DISSERTATION

INCORPORATING CRITICAL THINKING: TEACHING STRATEGIES IN MALAYSIAN TECHNICAL AND VOCATIONAL EDUCATION (TVE) PROGRAMS

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ABSTRACT

INCORPORATING CRITICAL THINKING: TEACHING STRATEGIES IN MALAYSIAN TECHNICAL AND VOCATIONAL EDUCATION (TVE) PROGRAMS

Teachers should be critical thinking agents who guide students to become better critical thinkers through teaching strategies (Halpern, 1999). The purpose of this study was to investigate the extent to which polytechnic lecturers in Malaysia incorporate critical thinking into their teaching strategies. The web-based survey, Qualtrics, was used to disseminate the teaching strategies questionnaire to 4,529 lecturers at 27 Malaysian polytechnics. A non-experimental design was employed to explore: the most frequently used and effective strategies; and the relationships and differences among frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies relative to the highest level of education, years of teaching experience, attendance at critical thinking workshops, and teaching major. The data were analyzed using frequencies, percentages, means, standard deviations, exploratory factor analysis (EFA), independent sample t-test, one-way ANOVA, and thematic content analysis. The response rate for this study was 7.9 percent, which included 358 lecturers. The findings from rank-ordering indicated that among the 58 critical thinking strategies, open-ended questioning was rated as the most frequently used strategy and small group discussions were perceived as most effective by lecturers. From 58 strategies, EFA determined four factors within, reduced to 25 strategies.

The findings from open-ended questions revealed cognitive and affective domains were used for student learning outcomes and rubrics, examinations, presentations, and lab experiments were incorporated to assess students' critical thinking. The findings of this study provide useful information to promote intellectual growth in enhancing critical thinking strategies among lecturers in Malaysia. Critical thinking training for lecturers at Malaysian polytechnics is recommended to improve the usage, perceptions, and knowledge of critical thinking teaching strategies.

Keywords: critical thinking, teaching strategies, Malaysian polytechnics, technical and vocational education (TVE)

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1 : INTRODUCTION

Rote learning and memorization are no longer appropriate for those who are hungry for new, meaningful knowledge and critical thinking (Marin & Halpern, 2011). Critical thinking is a mode of thinking that allows people to analyze and examine ideas of a topic, and then synthesize this into a process of decision-making (Paul & Elder, 2008). In educational settings, teachers should be critical thinking agents who guide students to become better critical thinkers through teaching strategies (Halpern, 1999). Critical thinking elicits problem solving, creativity, and decision-making (Pithers & Soden, 2000). These skills are essential traits within Technical and Vocational Education (TVE) development. Industrial personnel suggest TVE programs should incorporate skills that are consistent with today's labor market needs, central to which is critical thinking (Miliron & De Los Santos, 2004). Generally, TVE institutions promote programs for students who are more interested in technical and vocational skills than academics in a university setting (Mustapha & Abdullah, 2001). TVE graduates should be prepared to fully utilize their knowledge and technical skills compatible with critical thinking, creativity, and problem solving (Wicklein, 1997). Thus, global demands have forced TVE in Malaysia to move forward by planning and implementing critical thinking in its current and ongoing policy.

Background

TVE, which is also known as Career and Technical Education (CTE), is designed to prepare students for high skill jobs and directly support the economic growth of a country (Dennis & Hudson, 2007). The history of TVE in Malaysia began before the country's independence with trade schools in 1906 (Azman & Ahmad, 2006). Azman and Ahmad (2006) said that the trade school was introduced to "train technical assistants for the railways and Public Work Department" in Malaya, which was the name of Malaysia prior to independence in 1957 (p. 69).

In 1969, a Malaysian polytechnic institution was set up by the Ministry of Education to meet the fast growing demand for skilled employees within paraprofessional positions at a diploma level (Mustapha & Greenan, 2002). These positions included technicians, draft persons, mechanics, and assistant computer analysts. Today, polytechnic educational institutions, such as technical and vocational schools, community colleges, and technical universities from government and private sectors offer TVE programs for students who prefer these educational programs for their future paths (Saud, 2005). Since the Malaysian economy has changed from being predominately agricultural to more industrial sectors, the government has requested an emphasis on TVE in its education system by improving and strengthening programs at post-secondary and tertiary education levels (Hee, 1994). For instance, Malaysian polytechnics offer two-year certificates and three-year diplomas in engineering, architecture, construction, and business disciplines (Haas, 1999). At present, the number of TVE programs in Malaysia is increasing due to industry needs.

In addition to knowledge and technical skills, TVE programs in Malaysia are designed to expose students to learn approaches that generate critical thinking skills (Mustapha, 1999). Critical thinking is not a new term in the Malaysian educational system. The main Malaysian policy, Vision 2020, highlighted that Malaysian people should be trained as critical thinkers to accomplish "a developed nation status by the year

2020" (Yaacob & Seman, 1993, p. 11). Consequently, critical thinking has been embedded in current and ongoing policy implementation in education. TVE is included as the main agent for this education reform in Malaysia. TVE educators are provided with educational modules, along with critical thinking workshops and trainings, to encourage them to incorporate critical thinking in their teaching.

Statement of the Research Problem

TVE teachers must facilitate the development of critical thinking skills in students, which is essential for today's employers (Hyslop-Margison & Armstrong, 2004). The job-specific skills within TVE programs require the development of critical thinking such as problem solving, decision making, and creativity, which are the main attributes expected by business and industry (Rojewski, 2002). Therefore, teachers should be able to teach critical thinking appropriately (Rudd, 2007). With this goal, students as well as teachers may increase their thinking abilities to become better learners, independent thinkers, and problem solvers (Duron, Limbach, & Waugh, 2006).

In Malaysia, TVE educators teaching in polytechnic institutions are addressed as lecturers. Polytechnic lecturers are among the primary contributors to critical thinking development in Malaysia. Malaysian polytechnic lecturers need to offer students opportunities to build upon their knowledge and skills to explore new areas and learn new things with confidence. Moreover, TVE teachers should be willing to change the way they teach if other methods are shown to be more useful, because they are not only information providers, but also critical thinking promoters (Rudd, 2007).

