DCU Students Learning Resources.
- Hari P. 2008. *Developing Problem Solving and Critical Thinking Skills in Physics and Engineering Physics Courses*. The University of Tulsa.
- Hung W., Jonassen D.H., Liu R. 2007. *Problem-Based Learning*. pp.448-489.
- Ibrahim N.M. 2009. *Transition from Problem-Based Learning (PBL) to Task-Based Learning (TBL)*. Slide. International Medical University (IMU). Malaysia.
- Malaysian, (2012, March 4). *Education system not producing thinking graduates, says experts*. The Star On LINE. <http://thestar.com.my/news/story.asp?file=/2012/3/4/nation/20120304123742&sec=nation>. Retrieved on 25 March 2012.
- Mokhtar M.Z., Tarmizi M.A.A, Tarmizi R.A, Ayub A.F.M. 2010. *Problem-Based Learning in Calculus Course: Perception, Engagement and Performance*. Proceeding of 7th WSEAS International Conference on Engineering Education. Corfu Island, 22-24 July
- Potur A. A., Barkul O. 2009. *Gender and Creative Thinking in Education: A Theoretical and Experimental Overview*.
- Selçuk G.S., Çalışkan S. 2010. *A Small Study Comparing the Impact of Problem Based Learning and Traditional Methods on Students Satisfaction in the Introductory Physics Course*. Procedia Social and Behavioral Sciences.2:809-813.
- Stephens K.R., Karnes F.A., Whorton J. 2001. *Gender Differences in Creativity Among American Indian Third and Fourth Grade Students*. Journal of American Indian Education.4 (1).
- Stoltzfus G., Nibbelink B.L., Vredenburg D., Thyrum E. 2011. *Gender, Gender Role, and Creativity*. Journal of Social Behavior and Personality. 39(3):425-432.
- Sulaiman F. 2011. *The Effectiveness of Problem-Based Learning on Students' Creative and Critical Thinking in Physics at Tertiary Level in Malaysia*. University of Waikato: PhD Thesis.
- Sulaiman F., Coll R.K., Hassan S. 2013. *Comparison using PBL and Online Learning for Undergraduate Physics' Students for Creative Thinking*. Proceeding of the World Science, Engineering and Art Studies (WSEAS). Kuala Lumpur, 1-4 April.
- Zhou C. 2012. *Teaching Engineering Students Creativity: A Review of Applied Strategies*. Journal of Efficiency and Responsibility in Education and Science. 5(2):99-114.