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Improving Students Learning Approach in Mathematical Thinking through Constructivist Learning Approach with Creativity for Architecture Students

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ABSTRACT

The purpose of this research is to measure the effectiveness of constructivist learning approach in structural study specifically for architecture students. Theoretically, improving student's performance in mathematics is challenging for today education. In architectural education, structural study is part of the non- design courses in the syllabus under the area of technology and environment and it involve in mathematical calculations. In the context of typical classrooms that adopt conventional teaching method, students are usually taught using structured rules based on the given academic syllabus. However, teaching architecture students need a different approach. This is because architecture students learn by understanding the application into practice rather than by only solving the principle-problem. Purposive sampling which is the Torrance Test of Creative Thinking (TTCT) was selected as the method of the study and teaching experiment was conducted. In the experimental structural design, 26 groups of architecture students were tested based on two situations; pre-test (original) and post-test (change), and tests are conducted according to the stages and times set for each topic. The experiment was designed based on the Constructivist learning approach as foundation of the experiment to study the mathematical creativity of the students. The findings show that there are positive impacts on creativity in the subject of structural study which beneficially affects their understanding and application abilities. Further research needs to done to ensure this beneficial outcome can be greatly support students' long-term retention of knowledge and skills.

Keywords: *Constructivist learning approach, Creativity in mathematical thinking, and Experimental study for architecture students*

1. INTRODUCTION

In Malaysia, most educational practices of teaching mathematics are still referring to the traditional method of learning instructions and curricula (Zanzali, N. A. A, 2000). Basically, they are based on the transmission, or absorption, view of teaching and structured learning by using structured teaching and learning method. In this perspective, students are required to memorize mathematical structures which restricted their understanding on the application of the real site especially for architecture students. According to Nayak (2007) mention its application in the real site and situation, teaching practices will be more effective if students are given the possibility to explore and emphasize on their understanding into practicality. Nadjafikhah, Yaftian, and Bakhshalizadeh (2012), agreed with Laycock (1970), that creativity in mathematic can be achieved by analyzing a given problem from different perspective, such a seeing patterns, looking for differences and similarities, generate multiple ideas and choose a proper method to deal with unfamiliar mathematical situations. As a conclusion towards engaging mathematics and student's creativity, Inan (2013) claims that visual materials play a role in expanding exploration and storing organizing in the long-term memories (as cited in Erkan, 2006). This theory shows that

information is store in long-terms memory both in visually and verbally. In relation to above statement, it can be simply understood mathematical thinking can be injected through creative problem solving, divergent and convergent thinking by engaging students in lesson class.

1.1 Problem Statement

Mathematics has the ability to form a negative feeling of frighten, confuse, and demotivate learners all around the world (Solso,2009). Considering above mention, the experimental study have been done and they carried out with two reasons why students having difficulties in this subjects. As continuing reading Inan (2013), the reason was students are lack of motivation and conceptual abstractness (as cited in Durmus, 2004). It could be stated that this situation can be improved through teaching and constructivist learning approach which provide students with the opportunity to expand their knowledge and deliver new information through practice (Inan, 2013). According to Idris and Nor (2010), mathematics can foster creativity through a dynamic mental process including divergent thinking. Therefore, the real challenge is to provide an environment of practice and stimulates creativity through problem solving and divergent thinking especially in the classroom.

1.2 Purpose of study

The purpose of study is to investigate how creativity can be generated through mathematical thinking among architecture students. This study will involve a group of architecture students which involve traditional instruction and the influence of constructivist learning approach in the experimental group. As referring to the above purpose, the instructional material used in study (model making) to be engage in challenging problems and experience the aspect of creative problem solving. The experimental studies were construct through the material evaluation (on '*remember me'* test) developed by Inan (2013).

1.3 Objective of the study

The main objective of this research is to study on the effects of constructivist learning approach towards mathematical creativity for architecture students. In order to examine the effect of constructivist learning approach towards high achievement in mathematics hypothesis (on *'remember me'* test), several stages are develop based on the study by Ervynck (1991).

Those stages are as follows:

- Stage 1: *A preliminary technical stage.*
  Students understand on the concept of loading on structure by experiencing the process of model making.
- Stage 2: *Algorithmic activity stage*.
  Students capable to apply mathematical techniques which involve mathematical operations, to calculate, manipulate and solve.
- Stage 3: *The creative (conceptual, constructive) activity*.
  Students analyze theory into non-algorithmic decision (info graphics diagram) and solving the calculation.

