LEARNING STYLE PREFERENCE AND CRITICAL THINKING PERCEPTION AMONG ENGINEERING STUDENTS

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This thesis is dedicated to my Parents

(*Muhammad Ismail Jamali and Zainab Alam Jamali*)

&

My wife

(*Rabia Jamali*)

My Daughter

(*Aliya Jamali*)

My Son

(*Abdul Muiz Jamali*)

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ABSTRACT

Engineering education plays a vital role towards modernization of world. Therefore, engineering students need to be nurture with multiple skills like learning preferences and critical thinking skills. This study has been conducted to identify the learning style preferences and critical thinking perception of the engineering students from three programs electrical engineering, mechanical engineering and civil engineering at Universiti Tun Hussein Onn Malaysia (UTHM), Johor. Survey research design was applied in this study. The quantitative data was collected by two questionnaires Index of Learning Styles (ILS) that is based on Felder-Silverman Learning Style Model (FSLSM) and Critical Thinking Skills (CTS) questionnaire which consists of analysis, evaluation, induction and deduction in terms of problem solving and decision making. A total of 315 final year engineering students were participated in this study. Data was analyzed in descriptive and inferential statistics involving tests Analysis of Variance (ANOVA), Pearson Correlation and linear regression. The study discovered that engineering students are preferred to be visual learners (83.80%). Visual learning style denotes FSLSM input dimension and visual learners learn best by diagrams, charts, maps and graphical presentations. This study also found that engineering students possess critical thinking perception in all dimensions. However, there is no statistical significant difference of learning style found among engineering programs as “p” value found 0.357. Whereas, there is statistical significant critical thinking difference found among engineering programs as “p” value found 0.006. Lastly, findings revealed that there is no significant relationship found between learning styles and critical thinking skills. The study findings suggested that providing preferred learning style (visual learning style) in classroom will enhance students’ academic achievement and increase their cognitive level. This study might serve as a guideline for educators to facilitate learners to enhance their learning and thinking for better outcomes in academia as well as in workplace.

ABSTRAK

Pendidikan kejuruteraan memainkan peranan penting dalam dunia permodenan. Kajian telah dijalankan di Universiti Tun Hussein Onn Malaysia bagi mengenalpasti kecenderungan gaya pembelajaran dan kemahiran pemikiran kritikal dalam kalangan pelajar-pelajar kejuruteraan. Dari tiga Program kejuruteraan elektirk, kejuruteraan mekanikal dan kejuruteraan awam. Rekabentuk kajian secara tinjauan dijalankan dengan menggunakan pendekatan kuantittatif. Instrumen kajian yang digunakan adalah Indeks Gaya Pembelajaran (ILS) oleh Model Gaya Pembelajaran Felder-Silverman (FSLSM) dan soal selidik kemahiran pemikiran kritikal (CTS) yang mengandungi analisis, penilaian, induksi dan deduksi kearah penyelesaian masalah dan membuat keputusan. 315 orang pelajar tahun akhir kejuruteraan dilibatkan sebagai responden kajian. Data dianalisa menggunakan analisis deskriptif dan statistic inferens Analysis of Variance (ANOVA), korelasi Pearson dan regrasi linear. Hasil dari kajian ini mendapati pelajar-pelajar kejuruteraan cenderung ke arah gaya pembelajaran visual (83.80%). Gaya pembelajaran visual merangkumi diagram, carta, peta minda dan persembahan grafik. Bagi kemahiran pemikiran kritikal pelajar kejuruteraan mempunyai kemahiran yang hampir sama bagi setiap dimensi. Analisis secara inferensi menunjukkan tiada perbezaan signifikan bagi gaya pembelajaran dalam kalangan pelajar kejuruteraan berdasarkan program pengajian. Manakala bagi kemahiran pemikiran kritikal didapati wujud perbezaan yang signifikan dengan nilai $p = .006$. Dapatan kajian juga menunjukkan tiada hubungan yang signifikan antara gaya pembelajaran dan kemahiran pemikiran kritikal. Hasil keseluruhan dapatan kajian ini, adalah dirumuskan bahawa gaya pembelajaran visual seharusnya diaplikasikan bagi membantu meningkatkan pencapaian akademik pelajar. Selain dari itu kajian ini akan memberi panduan kepada pendidik untuk menggalakkan pelajar-pelajar meningkatkan fokus pembelajaran dan kemahiran berfikir sebagai persediaan bagi menghadapi pekerjaan.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
CE	Civil Engineering
CT	Critical thinking
CTS	Critical thinking skills
CTSQ	Critical thinking skills questionnaire
EE	Electrical Engineering
FSLSM	Felder and Silverman Learning style model
ILS	Index of learning style
LS	Learning Style
ME	Mechanical Engineering
MTUN	Malaysian Universities Technical Network
UTHM	Universiti Tun Hussein Onn Malaysia