There is no question about the importance of critical thinking in the Malaysian educational system. Critical thinking is placed on the Malaysian Qualification

Framework (MQF) as an essential learning outcome for higher education (Malaysian Qualification Agency, 2011). Aligned with MQF, critical thinking will be promoted as one of main elements in teaching when the Malaysian polytechnics are upgraded to university colleges in 2015 (Abd. Wahab, Zakaria, & Jasmi, 2010). Many experts agree that polytechnics have emphasized some aspects of critical thinking in teaching and learning materials (National Higher Education Research Institute, 2007). Yet, a study by Md. Yasin, Wan Mohd Shaupil, Mukhtar, Ab Ghani, and Rashid (2010) indicated that students' critical thinking skills still needed to be improved within the Malaysia's polytechnic system. In addition, limited literature related to critical thinking in a Malaysian setting makes it difficult for TVE educators to learn at which level of the polytechnic system the problems occur. This problem is likely to continue if more research is not done on this issue.

The usage of teaching strategies is influenced by the teachers' perceptions of the effectiveness of those strategies on students' learning (Twibell, Ryan, & Hermiz, 2005). Hence, this study examined Malaysian polytechnic lecturers' opinions about their usage and perceptions of critical thinking teaching strategies within polytechnic programs in Malaysia. This study attempted to discover what types of strategies are currently used and to what extent Malaysian polytechnic lecturers, in both engineering and non-engineering programs, are using these strategies.

Rationale for the Study

An effective TVE curriculum will not be successful if educators do not have a complex understanding of critical thinking in curriculum and instruction. TVE teachers are vital to the success of critical thinking within Malaysian TVE. Expectations for students to engage in critical thinking also requires TVE teachers to attain new knowledge and skills to incorporate learning strategies that promote critical thinking, problem solving, and decision making (Hyslop-Margison & Armstrong, 2004). In other words, the goal is for students to be more aware of what they learn and claim responsibility for what they do; subsequently, they will hopefully become critical, creative, innovative, and competent employees (Badran, 2007). This can best be accomplished with educators using effective techniques.

Purpose of Study

TVE in Malaysia is controlled and monitored by several ministries such as: the Ministry of Higher Education, the Ministry of Education, the Ministry of Human Resources, the Ministry of Youth and Sports, and the Ministry of Entrepreneurship and Cooperative Development (Board of Engineers, Malaysia Institution of Engineers, & Malaysia Federation of Engineering Institution of Islamic Countries, 2003). In 2007, the Ministry of Education was separated, adding the Ministry of Higher Education. Thus, this study specifically focuses on the Ministry of Higher Education, which administers the TVE polytechnics establishment.

The main purpose of this study was to investigate the extent to which polytechnic lecturers in Malaysia incorporate critical thinking into their teaching strategies. In addition, this study explored the types of teaching strategies that are frequently used and looked at Malaysian polytechnic lecturers' perceptions of the effectiveness of critical thinking teaching strategies. External factors such as: highest level of education achieved, years of teaching experience, number of critical thinking workshops attended, and whether the instructor majored in engineering or non-engineering field were also considered for possible influences on lecturers' use and perceptions of critical thinking teaching strategies. Also, this study looked at differences of critical thinking teaching strategy usages within engineering (civil, electrical, and mechanical) compared to non-engineering (commerce, hospitality, information technology, design, and visual communication) polytechnic programs as each have different goals and objectives. One of considerations to select teaching strategies including objectives of the process involved (Taba, 1966).

Furthermore, this study takes up Barnhill's (2010) suggestion for further investigation of critical thinking teaching strategies, after the researcher used her questionnaire to sample Liberal Arts faculty members within selective U.S. universities. Correspondingly, this study is intended to explore Malaysian polytechnic lecturers' use and perceptions of critical thinking teaching strategies.

Significance of the Study

This study is significant because it assesses the current teaching strategies of Malaysian polytechnic lecturers with respect to critical thinking, an important area in need of more research. Past research has been done on critical thinking within Malaysian TVE, yet there is a lack of substantive literature in relation to critical thinking in teaching. This study adds substantive information and helps in establishing strategies for teaching critical thinking.

This study adds knowledge to the topic by identifying the frequency of use of different critical thinking teaching strategies. Malaysian polytechnic lecturers also were asked to indicate their perceptions of which teaching strategies they presumed could develop and improve students' critical thinking in TVE programs. Furthermore, this study explored the frequent use of critical thinking teaching strategies between engineering and non-engineering lecturers. Findings from this study may be used to help Malaysian TVE practitioners and policy makers take initiatives to enhance and restructure critical thinking skills policy, not only within the polytechnic system, but also to other institutions that offer TVE programs.

With this study, it is hoped Malaysian polytechnic lecturers will acknowledge that critical thinking teaching is not limited to only a few strategies, but that many strategies can be used to encourage people to improve their critical thinking. Indirectly, it is hoped that Malaysian polytechnic lecturers will develop and refine their knowledge on critical thinking teaching strategies by their consideration of the study instrument questions.

Research Questions

Research questions were developed to understand the factors that influence Malaysian polytechnic lecturers' usage of critical thinking teaching strategies. These questions drove the investigation:

1. What teaching strategies do Malaysian polytechnic lecturers use most frequently to encourage students to think critically?
2. Which teaching strategies do Malaysian polytechnic lecturers perceive as effective in their teaching?
3. Is there an association between frequency of use and perception of effectiveness of teaching strategies by Malaysian polytechnic lecturers?
4. Is there an association between frequency of use of teaching strategies and years of teaching experience of Malaysian polytechnic lecturers?

5. Is there an association between perception of effectiveness of teaching strategies and the highest level of education completed by Malaysian polytechnic lecturers?
6. Are there any differences for frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies by the number of critical thinking workshops attended by Malaysian polytechnic lecturers?
7. Are there differences for frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies by Malaysian polytechnic lecturers from engineering and non-engineering disciplines?

Definition of Terms

Critical thinking teaching strategies: Instruction that uses critical thinking as a main element to help students "analyze, synthesize, and evaluate information to solve problems and make decisions (think) rather than merely to repeat information (memorize)" (Snyder & Snyder, 2008, p. 91). In this study, critical thinking teaching strategies relate to the choices of what teaching strategies polytechnic lecturers practice to encourage students to be independent learners and good problem solvers.

Critical thinking: In TVE, critical thinking is defined as "a set of heuristics, or guiding principles, intended to provide workers with effective problem solving regardless of occupational context" (Hyslop-Margison & Armstrong, 2004, p. 40). In this study, critical thinking is seen as the comparison of information with biases and prejudices taken into account, which lead to problem solving, judgment, decision-making, and creativity capabilities.

Metacognition: The ability to control cognitive processes by utilizing optimal thinking abilities to improve the capacity of the learning process.

Malaysian polytechnic lecturer: A Malaysian citizen who is appointed as an educational officer of Higher Education, based on degrees earned in Malaysia or abroad and recognized by Malaysian Government and other compulsory requirements. Polytechnic lecturer is a common name of this position. Generally, teaching is the main task for a Malaysian polytechnic lecturer, in addition to management work related to education at any polytechnics in Malaysia.