2. LITERATURE REVIEW

Jonassen (1992) explained that constructivism is concerned with how we construct knowledge from our experiences, mental structures, and beliefs that are used to interpret objects and events. Wilson (1995) also defines a constructivist learning environment as a place where learners may work together and support each other as they use a variety of tools and information resources in their pursuit of learning goals and problem-solving activities. Therefore, it can be argued that constructivism generates student's divergent thinking of authentic learning as long as the tasks closely replicate the real activity.

In addition to the above statement, Jarmon, Traphagan, and Mayrath (2008) reviewed the literature on the use of 3D virtual worlds for teaching and learning and supporting this statement, citing a great deal of research (e.g., Craig, 2007; Dede, Clarke, Ketelut, Nelson, & Bowman, 2005), they found that such activities have the potential to increase student motivation, collaboration, discovery, social interaction, creativity, and address different learning styles.

However, Kim (2005) states that, there are three fundamental differences between constructivist and traditional approach. Firstly, learning involves an active constructive process rather than the process of knowledge accession. Secondly, instead of delivering the information to learners, constructivist approach evolves the learner's process of thinking through creative problem solving. Lastly, constructivist approach is a learning-teaching concept rather than a teaching- learning concept. In other words, constructivist approach towards student centered learning. Therefore, students will be able to develop their creativity through critical thinking and problem-based learning by creating ideas and communicate with their colleagues mathematically.

3. METHODOLOGY

The research will be conducted by using purposive sampling method, Torrance Test of Creative Thinking. The participants consist of 52 semester four architecture students of University Technology Mara Campus Seri Iskandar, Perak. Students are assigned to form a group of two for the task. The study took one month to conduct and it focused on one topic only from the syllabus.

While preparing the experimental group, the table of study plan have been prepared base on syllabus content. According to this table, the researcher has divided into four weeks of lesson unit as shown in Table 1. First week will be an introduction to structural component and theories follow by introduction to forces. The Structural Assessment Test (SAT) were developed by researcher to justify on the mathematical creativity development analysis. In order to collect the relevant data for the study, the researcher prepare and use the (i) Torrance Test of Creative thinking (TTCT) (ii) Pilot Test in order to get some student's feedback about the experimental test.

Table 1: Teaching plan by following weeks prepared by the researcher

Syllabus Content	Week in 2017 (Duration: 1 month)
1. Introduction: ➢ Introduction to structural analysis, theories and components in building structure. ➢ Units, symbol and definitions.	**1**
2. Forces: ➢ Loading on structures ➢ Finding resultant Forces	**2**
3. Forces: ➢ Forces in equilibrium ➢ Moment of force	**3**
4. Structural Assessment Test (SAT)	**4**

3.1 Data Collection Tools

As the data collection tool, there are two stages of experimental constructivist learning approach. The researcher developed instructional material based on three stages development of mathematical creativity hypothesis. Instruction consisted of introduction of new material (model making), the formulation a problem through creating formula and followed by diagrammatic solving. Students are required to design a structure in order to achieve balance. In other word, the principle of moment will

be applied so that there is no obvious movement of force (turning points) to achieve equilibrium of a system.

Students are given a series of time in order to complete all the development stage during Structural Assessment Test (SAT). Depending on design of the structure model, students are given to solve the structure formulation and answer with the co-operative group member. *'Remember me'* test has been applied accordingly by repeating same stages of development but with different groups of students. Considering above mention, students are required to change their module among others group and repeating the same stages. The degree of difficulty of task may different for each group but it still maintained same principle of previous knowledge. This task encourages student interest and creativity towards constructivist leaning model.

As mention earlier, constructivist approach involved five steps: 1) inviting ideas; 2) exploring; 3) proposing; 4) explanation and solution; 5) taking action (Yager,2000). Throughout the test, measuring instrument of mathematical achievement of student have been develop by researcher and transferred into tables. At the end of the experimental test, the students were asked to do a pilot test regarding their own feelings and thought about the Structure Achievement Test (SAT) as part of their learning approach.

3.2 Experimental Design and Procedure

The present study was conducted according to non-equivalent pre-test/post-test design as follow in table 2:

Table 2. Experimental structure

Assigned Group	*Stages Involvement*	*Treatment*
Pre-Test *(Original module)*	S1, S2, S3	Learning constructivist framework
Post -Test *(Change module)*	S1, S2, S3	Learning constructivist framework

S1 - *A preliminary technical stage (p.42).*
S2 - *Algorithmic activity stage (p.43).*
S3 - *The creative (conceptual, constructive) activity (p.43).*

At the beginning, the researcher evaluated Structure Achievement Test (SAT) pre-test to ensure whether the groups achieved on the hypothesis stage one. At this point student achievement are considered through making stability of structure model and use their creativity in terms of design and material as shown in figure 1. In order to strengthen the task given, each group is required to identify 1: 100 scales of model, module length and weight. Subsequently, the model needs to be reassembled. Students are given a series of time to build and to present their concept idea and understanding of the application of the structure model based on previous lesson.