CHAPTER 1

INTRODUCTION

1.1 Introduction

Over the past years, there has been an increasing demand for engineering education providers to produce graduates who are more holistic in their attributes. To be a successful engineer. Engineering graduates need to have multiple competencies which encompass intellectual, technical and academic competencies (Johari, Abdullah, & Osman, 2002). For instance, the current demand of engineering education is not limited to solve assignments and problems in class rather it is more extended with producing engineers who can tackle the uncertainties of the modern technological challenges. Further, learning is a process and a product simultaneously. For instance, when a student actively engaged in a lesson during classroom whereby, he/she critically analyze the information and knowledge acquisition. That state of mind refers to learning as a process. On the other hand, when the same knowledge is created or when student develops a concept based on his/her refers to learning as a product (Carmo *et al*., 2006).

Therefore, learning provides knowledge and practice in engineering profession which never remains fixed but is continually varying. It can be said that engineering education enables learners to become professional and effective learner, equipped with the various learning and thinking skills specifically needed for their profession. Hence, it can be stated that engineering educators are aware of their students learning demand and thus facilitate learners accordingly in order to make learning easy to acquire.

However, an important issue while considering the contemporary demand of engineering education is the notion of modifying teaching methods and curricula, fostering with learning styles preferences and critical thinking skills. These are the apparent attributes that engineering graduates needed to achieve to become successful in their profession and academia. One of the major reasons of incorporating learning style and critical thinking into curricula and teaching method is to enhance learning and thinking among engineering students.

1.2 Background of Study

At present, change in technology rapidly occurs, curricula are developed time by time, and learners are trained according to their programs for that reason modern technological changes must be fostered among engineering undergraduate programs. Therefore, rather instructing technological discoveries, institutes should also give emphases on learning styles preferences and critical thinking skills (Chau, 2007). This encourages students for lifetime learning and equipping with skills that bring ability to understand new technological changes arisen as well as to enhance their academic performance (Rugarcia *et al*., 2000).

Furthermore, learning styles have a dynamic role in education. That describe the ways in which engineering students usually obtain, retain and get back information. It helps engineering learners to develop their intellectual ability and to cope with the learning aptitudes which in turn improves their academic performance (Graf, Liu, & Kinshuk, 2008). Engineering students have different learning style likings that depend on their ways of preference. Furthermore, students learn best by auditory, listening, observing, (visual) and doing (hands on). Learners make use of certain environmental stimuli namely seeing, hearing, reflecting and acting to acquire learning. These environmental stimuli help students in making learning a process as a way of reflecting and acting, reasoning logically and intuitively, memorizing and visualizing. Therefore, learning style is a concept which refers to an individual's preference of dealing with an activity or learning task, way of proving, receiving and then processing the information (Mohamad *et al*., 2015).