Engineering disciplines: Curricula incorporating science, mathematics, and technical components that "uses scientific knowledge and microscopic building blocks to create products, materials, and processes that are useful to people" (Tadmor, 2006, p. 21). For this study, engineering disciplines include civil, electrical, mechanical, marine, and petroleum engineering.

Non-engineering disciplines: Curricula with less emphasis on science, mathematics, and technical components, but more on providing knowledge of administration, management, and services such as commerce, hospitality, management, and fashion design.

Delimitations

Although critical thinking is a broad topic, this study focused on critical thinking teaching strategies of TVE educators in Malaysia. The intention of this study is to provide feasible recommendations specifically to benefit Malaysian TVE. The study does not cover all TVE educators in Malaysia. The accessible population for this study is Malaysian TVE lecturers from 27 operating polytechnic programs around Malaysia. The selected population is Malaysian polytechnic lecturers appointed to teach TVE programs in engineering or non-engineering departments.

Limitation

The questionnaire of this study was developed by a U.S. researcher and was adapted by this researcher for a Malaysian setting, possible biases may have occurred in this process but all attempts to minimize this possibility were taken. Participants were selected from 27 polytechnics in Malaysia who voluntarily completed the questionnaire, this represents a limited sample size out of the possible population. Due to time limits, the survey was administered in the middle of the spring semester at Malaysian polytechnics. Thus, the polytechnic lecturers were overloaded by work in teaching and management and this may have had an effect on the results of this study. Participation may have been limited by an unwillingness to complete the study due to its length and time needed for completion. Correspondingly, the findings of this study are limited by the willingness of the respondents to complete the questionnaire and respondents who are likely using critical thinking strategies in courses they teach.

Assumptions

This study assumes that Malaysian polytechnic lecturers represent TVE educators in Malaysia. Malaysia is a multicultural country, which consists of three main ethnic groups; Malay, Chinese, and Indian, who come from different religious backgrounds, beliefs, values, and cultures. The findings of this study are assumed to be influenced by those factors because there is a possibility that critical thinking can be perceived differently based on cultural background (Ennis, 1998). Likewise, personal issues, teaching experiences, and individual perspectives of critical thinking may affect the findings.

Another assumption made was that the questionnaire taken from U.S. perspectives on critical thinking accurately translates into Malay. This translation was done because it was assumed that participants were more comfortable responding in Malay. Correspondingly, the questionnaire could give new insight and aspiration for Malaysian polytechnic lecturers to experience using various teaching strategies that promote critical thinking.

Conceptual Framework

This study adapts the conceptual framework from a critical thinking study by Simpson and Courtney (2007) shown in Figure 1. Based on this conceptual framework, there are cognitive skills and strategies underlying the teaching of critical thinking. Questioning, small groups, role-playing, and debate appear as general strategies for teaching critical thinking (Simpson & Courtney, 2007). Questioning is “relevant to the nature of critical thinking as an epistemic process of inquiry” (Ikuenobe, 2001, p. 327). Small groups allow students to exchange ideas based on their own experiences and skills and experience different interpretations from others by thinking critically (Simpson & Courtney, 2007). Critical thinking expression can be displayed through role-play, as it implicates “decision-making ability and control over material” (Ertmer et al., 2010, p. 75). Debate techniques have students “recognize and deal with various points of view and improve their critical thinking” that develop their self-confidence when presenting arguments to the topic discussed (Scott, 2008, p. 41).

These four strategies: questioning, small groups, role-playing, and debate subsequently develop skills in critical thinking such as: analysis, interpretation, inference, explanation, evaluation, and self-regulation. According to Halpern (1999), cognitive skills will increase gradually with the improvement of critical thinking. However, critical thinking teaching strategies are not limited to this selected conceptual framework. There are many choices of strategies teachers can use to promote critical thinking in their teaching. The selection of teaching strategies also may depend on the structure of the educational programs (Mandernach, 2006). Suffice to say that this framework can be used as a guide to select appropriate teaching strategies to enhance critical thinking abilities, but it is not comprehensive.

TEACHING CRITICAL THINKING (CT)		
Dimensions	Cognitive Skills	CT Strategies
	↓	↓
Variables	Analysis Interpretation Inference Explanation Evaluation Self-regulation	Questioning Small Group Role-play Debate

Figure 1. *A conceptual framework to guide teaching critical thinking adapted from Simpson and Courtney (2007).*

Researcher's Perspective

As a Malaysian, the researcher has been working within the Malaysian TVE system after completing a master's in Technical Education at a Malaysian public university. The researcher's first job was teaching in an engineering program at a Malaysian polytechnic. These students had finished their Malaysian Certificate of Education at the age of 17 and were selected for engineering programs at polytechnics with minimal requirements. Most of the students were totally new to the engineering discipline and excitedly wanted to learn something new. Colleagues at the school were divided into two groups, engineering and non-engineering lecturers. Obviously, they were from various backgrounds and disciplines, depending on which department they were assigned to teach.

In the beginning, the researcher's first assignment was to utilize a curriculum document, which was handed down by the head lecturer in the electrical engineering department. The curriculum for polytechnics was focused on 60 percent theory and 40 percent practice. Theory was taught in classrooms; practice was taught in labs and emphasized hands-on skills based on what students learned from theory. The aim of the polytechnic program was to provide professional training for technicians, apprentices, and others to meet requirements for various industries in Malaysia.

Instructions were given to complete teaching the course within a semester, followed by a standard procedure approved by the Ministry. While the curriculum was known, the researcher never expected to be forced to use it without any direction or guidance. It took time to understand and apply it effectively. It was not an easy task to teach both theory and practice, but it was highly enjoyable. The most challenging part was the necessity to create new lab sheets for lab experiments and ensure that the results were similar to the theory. Final examination questions also had to be created by referring to the curriculum document. From this experience, it was felt that the teaching could be more effective with more guidance beyond merely the curriculum document.

Later, the researcher was transferred to the Curriculum Division in the Technical Department of the Ministry of Higher Education, Malaysia. This was an important transition because it meant responsibilities were to control, centralize, coordinate, and monitor the curriculum documents used in community colleges and polytechnics programs. Responsibilities also included gathering curriculum experts within the polytechnic system, most of whom were senior staff members in their respective programs. There were no curriculum manuals, documents, or standardized procedures for these lecturers. There was no opportunity to learn how the curriculum was translated according to our national policy.