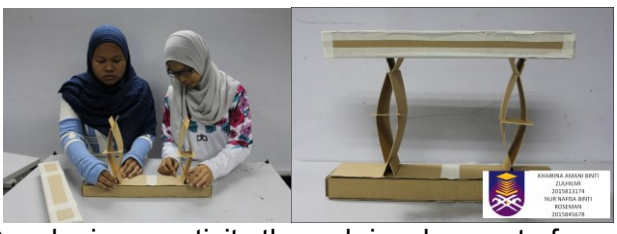

Figure 1 Developing creativity through involvement of model making.

Once they have achieved the results in stage one, the students are required to proceed to next stage of formulation concept and solve the calculation. At the end of the experiment, the same Structure Achievement Test (SAT) are repeated among others group and Pilot Test to complete the experimental analysis.

4. RESULTS AND DISCUSSION

Findings and discussions of this study will focus on student's achievement on creativity in mathematical thinking through constructivist approach and their learning success in understanding on the mathematical application.

4.1 Evaluate Structural Assessment Test Pre/ Post improvement.

Pre/Post from the Torrance Test of Creative Thinking result can be seen in figure 2. Analysis shows that, they are an increment in student's divergent thinking and problem solving on post-test. The researcher noticed that, student's performance on SAT definitely changed during the post-test. This was indicated by the student's increase level of using their own creativity in order to solve on the mathematical tricks. The level of difficulties is slightly higher during post-test for each stage as been shown in figure 2. As being mention on previous three stages of hypothesis, most of the students complied with above statement and manage to complete the task within the times given.

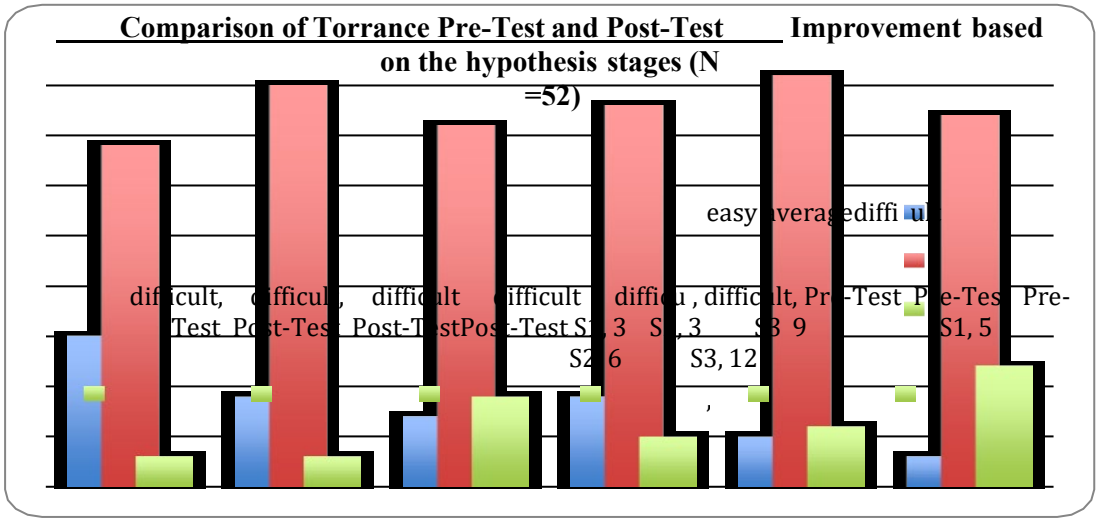

Figure 2: SAT Pre/Post Improvement Result

4.2 Review on students' views based on Torrance Creativity Test (SAT)

In these sections, students have been rated based on three categories sections of divergent thinking which led to creativity development in mathematical principle. This consist of self-rated creativity, originality and extending or breaking boundaries as shown in figure 3, figure 4, and figure 5. Based on the data collection, the researcher concludes, the constructivist approached successfully improved on student's creativity and understanding in mathematic application.