In engineering education, third year and final year students are assumed to be matured enough to deal with their capacity of understanding lessons and assignments

by their own. However, majority of them do the examination, though students who fails usually endorsed their failure to external stimulus such as lack of academic standards or teaching methods (Robert, 2006). Furthermore, learners obtain the knowledge well when teaching and learning materials match with their learning style preferences (Felder, 2005). In addition, the preferred learning style is the strengths of the characteristics and preferences in the ways individual take-in and process information. Students and teachers may prefer one learning style in one subject but generally prefer one style for most subjects that they learn or teach. For instance, a classroom is comprising of variation in terms of educational background, cognitive ability, preferred learning style and cultural influence of a social perspective. Moreover, mismatches in teaching style and students preferred learning style often leads students towards poor academic performance (Graf *et al.,* 2009). Therefore, to understand a particular learning style which meets the needs of a student, there is a strong requirement to determine the best possible learning style which can flourish the classroom (Mayer, 2008).

Furthermore, teaching methods and learning style preferences are the connection between teacher students in classroom. For instance, teacher use teaching strategies to actively engage students towards learning; accordingly, students will also make use of their optimal potentials to achieve their learning goals thus could be able to raise the level of their academic performance (Graf, Liu, & Kinshuk, 2008). Further, implementation of a particular teaching method is to achieve effective outcomes in class. Educators have capacity of facilitation and guidance during teaching and learning process (Letele, Alexander & Swanepoel, 2013). Therefore, it is necessary that teachers must adjust their teaching approaches according to the ways which helps students in their learning style preferences. Discrepancies in teaching style and learning style preferences resulted in students' poor academic performance (Jamali & Mohamad, 2017). Thus, there is a need to provide an effective teaching that comprised the elements of teaching style and preferred learning style in their teaching activities particularly taking cognitive and intellectual demands into consideration. Moreover, students and instructors may favor single learning style in single subject but usually choose one method of teaching and learning for many subjects. Educators should use different teaching methods in a class room and apply all different learning styles (Mohamad, Heong & Kiong, 2014). Hence, identifying learning style preferences may

facilitate teachers to deliver lecture in classroom according to students' required teaching methods.

Consequently, a number of engineering students favor to learn in a group, whereas others do better on their own, some students like to prefer practical doings and hands-on experience while others favor to learn by interpretations and theories of the subjects. Learners process and perceive information according to their preferred way, because of this learning styles are the beneficial tools to help learners and educators know how to develop learning and teaching (Mansor & Ismail, 2012). Learning styles can be explained as educational circumstances under which a learner is most likely to acquire information, it denotes to how learning goes on. It is generally recognized that learning styles indicate a student's preferred ways of learning or how the learner gets information (Koh & Chua, 2012).

Hence, educational organizations must give emphasis on the learning style aspects which affecting the students' academic performance. As a result, they can perform well in their classrooms and achieve high performance in academics. A continuous process of learning styles may lead students' higher performance (Tee, Widad & Yee, 2009). Felder and Spurlin (2005) opinions that strong preference of any student for a particular learning style may trouble if teaching style do not match with student learning style. Every student has different mental approach, preferred learning styles, speed of pickup any information, passion, and motivation to learn. So, the preferred learning styles try to find out individual thinking skills, motivation and critical thinking to enhance students' performance (Eishani, Saa'd, & Nami, 2014).

This is the reason successful learning process depends not only based on encouraging environmental and physical situation of the class but a mismatch between learning style and teaching style lead students towards ineffective learning procedure. It is shown that in a classroom, the educational outcomes can be reached by providing teaching styles that are well-matched to the learners' learning styles (Yee *et al*., 2015). Moreover, knowledge on learning style theories and understanding that students prefer one learning style above the other could support instructors to cater students' preferred learning style (Ismail, Hussain, & Jamaluddin, 2010). Therefore, learning styles are preferred techniques of using one's skills and their decisions about how to arrange the skills of any person which they possess. Hence learning styles are particularly important for critical thinking (Sternberg, 2006).