It was discovered that the discussion among stakeholders who were industrial and business representatives was shallow and it was difficult to obtain better information, especially regarding employability based on technical skills that the stakeholders desired from polytechnic graduates. Again, the critical thinking issue was encountered. Everyone in the discussion acknowledged the importance of this skill set, yet only a general solution was suggested. Moreover, a committee composed of university representatives approved the final draft of the polytechnic curriculum. While most of these polytechnic programs are similar to university programs, university standards are not suitable for polytechnic students and admission requirements are lower than at universities.

After leaving the ministry post, the researcher sought to find some answers for the TVE curriculum in Malaysia. The researcher again worked as a lecturer, but this time in the Technical Education Faculty of a university. This faculty prepares the next generation who want to become lecturers at community colleges and polytechnics in Malaysia. This faculty led TVE in Malaysia by providing both teaching programs for future TVE lecturers and research and development to the Department of Polytechnic Management. This job gave the opportunity to meet TVE experts in Malaysia, including university representatives of the polytechnic curriculum committees and several TVE professionals from other countries in Asia and Europe. It was fascinating to learn that different countries have different obstacles in finding good TVE practices in curriculum development. Critical thinking is one of the most common issues TVE people attempt to improve within the systems of their countries.

Based on this working experience within the TVE system in Malaysia, TVE lecturers at polytechnics recognize what critical thinking is, but they are unclear about the practices of teaching critical thinking. The polytechnic curriculum was based on Bloom's taxonomy of the cognitive domain. Polytechnic lecturers identified levels of Bloom's taxonomy, which might help students to think critically. However, there are some teaching approaches that polytechnic lecturers are not familiar with and could be infused within their teaching strategies. The researcher was not excluded from this issue due to only limited knowledge and education about critical thinking. Throughout the Ph.D. process, the researcher's skills as a critical thinker have gradually expanded. Now, the researcher is trying to integrate this understanding of critical thinking with those who are experts in this field. It has been difficult to blend opinions from different systems with pre-existing knowledge, but the experience has been priceless. It is hoped that, by exploring this topic and gaining knowledge to better understand critical thinking, this insight can be shared with colleagues upon returning to Malaysia.

CHAPTER 2 : LITERATURE REVIEW

The purpose of this chapter is to review literature about critical thinking and how it relates to teaching strategies. Although critical thinking embodies every level of education, this review concentrates on higher education focusing on Technical and Vocational Education (TVE).

Critical Thinking

Thinking is a natural process that develops in every individual from birth. Thinking allows a person to impart knowledge through a process of reasoning, analyzing, problem solving, and decision-making (Nickerson, Perkins, & Smith, 1985). Nevertheless, people may get confused in learning about their own thinking skills unless they understand that there are different definitions and functions about thinking (King, Goodson, & Rohani, n.d.). Thinking can lead people to view a problem as if receiving new information by developing the ability to reason inductively and deductively before making a decision (Nickerson et al., 1985). Oftentimes, our thinking is influenced by bias, prejudice, discrimination, and poor judgment (Paul & Elder, 2008). To avoid one-shot thinking, individuals should develop their abilities to filter negative influences by increasing their thinking skills through training (Nickerson et al., 1985). Through teaching and learning, an individual may train their brain to think sensibly and cohesively. Moreover, the stages of thinking take place over time, reflecting personal development and professional growth (Van Gelder, 2005).

Taba (1966) described thinking skills as “something which can be taught, provided that the specific processes and skills composing it are identified and, among those, the skills and processes that can be enhanced by systematic assistance are distinguished" (p. 34). According to Edwards and Briers (2000), thinking skills are divided into two levels: lower-order thinking (level of remembering and processing information) and higher-order thinking (level of creating and evaluating information). In contrast, Paul and Elder (2008) found three levels of thinking, which includes the previous two and also highest-order thinking. Highest-order thinking comprises critical thinking, which is more likely to be the main interest in today's education (Paul & Elder, 2008).

Although some researchers postulate critical thinking is interchangeable with higher-order thinking, a counterclaim categorizes critical thinking under the umbrella of higher-order thinking skills (King et al., n.d.). Rudd (2007) asserted critical thinking is not in the same category as higher-order thinking, but a subcategory of higher-order thinking. In addition, Bloom (1984) also believed critical thinking is a type of higher-order thinking. "Higher-order thinking includes critical, logical, reflective, metacognitive, and creative thinking" (King et al., n.d., p. 32), whereas critical thinking is "reasoned, purposive and reflective thinking used to make decisions, solve problems, and master concepts" (Rudd, 2007, p. 47). Whether critical thinking is under higher-order thinking or is in the highest categories in thinking, the expectation is practically similar.

There are many explanations of critical thinking. Ideas, concepts, and interpretations about critical thinking have been meticulously explained with philosophy and psychology perspectives, yet people have a long-term query about this universal concept (Lewis & Smith, 1993). Authors, theorists, and educators often raise questions on critical thinking related to teaching, perceptions of professional and practice contexts, and aptitude measurement (Kincheloe, 2004).

Despite of all the inquiries and lack of definitive answers about critical thinking, scholars and educators are still aware and acknowledge critical thinking as a key skill that should be highlighted in the main agenda of education (Pithers & Soden, 2000). That is to say, critical thinking is sin qua non in education settings. Tsui (1999) noted critical thinking has become an educational objective that is essential for students to be able to work independently and to think critically once they complete their degrees. Nieto and Saiz (2008) agreed that critical thinking is a prominent topic at every level in education. These scholars predicted critical thinking as one of biggest challenges in 21st century education and educators should actively integrate critical thinking into their teaching. For this reason, many educational institutions impart critical thinking skills into programs with the intent to improve students' thinking skills (Tsui, 1999). Besides educational settings, critical thinking is known as one of the vital attributes that help workers improve their career development and viability in the workplace (Serrat, 2009). Singularly, critical thinking is needed to perform and deliver information deliberately in a variety of settings.

Due to an increased demand of critical thinking expectations, scholars and educators attempt to introduce critical thinking in teaching and educational systems in order for students to become better critical thinkers (Duron et al., 2006). Students are good learners when they know how to report and present what they learn and can retain the information longer. This process needs regular practice and teachers should take charge to assist students to be more critical in achieving a level of high-order thinking (Van Gelder, 2005).

