THE EFFECT OF CONTEXTUAL TEACHING ON COGNITIVE AND NON-COGNITIVE LEARNING CONSTRUCT AMONG ENGINEERING STUDENTS

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DEDICATION

For my beloved parents,
Hjh Nik Hannah and Hj Md Kamaruddin, who gave me a lot of support and encouragment.

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ABSTRAK

Di universiti, kebanyakan pelajar kejuruteraan menghadapi kesukaran memahami konsep statistik dan tidak dapat mengaitkan apa yang pelajari di kelas dengan dunia nyata atau kejuruteraan. Pengajaran dan pembelajaran kontekstual menyatakan pelajar aktif dalam membina pengetahuan mereka sendiri berdasarkan situasi kehidupan sebenar. Oleh itu, kajian ini dijalankan untuk mengenalpasti gaya pembelajaran dominan pelajar dan kesan pembelajaran kontekstual terhadap aspek kognitif iaitu pencapaian statistik dan juga aspek bukan kognitif iaitu motivasi dan kaedah pembelajaran dalam kalangan pelajar kejuruteraan. Dalam kajian ini, empat kumpulan Solomon digunakan untuk reka bentuk eksperimen Quasi. Pelajar yang terlibat dalam kajian ini merupakan pelajar tahun dua diploma di UTHM dari semester 2 sesi 2016/2017 iaitu 268 pelajar kejuruteraan awam, elektrik dan mekanikal. Empat kumpulan dalam kajian ini terdiri daripada kumpulan kontekstual dengan ujian pra (G1 CTL Pra), bukan-kontekstual dengan ujian pra (G2 NCTL Pra), kontekstual tanpa ujian pra (G3 CTL) dan bukan-kontekstual tanpa ujian pra (G4 NCTL). Majoriti pelajar adalah lelaki Melayu. Setiap kumpulan terdiri daripada kejuruteraan dalam ketiga bidang. Tidak ada interaksi antara kumpulan ini kerana tidak ada perbezaan yang signifikan antara ujian pra dan ujian pasca pada tahap signifikansi .05 (P = .57). Dari Ujian Pasca, tiada perbezaan yang signifikan antara G1 CTL Pra dan G2 NCTL Pra bagi soalan penyelesaian masalah secara bukan kontekstual dan kontekstual. Namun, pada soalan penyelesaian masalah aplikasi statistik, terdapat perbezaan yang signifikan antara G1 CTL Pra dan G2 NCTL Pra. Tidak ada perbezaan yang signifikan bagi Motivasi: *Extrinsic*, *Control Belief*, *Task Value*,dan *Test Anxiety* dan terdapat perbezaan yang signifikan antara Motivasi: *Intrinsic* dan *Self-efficacy*. Dari ujian Pasca, kumpulan kontekstual menunjukkan prestasi yang lebih baik. Dari temu bual, kedua kumpulan bersetuju bahawa video kontekstual menjelaskan bagaimana statistik digunakan dalam kehidupan sebenar. Kesimpulannya, kajian ini menunjukkan bahawa pengajaran dan pembelajaran statistik secara kontekstual berkesan untuk pelajar kejuruteraan yang majoritinya mempunyai gaya pembelajaran *Auditory Digital* dan menggunakan kaedah pembelajaran *Deep Approach*.