For the solving above issues, educators must understand students preferred ways of learning to enhance the learning abilities so that they can meet expected educational goals (Krathwohl, 2002). Therefore, for better performance in academics, engineering students have not only able to learn and to achieve, but also they should possess the critical thinking abilities such as problem solving and decision making to enhance their academic successes (McKeag, 2008).

Thus, existing trends in technology and work place need engineers equipped with critical thinking skills such as solve problems, take decisions and understanding of engineering as a broader way for successful future. Educational and industrial sectors agree that several engineering learners are graduated deprived of having critical thinking skills. Industries criticize that technically engineers are competent but deficiency in critical thinking skills like problem solving and taking judgments. Therefore engineering students need the critical thinking skills in their courses (Rodzalan & Saat, 2015). In a class room, educator focus on memorizing the content knowledge provided in curriculum rather than to evaluate and synthesize the significance of knowledge. Lack of critical thinking skills is unfortunately due to the old courses are taught with the old tools and procedures, which have been practiced fifty years before. The traditional teaching methods do not produce engineers having multiple capabilities including critical thinking ability (Douglas, 2012). Teachers must use their teaching strategies to guide learners to develop critical thinking skills. Engineering educationalists should boost the significance of critical thinking skills to learners this will support them in modern changes of technology.

The development of critical thinking perception in engineering education is important in creating a scientific innovation for the profession. The critical thinking skills allows engineers to logically measure their own mental skills and experiences and apply those skills to create new thing. The ability of engineers to cope with complications, their skills in defining what needs and how to solve problems and take better decisions (Thaiposri & Wannapiroon, 2015). Critical thinking skills enables the capacity to examine information, to define the significance of information collected and interpret that information in problem solving and decision making. This process requires higher thinking level contains the process of analysis, assessment, rationality, and reflection. Therefore, critical thinking skill has become more prominent factor of engineering education (Özsoy-Güneş *et al*., 2015). Thus, to achieve the critical thinking standards, institutes are continually challenged to improve and reflect on the

success of teaching approaches that may boost the development of learners' critical thinking skills.

Adopting modern techniques of teaching to support student learning is an essential part of ensuring that learners involve positively with subject and improve the learning skills and intellectual skills (Pritchard & Baillie, 2006). Educators of engineering institutes have the challenge to assure that strategies of teaching reflect the various nature of learners and make students of engineering with the understanding to be competent, and critical thinker who can face future challenges of modern world (Rodzalan & Saat, 2015). Critical thinking allows students to explore and observe ideas, then process it which leads to problem solving and decision making. Moreover, problem solving is a thoughtful process that supports students to changing condition, unify thinking abilities, manage gaps in information, produce ideas, make better decisions and is important to enhance intellectual capabilities of students. It is a mental process that includes discovering, analyzing and resolving difficulties is problem-solving skill. It is to reduce obstacles and discover a solution that solve the issue. Further, problem solving is a method that engineering students observe and solve gap among a present situation and preferred goal through the way to the objective blocked by identified or unidentified obstacles. Problem solving is sometimes perceived as take out something that is not required or as finding an error and correct it to right (Alci & Canca, 2011).

Correspondingly, an intellectual process that is concerned with the process of choosing a reasonable choice from the obtainable alternatives is considered decision making. One or more possible solutions are chosen in a selection procedure to reach a wanted goal is known as decision making process (Aurum & Wohlin, 2003). In engineering, decision making is mainly problematic where it comprises of dissimilar values, the considering of dissimilar attributes and measuring uncertainties. Decision is an effort to predict the upcoming and thus cannot ever be engaged without risk. And there are many conditions where decision making is affected by uncertainty and doubt. Mostly repetitive and well-defined problems learners face in class and in repetitive way they solve those problems and take decisions about them (Chen, 2009).