Definitions of critical thinking abound. According to Ennis (1985), “critical thinking is reflective and reasonable thinking that is focused on deciding what to believe or do” (p. 45). Halpern (1999) simply defined critical thinking as “the use of cognitive skills or strategies that increase the probability of a desirable outcome” (p. 70). Facione (2000) stated critical thinking is judgment, reasoning, reflective, and purposeful thinking processes, which allow people to find reasonable meaning to their problem solving tasks. In the same way, critical thinking is posited as an “art of analyzing and evaluating thinking” (Paul & Elder, 2008, p. 2), which enables people to “raise vital questions and problems, formulate them clearly, gather and access relevant information, use abstract ideas, think open-mindedly, and communicate effectively with others” (Duron, et al., 2006, p. 160). In brief, questioning, reasoning, analyzing, evaluating, and problem solving are some features that should be considered to become a rational, fair, and independent critical thinker.

Paul and Elder (2008), two experts on critical thinking, suggest critical thinkers can be developed by providing some extensive information convincing people that (a) critical thinking improves fair-minded life, (b) skills can be routinely taught and consistently fostered, and (c) there are universal intellectual standards.

Bloom’s Taxonomy of Cognitive Domain

Teachers may comprehend more about critical thinking when it is associated with the cognitive domains of Bloom’s taxonomy because it has proven to be a useful and an influential tool (Paul, 1985). Brown (2004) asserted Bloom’s taxonomy is a significant structure to foster critical thinking, which generally gives guidelines for students to "establish clarity and accuracy, assess relevance, and demonstrate the ability to think in depth" (p. 76). Teachers can make use of Bloom's taxonomy in their teaching as a reference for writing learning objectives, developing lesson plans, asking questions of students, organizing class activities, and preparing tests and examinations to access students' critical thinking (Anderson, 1994). Bloom's taxonomy is a "convenient, quick, efficient, testable, measurable and accountable" multi-tiered model of knowledge production and thinking (Berry, 2004, p. 464). Bloom's taxonomy classifies six levels of thinking: "(a) knowledge, (b) comprehension, and (c) application represent lower-order thinking skills; (d) analysis, (e) synthesis, and (f) evaluation signify higher-order thinking or critical thinking skills" (Bloom, 1984, p. 18). The levels are ordered from simple to complex in terms of the development of critical thinking. The steps to engage in critical thinking are the higher order skills of Bloom's taxonomy, which only can be reached based upon prerequisites of the lower level (Brown, 2004). Furthermore, some categories in Bloom's hierarchy embodied terms that confuse teachers and learners in their effort to optimize the usage of Bloom's hierarchy (Krathwohl, 2002).

Hence, there are attempts to replace Bloom's taxonomy with a Revised Bloom's Taxonomy. The Revised Bloom's Taxonomy is designed to give clear and concise definitions and explanations for classifying statements of the cognitive process dimension of thinking (Krathwohl, 2002). Likewise, the New Taxonomy gives explicit details about thinking skills within educational objectives because the skills are "accepted as a viable type of supporting or complimentary curriculum to academic content" (Marzano & Kendall, 2008, p. 167). Regardless of new recognitions of the cognitive domains, Bloom's taxonomy is still recognized as an essential tool in education. By using Bloom's taxonomy, teachers can incorporate appropriate strategies to develop student thinking and help "students master different types or levels of objectives" in their learning (Anderson, 1994, p. 134). By and large, teachers are responsible to incorporate strategies that encourage students to optimize their learning more effectively.

Metacognition

Other than Bloom's taxonomy, the metacognitive approach is significant to enhance students' critical thinking. Yet, there are inconsistencies in defining metacognition as well. Scholars and educators often associate metacognition with "metacognitive beliefs, metacognitive awareness, metacognitive experiences, metacognitive knowledge, feeling of knowing, judgment of learning, theory of mind, metamemory, metacognitive skills, executive skills, higher-order skills, metacomponents, comprehension monitoring, learning strategies, heuristic strategies, and self-regulation" and the lists go on (Veenman, Van Hout-Wolters, & Afflerbach, 2006, p. 4). Flavell (1979) defined metacognition as "knowledge and cognition about cognitive phenomena" (p. 906). Livingston (2003) refers to metacognition as "higher-order thinking that involves active control over the cognitive processes engaged in learning" (p. 2). In particular, teachers are accountable to make changes in their teaching and to incorporate strategies that motivate students to enhance their learning. Also, critical thinking can help students to develop other thinking skills.

Metacognition is described as "awareness and management of one's own thought," which uses "inquiry, analysis, inference, and argument" in its process, all are important elements in critical thinking (Dean & Kuhn, 2003, p. 3). Flavell (1979) classified metacognition into four categories: "(a) metacognitive knowledge, [e.g., I am good at delivering content rather than teaching critical thinking], (b) metacognitive experiences [e.g., emotional reactions when incorporating critical thinking in teaching], (c) goals or tasks [e.g., a goal to be a good critical thinker], and (d) actions or strategies [e.g., plans to implement active learning, cooperative learning, and other teaching strategies in class to stimulate students thinking skills]" (p. 906).

Consciously or not, people use metacognition in their daily routines, as metacognition is a process of thinking about thinking (Livingston, 2003). Metacognition takes place in "planning, monitoring and evaluating thought" (Luckey, 2003, p. 266). For example, the researcher is engaging with metacognition if she discovers there are flaws in the literature review section after reading more articles related to the study and makes improvements by adding more citations and correcting grammar. Metacognition is used to emphasize thinking about teaching in developing teachers' own teaching concepts which called metateaching (Timpson, 1999). Simultaneously, teachers plan, develop, analyze, and improve their teaching.

For students, knowledge and regulation in metacognition may be effective for self-reflective learning, specifically regarding their academic performance and personal development (Joseph, 2010). Accordingly, teachers and students gain benefits from this metacognition process and it helps to develop and improve their thinking skills. Notwithstanding, teachers tend to neglect metacognition processes in classes because curriculum provided by the institutions guide instructors to focus on the subject not on thought (Joseph, 2010). It is difficult to utilize metacognition approaches when someone has inadequate metacognitive knowledge and lacks the ability to apply cognitive thinking skills in daily activities “such as generating problem-solving steps and sequencing those steps” (Veenman et al., 2006, p. 5). In summary, metacognition cannot be implemented without proper planning and awareness of cognitive thinking skills needed in learning and instruction.

Critical Thinking in Higher Education

Critical thinking is claimed to be the most recommended skill set in higher education because it gives added value to students’ learning outcomes (Ennis, 2008). Today’s college and universities are concerned to “define the enhancement of critical thinking as a primary reason for higher education” (Halpern, 1999, p. 70). Correspondingly, universities and colleges are doing their best to enrich the quality of learning processes to drive students to be active and empowered citizens (Wals & Jickling, 2002). At universities, lecture is one of the prominent methods usually used to convey information. In contrast, many students prefer to be challenged by active methods that encourage them to be critical in what they learn (Levine & Cureton, 1998). Students are more interested to have educative experiences that give more focus on what they can do and contribute in the real world (Wurdinger & Rudolph, 2009). These experiences include sharing ideas, exploring real life situations, and solving problems on real issues.