ABSTRACT

In universities, most engineering students have difficulty in understanding the statistics concepts and cannot relate the learning in class to the real world or engineering world. Contextual teaching and learning based on the constructivism theory that students are active learners who construct their own knowledge based on real life situations. Thus, this research was done to determine the dominant learning style and to investigate the effect of contextual learning on cognitive aspect which is the statistics achievement and on non-cognitive aspect which are approaches to learning and motivation, among university engineering students. In this study, four Solomon's groups were used for Quasi-experimental designs. All year two diploma-engineering students at UTHM from semester 2 session 2016/2017 were involved in this study: 268 civil, electrical and mechanical students. The four groups in this study consist of group 1 contextual with pre-test (G1 CTL Pre), group 2 non-contextual with pre-test (G2 NCTL Pre), group 3 contextual without pre-test (G3 CTL) and group 4 non-contextual without pre-test (G4 NCTL). Majority of the students are Malay male students. Each group consisted of civil, electrical and mechanical engineering students. There was no interaction between these groups as there was no significant difference between pre-test and post-test at a significance level of .05 (P = .57). From the Post-test, questions on the problem solving for non-contextual and contextual, there was no significant difference between the groups. However, on the problem solving application of statistics, there was significant difference between the contextual and non-contextual groups. There was no significant difference between Motivation: Extrinsic, Control Belief, Task Value, Test Anxiety among the groups. However, there is significant difference between Motivation: Intrinsic and Self-efficacy among the groups. From the total marks of the Post-test, the contextual groups performed better than the non-contextual group. From the interviews, majority of non-contextual and contextual agreed that contextual video are able to explain how statistics were used in real-life situations. In conclusion, this study shows that the teaching and learning statistics contextually is effective to the engineering students where majority of them were Auditory Digital and using Deep Approach.

TABLES OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

CGPA	-	Cumulative Grade Point Average
CTL	-	Contextual Teaching and Learning
ICT	-	Information & Computer Technology
JPU	-	*Jadual Penentuan Ujian*
MLSQ	-	Motivated Strategies for Learning Questionnaire
MoHE	-	Ministry of Higher Education or *Kementerian Pengajian Tinggi Malaysia*
MOSTI	-	Ministry of Science, Technology and Innovation
MTUN	-	Malaysian Technical University Network
MTU	-	Malaysian Technical University
NonCTL	-	Non-contextual Teaching and Learning
NLP	-	Neuro-Linguistics Programming
R-SPQ-2F	-	Revised Two Factor Study Process Questionnaire
SOFTAM	-	Center for Software Technology and Management
SPSS	-	Statistical Package for the Social Sciences
STEM	-	Science, Technology, Engineering and Mathematics
TIMSS	-	Trends International Mathematics and Science Study
UMP	-	Universiti Malaysia Pahang
UniMAP	-	Universiti Malaysia Perlis
UTHM	-	Universiti Tun Hussein Onn Malaysia
UTeM	-	Universiti Teknikal Malaysia Melaka

LIST OF SYMBOLS

n	-	number of data values in a sample
N	-	number of data values in a population
$\bar{x}$	-	sample mean
μ	-	population mean
s	-	sample standard deviation
σ	-	population standard deviation
x, z	-	represent a specific observed data value
$\sum$	-	summtion

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Based on the STEM initiatives in Malaysia Education Blueprint 2013 – 2025, Ministry of Education Malaysia's (2013) aims are to prepare students with the skills to meet the science and technology challenges and to ensure that Malaysia has a sufficient number of qualified Science, Technology, Engineering and Mathematics (STEM) graduates. However, according to the report, only 45 % students were in the science, technical and vocational streams, which are obviously very far from 60%. Not only Malaysia was not able to meet the target 60: 40 ratio of Science/Technical to Arts, the number of students is declining. According to the Blueprint, in 2016, the number of students who chose STEM fields had continued to decline to 42%. Even students who met the requirement did not chose to enter the science stream. Due to this factor, Ministry of Science, Technology and Innovation (MOSTI) estimates that there will be a shortfall of scientists and engineers in 2020 (Malaysia Education Blueprint, 2013).