In addition, for this module each webs show positive self-development as in figure 3, figure 4, and figure 5. Surprisingly figure 3 at point number 4 shows that, majority of students are disagree if we conducted the class without involvement of the activity. This finding shows that students would prefer thought in constructivist learning environment which remarkably strengthen their understanding and application abilities in mathematical knowledge.

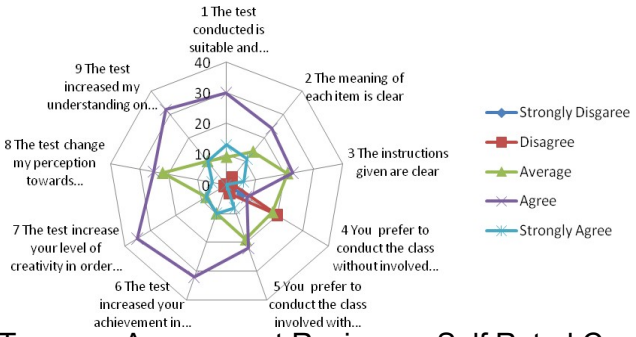

Figure 3: Torrance Assessment Review on Self Rated Creativity

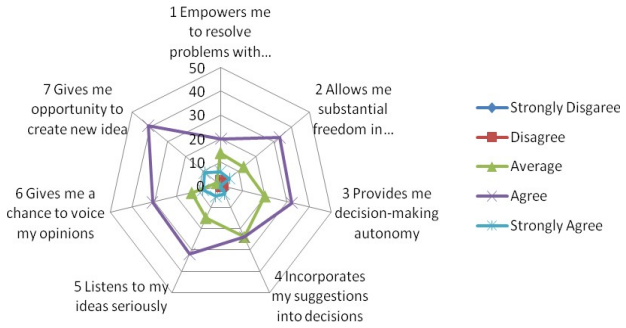

Figure 4: Torrance Assessment Review on Originality

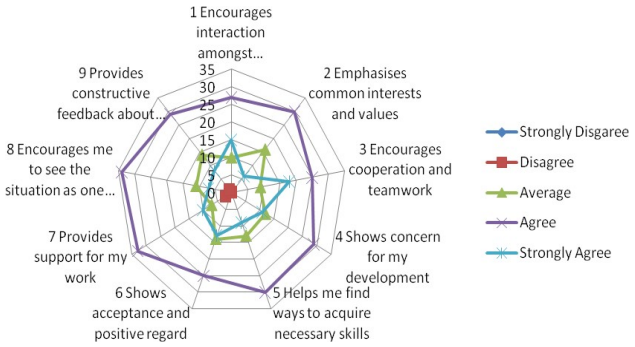

Figure 5: Torrance Assessment Review on Extending or Breaking Boundaries

5. CONCLUSION

Fostering mathematical thinking through creativity in learning environment can be effective by implementing constructivist approach. Developing creative thinking for architecture students basically is not only by teaching numbers and formulas in mathematical problems. The students also need to look at mathematics from both the divergent and convergent thinking perspective. This will allow them to be more creative in solving architectural problems related to structure.

Nowadays, it is a common issue among the teachers and educators to see many students who fail in mathematics. Unfortunately, many educators are focusing to improve subject content rather than the instructional practice to overcome the failure problems. This study shows that the role of instructional is also essential to improve student creativity through mathematic thinking.

As mention previously, the outcomes of the main objective of this research have shown that application of constructivist approach in learning can improve student's mathematical creativity. Students become more active, enjoyable and participative while doing the task given to them. Constructivist-learning, the emphasis is on learning and on the student-centric the learning environment. Students become active participants in their own learning processes including problem solving, critical thinking, communication, collaboration and self-management.
Therefore, this study is to provide the practical evidences of students learning in constructivist approach which have significant impacts on student's creativity and achievement in mathematics. Those impacts can be seen from the evaluation based on their understanding and applicability on the integrations of their previous learning concept to developed knowledge. In addition, adapting constructivist learning approach in this study also enhances student's soft skills ability such as sharing opinions, learning from peers and communication ability.

The main limitations of this study are the numbers of architecture participants and the size of the task given. Perhaps, those numbers and size can be increased to get more substantial data for a more profound findings and insights on creativity and learning.

As a conclusion, the process of learning in architecture field is not only focused on the need to enhance students' creativity but also the importance of using knowledge and skills throughout the semester and application in workplaces need to be emphasized. As mention by Laal (2012), long term knowledge is very important and becoming the part of Lifelong Learning. Therefore, the recommendation for further research needs to be done to ensure that this outcome of this research will supports in long term retention of knowledge and skills of it has a great impact on students' ability to deal with situations in the workplace.

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