Changing from teacher-centered to student-centered approaches enables higher education students to increase their intellectual abilities such as critical thinking and self-regulated learning through “problem orientation, experiential learning, and lifelong learning” (Wal & Jickling, 2002, p. 229). Those educational directions can be applied as “a range of complex interactions between student, teacher, setting and learning activities”

(Maher, 2004, p. 51). In student-centered classrooms, students can be guided in their learning to achieve the expected learning outcomes of the course (Wright, 2011).

The development of critical thinking is not a short-term process. The initial stage of critical thinking should be introduced and fostered at elementary levels (Ricca, Lulis, & Bade, 2006), followed by retaining and further developing the critical thinking concepts at the lower secondary and upper secondary level (Snyder & Snyder, 2008), and consistently practiced at college and university levels (Halpern, 1999). For example, elementary students from grade five through eight showed an improvement in critical thinking development based on problem solving tasks using Lego Mindstorm robots (Ricca et al., 2006). In essence, critical thinking can be fostered at any educational level and appropriate approaches are recommended. Siller (2001) recommends training and encouragement are important to develop students' critical thinking. For this purpose, students in higher education should be explicitly taught to think critically, which leads to problem solving and creativity and at the same time enables them to articulate their knowledge, reasoning, and problem solving in the world of work (Halpern, 1999). Fostering critical thinking also facilitates effective thinking, important to workplace demands (Smith, 2003). Subsequently, critical thinking skills developed over time are useful for life. With critical thinking, students impart their knowledge into a lifetime context, which helps them to improve their ways of thinking (King et al., n.d.). Facione (1998) stated that critical thinking is not limited to the classroom, but it is also relevant to many situations in people's lives.

Critical Thinking in Malaysia

Critical thinking is important in the education of every country, and Malaysia is not excluded. To highlight the importance of critical thinking in 21st century education, critical thinking is recognized as one of eight domains in learning outcomes of the Malaysian Qualifications Framework (MQF) for tertiary education under the Ministry of Higher Education (Malaysian Qualification Agency, n.d.). MQF is:

> An instrument that develops and classifies qualifications based on a set of criteria that are approved nationally and benchmarked against international best practices, and which clarifies the earned academic levels, learning outcomes of study areas and credit system based on student academic load (Malaysian Qualification Agency, 2011, para. 2).

In this qualification framework, critical thinking is directly represented under the problem solving and scientific skills domain (Malaysian Qualification Agency, n.d.). In brief, MQF is a standardized tool for the purpose of maintaining educational program quality and accreditation standards for Malaysian higher institutions monitored by the Ministry of Higher Education.

Critical thinking is included in Malaysian education policy, but its implementation and achievement are unclear. A study from Choy and Cheah (2009) indicated that Malaysian teachers in higher education are lacking in understanding and applying critical thinking to their current instructional methods. They noted possible reasons for Malaysian teachers not incorporating critical thinking in their teaching are due to expectations of content delivery, traditional classroom physical structures, lack of training, and perceptions that students will not participate.

Similar concerns of Malaysian teachers regarding inclusion of critical thinking in the classroom can also be found in the United States. Partnership for 21st Century Skills and Society for Human Resource Management (2006) reported that 27.6 percent of U.S. college graduates are capable of performing adequately on critical thinking and problem solving tasks. With the majority lacking this capability, one possible solution to overcome this deficiency is that teachers should embrace critical thinking in teaching and embed practices to guide students to develop their critical thinking (Snyder & Snyder, 2008).

Teachers and students should both learn and practice how to think critically (Khojasteh & Smith, 2010). Equally important, students will feel free to express their opinions and thoughts when the "classroom climate is open, stimulating, and supportive" otherwise, students may not take the risk to engage with critical thinking processes (Black, 2005, p. 4). Therefore, teachers ought to consider factors that may influence their performance in fostering effective critical thinking in their students.

Critical Thinking in Technical and Vocational Education (TVE)

Critical thinking "requires students to consider alternative view points, knowledge, and possibilities" to enhance their thinking (Hyslop-Margison & Armstrong, 2004, p. 45). In higher education, critical thinking is necessary within TVE programs because "increasing the number and quality of critical thinkers in career and technical education [also known as TVE] will be a great asset to industry" (Rudd, 2007, p. 49). Copper (2006) stressed TVE teachers should be "more pragmatic" and "inspire a resourceful creative, and flexible" approach to teach critical thinking more effectively (p. 71). With critical thinking, teachers can offer opportunities for students to explore their abilities to manage new and existing information (Marin & Halpern, 2011). If TVE teachers do not have knowledge and understanding of the concept of critical thinking itself, and do not rigorously promote it, then it is no wonder that current TVE students may not become good critical thinkers (Rudd, 2007). Indeed, critical thinking is significant to education.

Despite the increasing focus on the importance of critical thinking, Malaysian TVE teachers tend to focus more on problem solving and creativity than critical thinking (Minghat & Yasin, 2010). Minghat and Yassin (2010) developed a sustainable framework tool for Malaysian TVE based on qualitative data from 12 Malaysian TVE experts from various disciplines within higher education institutions. The implication of these findings may confuse TVE teachers in Malaysia because critical thinking was not emphasized in their framework. The implementation of critical thinking in TVE cannot be a success without any recognition of those decisions from its society (Hyslop-Margison & Armstrong, 2004). Thus, critical awareness and acceptance of critical thinking among educators are essential.

In general, TVE curricula are designed to encourage incorporation of problem solving and creativity, but less focused on the more complex process of teaching and learning critical thinking (Cooper, 2006). TVE curricula have a primary emphasis on employability skills (Levin, 2005). Finch and Crunkilton (1999) claim, "the ideal of TVE curriculum is neither academic nor vocational and technical" because TVE curricula are not balanced between academic and practical skills, but rather focus on today's occupational needs (p. 15). They added that curriculum developers should formulate a proper strategic plan to ensure TVE curricula are “more systematic and future-oriented” for job requirements (p. 47).

Like any form of education, TVE experts attempt to define critical thinking within the TVE context. Critical thinking in TVE represents transferable employability skills that will stretch students to be more competent and employable in careers (Hyslop-Margison & Armstrong, 2004). In particular, critical thinking has significant relationships with what should be within TVE programs. For this reason, it is important for TVE teachers to find appropriate and valid approaches that motivate students to develop their critical thinking in learning (Rojewski, 2002).