Based on the Trends in International Mathematics and Science Study (TIMSS), the findings indicate that Malaysian students' performance has fallen (IES -NCES National Center for Education Statistics, 2015). Thus, not only on national level but also for international level, Malaysian students' performances still need to improve. As a result, steps should be taken to improve the students' performances such as the introduction new or improving the method of teaching, new materials or improved the

existing materials, etc. Steps mentioned in the Malaysia Education Blueprint 2013 – 2025 (2013) are to raise students' interest through new learning approaches and an enhanced curriculum. In order for the students to be attracted to learn Science and Mathematics, the learning approach that has been suggested in the STEM approach, must have pedagogical strategy that emphasizes application of knowledge, skills and values from the disciplines of Science, Technology, Engineering and Mathematics. Ng & Kulasagaran (2012), commented that students were not interested the way science and mathematics were taught in the first place in Malaysia, which has been focusing on memorisation of formulas and experiments. In order to fulfil the education policy, one of the STEM approach suggested in the Malaysia Education Blueprint (2013) is problem solving related to the real world (Malaysia Education Blueprint, 2013; Mohd Shahali, Ismail and Halim, 2017).

1.2 Background to the study

In 2015, MTUN with four technology based university in Malaysia, Universiti Tun Hussein Onn Malaysia (UTHM), Universiti Teknikal Malaysia Melaka (UTeM), Universiti Malaysia Pahang (UMP) and Universiti Malaysia Perlis (UniMAP), were rebranded to Malaysian Technical University (MTU). One of the things that makes MTU different from other universities is MTU students go through experiential learning as they spend more time in practical sessions doing relevant experiments than in lecture rooms. Experiential learning means learning from experience or learning by doing which built upon a foundation of interdisciplinary and constructivist teaching (Schwartz, 2012). Students in Malaysian Technical University (MTU) universities should be able to solve practical problems as since MTUN was officially formed in 2006 and its education system is "Practical Oriented" and focuses towards "Problem Centred Teaching, Action & Experiential Learning".

Problems occur as students tend to forget what they learn in mathematics courses and thus they are not able to apply in their engineering courses. Bacon & Stewart (2006) said that students should take course's prerequisites immediately before the course. They said that students, who take introduction to statistics 2 years before marketing research, would have forgotten most of their statistics by the time

they need it, and so the prerequisite is of little value. For the MTU students to be able to solve practical problems in their major courses such as civil engineering, electrical engineering, mechanical engineering, chemical engineering or computer engineering courses, they must be good in mathematics. If they cannot remember what they learn in Mathematics courses, this will be a big problem as we say mathematics is the language for engineering courses. Another problem is because we have students learning mathematics just for the sake of passing the examinations. This is due to engineering students judge learning mathematics at conceptual learning as irrelevant but the motivation narrows down to "passing the exam" (Hernandez-Martinez &and Vos 2017). Owing to this, many of them forget what they learn in mathematics after the examination.

Usually when we say mathematics, we include statistics in this discipline. However, according to Journal of Statistics and Mathematical Sciences, mathematics is a broad discipline of geometry, algebra, trigonometry and arithmetic's and also the study of quantity, space, change and structure, while statistics is a branch of applied mathematics dealing with comprehension, analysis, assimilation and collection of data. According to Hamzalouh (2015), in mathematics, measurement typically refers to understanding units and precision in problems that deal with most concrete measures such as length, area, and volume, however, in statistics, measurement can be a bit more abstract. She added that variability and the uncertainty of conclusions was another major difference between statistics and mathematics. In mathematics, results are usually reached by means of deduction, logical proof, or mathematical induction and typically, there is one correct answer, however, statistics utilizes inductive reasoning and conclusions are always uncertain.

Since some mathematicians define mathematics and statistics differently, now the question will be which of these two that students or lecturers find difficult to learn or to understand the concept. Based on the feedback from students and lecturers from https://www.quora.com (2018) that students have different reasons when they were asked why they found statistics more difficult than calculus. Sigma, a student from Massachusetts Institute of Technology, USA (MIT) that is one of the most prestigious institutions of higher learning in the world, felt that when given probability problems, he has to figure out what kind of distribution is involved. This is one of the reasons that students get confuse every time, as the answers are not as straightforward as in