Besides, problem solving and decision making involve mixing previous knowledge and experience together to solve a problem whose result is unknown with use of mental skills (Berredo *et al*., 2011). There are certain obstacles in problem solving and decision making which block the approach to reaching an objective. If the

obstacle can be understood it may be thinkable to eliminate it, or discover a method about it. And some are well described and the technique of solve those problems is clearly organized. For example, a designed system is installed, it works well but suddenly breakdowns. A technical engineer who is skilled, identifies the error and repairs it. For a technical engineer, these are routine problems discover the error and repairs it (Cress *et al*., 2012). Therefore, for this kind of problems, it may be appropriate to adapt techniques they already used successfully in solving problems.

Therefore, enhancing cognitive skills and experience can contribute to solve problem and take decisions successfully. The age, professional background, technical background, knowledge of problem finding techniques, and knowledge of content and context of problem these are experience factors. Analytical ability, holistic thinking, logic and reasoning, intuition, imagination synthesizing ability, and memory these are mental factors (Bortoli & Macaskill, 2014). There are three stages of problem solving and decision making. The first stage is understanding the problem then generating solutions and finally choosing the best solution. First and second steps come under problem solving and last one is decision making (Yearworth *et al*., 2013). Therefore, these stages show that both variables are related to each other. These steps generally include analysis, evaluation, deduction and induction.

Critical thinking assists understanding the notion of problem solving and decision making through thoughtful manner which increases learners' mental capabilities. In a present technological environment rapidly changing progresses and insistently growing awareness, professional engineers need to improve critical thinking skills that will deliver them with expertise in problem solving and decision making (Sophonhiranraka, Suwannatthachoteb, & Ngudgratokec, 2015). Therefore, for a strategic learner, it is useful to improve the critical thinking ability through preferred learning style. In engineering education, mostly repetitive and well-defined problems learners face in class and in repetitive way they solve those problems and take decisions. Further, it is seen that critical thinking and learning styles are closely connected to each other, both are methods of finding (İşlek & Hürsen, 2014).

In this modern world of information, the belief that students must be capable to identify preferred learning style and critical thinking skills to enhance academic achievements. It is problematic to breakdown with old customs and to explore different techniques of thinking therefore learners should be active in learning process (Mohamad & Rajuddin, 2010). Therefore, the assessment of critical thinking and

learning styles ability is often carried on students in engineering education. Tailoring the instructive process based on a specific learning style may effect student critical thinking ability. It is assumed that learning styles may have impact on learner's critical thinking ability.

Therefore, this study has been carried out to survey learning style preferences and critical thinking perception among engineering students.

1.3 Problem Statement

The learning procedure is a communication between learners, educators, and teaching resources. Student learning process should always be given importance. Preferably, educator's teaching style should match with students' preferred learning style. Knowledge is polished when emphasis is placed on students preferred leaning style as it not only helps in achieving required academic demands rather also develops critical thinking skills such as problem solving, analytical ability and decision making. Looking into engineering education perspective, most engineering academic courses demand critical thinking skills. Although theory supports the notion that the critical thinking skills in engineering is highly valued and required to enhance the achievement of cognitive learning goals in engineering education. However, learning styles and critical thinking have not been well studied in undergraduate engineering programs for achieving learning and cognitive goals particularly in engineering education. Ignoring the role of critical thinking skills has resulted in developing a perception among engineering students as undervaluing the significance of critical thinking skills. Also, mismatch between learning and teaching styles may lead students' poor academic performance. Thus, there is a need to study both learning styles and critical thinking in engineering education.

Therefore, this study has been conducted a survey on learning style preferences and critical thinking perception among engineering students at University Tun Hussein Onn Malaysia (UTHM) for better academic performance.

1.4 Aim of Study

The aim of this study is to conduct a survey on learning style preferences and critical thinking perceptions among engineering students at Universiti Tun Hussein Onn Malaysia.

1.5 Objective of Study

Five research objectives have been formulated for the research are;

1. To identify learning style preferences among engineering students.
2. To identify the critical thinking perception among the engineering students.
3. To identify differences of learning style among the programs.
4. To identify differences of critical thinking among the programs.
5. To examine the relationship between learning styles and critical thinking skills among engineering students.