Critical thinking is part of intellectual development, which needs to be fostered. It can be taught in a way that creates a “consistent internal motivation” that encourages people to think (Facione, 2000, p. 61). For students to engage in critical thinking, teachers must be confident in their own ability to incorporate critical thinking skills in classroom settings and assigned work. Teachers can design and develop new interventions to generate multiple perspectives for learning knowledge and skills (Willingham, 2008). Yet, it is not easy to teach critical thinking in the classroom because it involves a deep understanding of a problem’s structure and applying knowledge about how to solve it (Willingham, 2008). People accept the importance of critical thinking but sometimes there is “confusion about critical thinking under superficially different ways of talking” (Bailin, Case, Coombs, & Daniels, 1999, p. 270). Understanding the critical thinking concept may influence what strategies teachers choose in their teaching. Nevertheless, this issue should not be a barrier to formulate the best practices for teaching critical thinking because it can be gradually improved.

Overview of Technical and Vocational Education (TVE)

Vocational Education, TVE, Career and Technical Education, and Workforce Education are some of the terms used by different countries. The terminologies are a reflection of political, cultural, and economic perspectives, which attempt to build a good image of vocational education for the 21st century (Catri, 1998). For example, according to Gordon (1999), although the original vocational programs in the United States began in the 20th century, the vocational movement has existed since the 19th century. Starting with “manual” education, the name has been replaced with “vocational” education, influenced by political and economic demands to form mass institutions in American formal education (Lazerson & Grubb, 1974). Currently, in the U.S., it is formally known as Career and Technical Education (CTE) (Levesque et al., 2008). CTE has been mandated in federal legislation as playing a pivotal role in shaping the current and future trends of socioeconomic and labor market development (Threeton, 2007). CTE is recognized in the Perkins Act as an organized educational activity that:

1. provides individuals with coherent and rigorous content aligned with challenging academic standards and relevant technical knowledge and skills needed to prepare for further education and careers in current or emerging professions;
2. provides technical skill proficiency, an industry-recognized credential, a certificate, or an associate degree; and
3. may include prerequisite courses (other than remedial courses) that meet the requirements of this subparagraph; and include competency-based applied learning that contributes to the academic knowledge, higher-order reasoning and problem-solving skills, work attitudes, general employability skills, technical

skills, and occupation-specific skills, and knowledge of all aspects of an industry, including entrepreneurship, of an individual (S.250, 2006, p. 3).

In European countries, TVE is seen as a primary factor in the development of human resources and a main contributor to economic success (Wu, 2003). Currently, approximately 25 European countries, including Germany, Italy, Denmark, and Finland, are registered under the European Forum of Technical and Vocational Educational Training (EFTVET), an organization that provides substantial information to improve TVE (European Forum of Technical and Vocational and Training, 2011). European countries' TVE is built on the principles of lifelong learning and occupational profiling, which align with the development of TVE systems (Wu, 2003). Historically, industries support and facilitate European countries' national reforms, as industries have been good collaborators with the governments since the very beginning of TVE (Wu, 2003).

However, the TVE movement in other countries is different. In many countries, TVE, while being recognized as a factor in shaping social and economic development of a country, is also seen as being for people not qualified to attend traditional universities (Seng, 2007). For example, in China, TVE is a platform for students who are not able to excel academically (Velde, 2009). Because of these perceptions, Chinese parents prefer their children are educated at schools and universities, which are not vocationally oriented (Velde, 2009). Also in Singapore, the negative perception of TVE has only changed since the early 1980s, when the government accelerated its efforts to emphasize TVE in schools, polytechnics, and universities (Seng, 2007).

The negative connotation associated with TVE also happens in Malaysia. In Malaysia, the early establishment of TVE was to be an alternative for students who were not accepted at academic schools and universities due to unsuccessful completion of national examinations (Wilson, 1991). TVE was not a first choice, but a last option leading to perceptions of failure. Despite prejudice and negative associations with TVE, people still recognized its importance. Initially, TVE was not well accepted by Malaysian society, but TVE is seen as one of the solutions for Malaysia to upgrade its economy (Hee, 1994). It is undeniable that TVE can contribute to the social and economic success of a country (Seng, 2007). TVE programs have gradually contributed to an increase of awareness and acceptance among Malaysian society (Mustapha, 1999). TVE programs offered by secondary schools, colleges, and universities in Malaysia may be pathways to encourage students to further studies at higher levels (Haas, 1999). To change the negative stigma, the Malaysian government is making an effort to re-brand and improve TVE programs in the hopes of having them accepted by society as vital for driving economic development and individual achievement (Mustapha & Abdullah, 2001).

TVE is becoming successful because it provides opportunities for viable career options as it commonly offers sufficient knowledge, technical skills, and employability skills for students to be competent in the workplace (Stone III & Aliaga, 2005). Hence, TVE institutions emphasize technical skills as a core component in programs (S.250, 2006). Students are most frequently trained using technical equipment and computer-based technologies, as most of the learning materials supplied by the TVE institutions are relevant to industrial applications (Holvikivi, 2007). In other words, TVE programs offer opportunities for students to have greater success in engaging with tools and technologies of a given industry compared to students in general education (Brown, 2003). Further, TVE can help prepare students to enter a pool of successful and highly skilled personnel who are competent in meeting the needs and demands of industries in Malaysia (Bakar & Hanafi, 2007).

The concepts and techniques in delivering TVE are designed to relate the objectives of the curriculum, content knowledge of the subject matter, and relevant pedagogical approaches to the development of graduates' employability (Finch & Crunkilton, 1999). Therefore, TVE institutions have shifted to a new paradigm for teaching and learning methods in classrooms. Traditional learning principles and learning methods are gradually being improved to promote students' engagement in classrooms (Ausburn & Brown, 2006). TVE in Malaysia is developing a consistent relationship with global economic growth and technology advances (Mustapha & Abdullah, 2001). TVE programs' main key objectives are to prepare students with the knowledge acquisition and hands-on skills required by business and industry (Mustapha, 1999). However, TVE teachers have diverse groups of learners and the incorporation of different strategies in their teaching may improve student learning (Threeton, 2007).