Calculus. Wu, with a Bachelor Degree in Cognitive Science from Carnegie Mellon University, USA said that he prefers calculus. He feels that statistics is harder because statistics requires good reading comprehension, as the word problems are generally less straightforward than of calculus. Ma, with a PhD in Plant Breeding and Genetics and Master in Analytics emphasized on the method of teaching. He said that the main problem is that statistics is taught poorly and it should be taught in a more approachable manner for people to understand its principles. Georgiev, an applied statistician said that many teachers in statistics are not great at what they do as they come from a math-heavy background and lack the philosophical training. They have little understanding of how and why statistics is to be applied. Lastly, Moore with a PhD in statistics said that the real world is complicated. Any use of mathematics apply to the real world problems needs to cope with the complications. He continued that statistics should not treated as a bunch of formula to plug numbers into and out would lies chaos as students were not sure that they are using the right formula. This problem is also face by engineering students in Malaysia For example, from an interview with the assistant monitor of a statistics class, an electrical engineering UTHM student, he argued that engineering students only needed to learn algebra and calculus as they used complex number, differentiation and integration in their engineering courses. Nobody in class objected his statement. He added that he never considered statistics being used in their engineering subjects or realised that one of the applications of statistics in engineering is the use of probability in random signals processing. He said he had difficulties learning statistics and wanted to drop the course. Even though he got A in other math classes, he questioned why engineering students have to learn statistics.

Engineering students are unable to make connections between what they are learning in mathematics and how this knowledge is used in their engineering courses. Generally, the students are expected to make connections on their own. This is because students learn mathematics mechanistically, that is, memorizing the formula and then manipulate the formula with different numbers (Ng & Kulasagaran**,** 2102; Md Kamaruddin, 2009). Students may be excellent and scored good grades in their statistics course even though they feel that statistics do not relate to the real world and is not relevant to the engineering field (Sahari @ Ashaari, Mohamad Judi, Mohamed and Tengku Wook. (2011). This is because they are able to memorize the statistics formulas and apply them as the teaching and learning statistics or mathematics is more

on focusing on the mathematical procedure which the students can memorize the steps (Md Kamaruddin, 2012). In addition, the students have difficulty in understanding the abstract concept in mathematics or statistics.. Sahari@Ashaari, Mohamad Judi, Mohamed and Tengku Wook (2011) suggested that further research should be done to produce suitable approach to balance the students' attitude and perception towards statistics.

In order to make the learning memorable, we need the lesson to be meaningful to students as they are able to connect their studies to the real world. This is also being emphasis in STEM (Malaysia Education Blueprint 2013 – 2025). Thus teaching and learning mathematics and statistics contextually should be used as in contextual learning theory, learning occurs only when students process new information or knowledge in such a way that it makes sense to them in their own inner worlds of memory, experience, and response (CORD, 1999; CORD, 2016). New concepts presented in real-life (outside the classroom) situations and experiences that are familiar to the student as the mind naturally seeks meaning in context by searching for relationships that make sense and appear useful (CORD, 1999; CORD, 2016). CORD (1999, 2016), said that students discover meaningful relationships between abstract ideas and practical applications in the context of the real world; concepts are internalized through the process of discovering, reinforcing, and relating.

Contextual teaching and learning mathematics and science subjects in all the Malaysian technical secondary schools were first introduced in 1997 by the Technical Education Department under the Ministry of Education, Malaysia. The Ministry got the idea from the Centre for Occupational Research and Development in Waco, Texas, USA when the Malaysian education officers, technical lecturers and teachers attended courses at the centre. From the pilot test, through the contextual concept, the students were able to understand abstract concepts through concrete experiences (First Tech Prep Convention, 1997). Students preferred this method because usually they learn mathematics very mechanistic, which is, memorizing the formula and solving problems using the formula. Not only the students are able to learn faster but the workplace and lab activities help students to develop critical thinking skills. From the research done by Subramaniam (2005), computer-based simulations into contextual approach provided students the opportunity to reflect on their cognitive processes within the context mathematics. The findings indicated that the contextual group were

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