1.6 Research Questions

1. What is the dominant learning style preference among the engineering students?
2. What is the critical thinking perception among engineering students?
3. Is there any significant difference of learning styles among the engineering programs?
4. Is there any significant difference of critical thinking among the engineering programs?
5. What is the relationship between learning styles and critical thinking skills among engineering students?

1.7 Hypotheses

There has been three research hypotheses formulated in this study as stated below;

1. $H_{o.}$ There is no statistically significant learning style difference among three engineering programs electrical, mechanical and civil.

2. $H_{o.}$ There is no statistically significant critical thinking difference among three engineering programs electrical, mechanical and civil.

3. $H_{o.}$ There is no statistically significant relationship between learning styles and critical thinking skills for engineering students.

1.8 Scope and Limitation of the Study

The existing study only investigated learning style and critical thinking for engineering students. The study focused three primer engineering programs which are Electrical, Mechanical and Civil taken from Universiti Tun Hussein Onn Malaysia. This study is limited to Universiti Tun Hussein Onn Malaysia, Johor, Malaysia, focused final year undergraduate engineering students from three primer engineering programs civil, electrical and mechanical.

1.9 Significance of the Study

The study is significant as they are related to the following:

1. The study is pertinent to UTHM (Universiti Tun Hussein Onn Malaysia) administrators and educators as findings may impact on the development of teaching material, effective implementation of current and future engineering education programs, improvement of the existing programs as well as informing faculty on support services for engineering learners.
2. The study may give input to engineering education educators in their endeavor to diversify instructional resources and strategies. The study may directly have a significant impact on the engineering programs civil, electrical and mechanical at the Universiti Tun Hussein Onn Malaysia (UTHM) as it may inform and illuminate aspects of the program design that support or that deter learning. The study may also inform material developers, course designers and course tutors on what kind of instructional techniques would be effective and suitable for the engineering students of civil, electrical and mechanical at Universiti Tun Hussein Onn Malaysia. Furthermore, the study may inform faculty on the role

of learning styles and critical thinking in three engineering programs civil, electrical and mechanical.

3. The study may also contribute to a body of knowledge on learning in engineering education environments, thus in a way make the findings and output of this study useful for engineering programs in similar educational contexts.

1.10 Research Framework

The framework conveys all the parameters, circumstances, and support learning. A research framework is planned as a guideline to combine the theory, model, and factors to overcome research problems (Kuchi, Gardner & Tipton, 2003). This research has been focused on two aspects which are learning styles and critical thinking associated to undergraduate engineering education.

Felder-Silverman Learning Style Model (FSLSM) was categorized into four major dimensions called process, perceive, receive and understand information. Each dimension consists of two sub dimensions; (1) process information (active vs. reflective), (2) perceive information (sensing vs. intuitive), (3) receive information (verbal vs. visual), and (4) understand information (sequential vs. global). Active learners learn by trying things out, working with others. While on other hand reflective learners learn by thinking things through, working alone. Sensing learners learn by the way practical, oriented towards facts and procedures. While on other hand intuitive learners learn by the way conceptual information, innovative, oriented towards theories and meanings. Visual learners prefer to learn by visual representations of presented material for example pictures, diagrams, flow charts. While on other hand verbal learners prefer to learn through written and spoken explanation. Sequential learners preferred to learn best by linear, orderly manner, learn in small incremental steps. While on other hand global learners are holistic, systems thinkers, learn in large leaps.

However, critical thinking skills are fundamental to thoughtful thinking, and its procedure employing the cognitive skills of analysis, evaluation, deduction and induction as given in (Ghadi *et al.,* 2013). Critical thinking skills are categorized into four scales analysis, evaluation, induction and deduction. Where analysis is tendency to examine a situation carefully and thoroughly, determine significance and interpret

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