TVE is growing for several reasons. Commonly, students give credit to TVE institutions for offering programs that are convenient, accessible, and support their academic success by imparting knowledge and skills required by the industries (O'Gara, Mechur Karp, & Hughes, 2009). Various policies and strategies have been implemented to ensure the acceptance of TVE as a credible education choice (Seng, 2007). In addition to the efforts from government, policy makers, educators, and administrators, TVE would not be successful without consistent supports from business and industry. Presently, industries are looking for employees who are capable of doing jobs based on the standards they have at the workplace, and graduates should know how to apply what they have learned at school appropriately (Hyslop-Margison & Armstrong, 2004). The success of future students obtaining jobs is dependent on the dynamic progression of economic growth (Badran, 2007). Significantly, educational goals are dependent on economic development. Thus, the TVE system has been changing consistently with business and industry needs (Dewey, Montrosse, Schröter, Sullins, & Mattox, 2008). Accordingly, people in business and industry need to work together with universities to sustain education. Employers also should be aware of the quality of TVE programs when considering job candidates (Dewey et al., 2008).

Critical Thinking Teaching Strategies

How can I teach critical thinking? Is it hard to teach? Will it impact the ability to teach content? These are the questions teachers might ask when considering to incorporate critical thinking in teaching (Willingham, 2008). Teaching and learning critical thinking is not an easy task (Khojasteh & Smith, 2010). To enable students to think critically, teachers must be critical thinkers themselves (Kincheloe, 2004). Yet, teachers may presume their job is only to provide students with content information, without understanding the importance of facilitating experiences for students to develop and improve their thinking (Jensen, 2004). By preparing positive classroom climates that include inquiry and problem solving processes, students may be motivated to maximize their learning and experience to enhance their critical and reflective abilities (Timpson & Burgoyne, 2002).

Some argue that critical thinking is a natural thinking process. On the other hand, critical thinking cannot be improved without practice (Moore & Parker, 1995). In other words, critical thinking should be practiced daily, for instance, in reading and writing. A lot of questions are needed to explore the meaning and value of learning that is suitable to an individual's culture, values, and beliefs. Perhaps, if one wants to integrate new information with existing knowledge, one might ignore, consider, question, criticize, defend, challenge, or use humor to better understand the issue (Moore & Parker, 1995). The process of analyzing, critical thinking, and truth seeking and the traits of self-confidence, inquisitiveness, maturity, and open-mindedness commonly emerge when nurturing critical thinking (Facione, Sánchez, Facione, & Gainen, 1995).

Many philosophers, psychologists, and education experts have considered critical thinking. The establishment of critical thinking in education prompted Halpern (1998) to promote four structural components for improving teaching and learning of critical thinking to include: "a dispositional or attitudinal component, instruction in and practice with critical thinking skills, structured activities designed to facilitate transfer across contexts, and a metacognitive component used to direct and assess thinking" (p. 451).

The critical thinking process can be misinterpreted as simply a mental process. However, mental processes cannot be considered critical thinking when solving a problem and make a decision only through assumptions, beliefs, precognition, and telepathy (Halpern, 1998). The process of critical thinking involves scientific training and scientific methods to seek meaningful connections to our judgments (Halpern, 1998). In short, critical thinking is scientific associative thinking, not simply an undirected mental process.

Teaching Strategies

Direct teaching, or the lecture method, is a common practice in classrooms. Direct teaching provides an abundance of knowledge, which can be delivered within a course schedule. Students listen, take notes, and concentrate on the content. Students claim to like this method because it is an "explicit, direct, and highly scaffolded manner" of learning, which make them successful learners (Kuhn, 2007. p. 109). According to Rittle-Johnson (2006), direct teaching can improve students' behavior in the classroom. However, the big question is: do students learn effectively? Can teachers identify students' achievement if they do not pose questions to their students? With the lecture method, students may be distracted while being given large amounts of information (Wurdinger & Rudolph, 2009). Direct teaching also may not be the best fit for all students (Warner & Myers, 2011). Meanwhile, a variety of teaching strategies that involve students' reflections and applications can contribute to work force performance (Mohr, 2007).

Teachers can design and develop new teaching strategies and lessons that encourage multiple perspectives and the deeper understanding of content (Willingham, 2008). Seaman and Fellenz (1989) claim there are four basic factors that influence teachers' selection of teaching strategies: (a) learners, (b) teachers, (c) organizations, and (d) content. Student learning is impacted by a teacher's decision-making in planning for the creation of successful instruction. With proper and good planning, teachers can provide excellent instruction and can manage teaching effectively (Timpson & Burgoyne, 2002). Student learning is influenced by the teacher's abilities to deliver course content. Students will improve their thinking process depending on the strategies teachers incorporate in teaching (Tyler, 1949). Teachers can use the Learning Style Inventory (LSI) as a tool to better understand individual learning styles (Henson, 2006). Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE) are the learning modes used in the LSI; these identify people's choices in learning style (Kolb, 1981).

Although teachers may believe that their sole role is to convey information to their students, they should continue to learn and grow as professionals to incorporate updated content and teaching strategies (Kugel, 1993). Teachers are also learners, and every teacher has a learning style. Teachers need to understand their own learning styles and their students' learning styles to better deliver content and to deepen understanding. However, Henson (2006) argued, "not everyone believes in the powers of matching teaching styles with learning style" (p. 345).

Still, there is continuing research in the association of teaching and learning styles. For example, a study conducted by Charkins, O'Toole, and Wetzel (1985) showed a link between teaching and learning styles among teachers and students in Economics at Purdue University. Teaching strategies do allow teachers to facilitate students' learning effectively (Franzoni & Assar, 2009). Nevertheless, it is not simple to select the most effective teaching strategy that improves students' learning and trains students to become critical thinkers because teaching itself is a complicated task to perform (Taba, 1966). An understanding of Bloom's taxonomy is a good place to start. The cognitive domain of Bloom's taxonomy could be used to aid teachers to individualize instruction more effectively (Orlich et al., 1985). Bloom (1984) emphasized the taxonomy was an essential tool to determine types of instruction appropriate to the students' learning process.

Figure 2 shows another option for consideration of decisions about teaching strategies for learning. Learning process, learners, variations in students' capacities and readiness, the institutional setting and its requirements, objectives and the structure of the processes involved, content and its structure, and personal teaching style are some main aspects teachers should think through when making decisions of suitable teaching strategies (Taba, 1966). With proper planning and management, it is possible for teachers to use a variety of methods. Students may learn best when a teacher delivers the curriculum with appropriate teaching strategies and materials. Franzoni and Assar (2009) pointed out that "teaching strategies must be designed in a way that students are encouraged to observe, analyze, express opinion, create a hypothesis, look for a solution, and discover knowledge by themselves" (p. 19). As a result, students do more exploration in the learning process to enhance their thinking skills (Kolb & Kolb, 2005). Teachers should discipline their minds to continually reflect on their own teaching and to routinely consider other perspectives exploring teaching strategies and methods that could improve students' ability to think critically (Gardner, 1999).

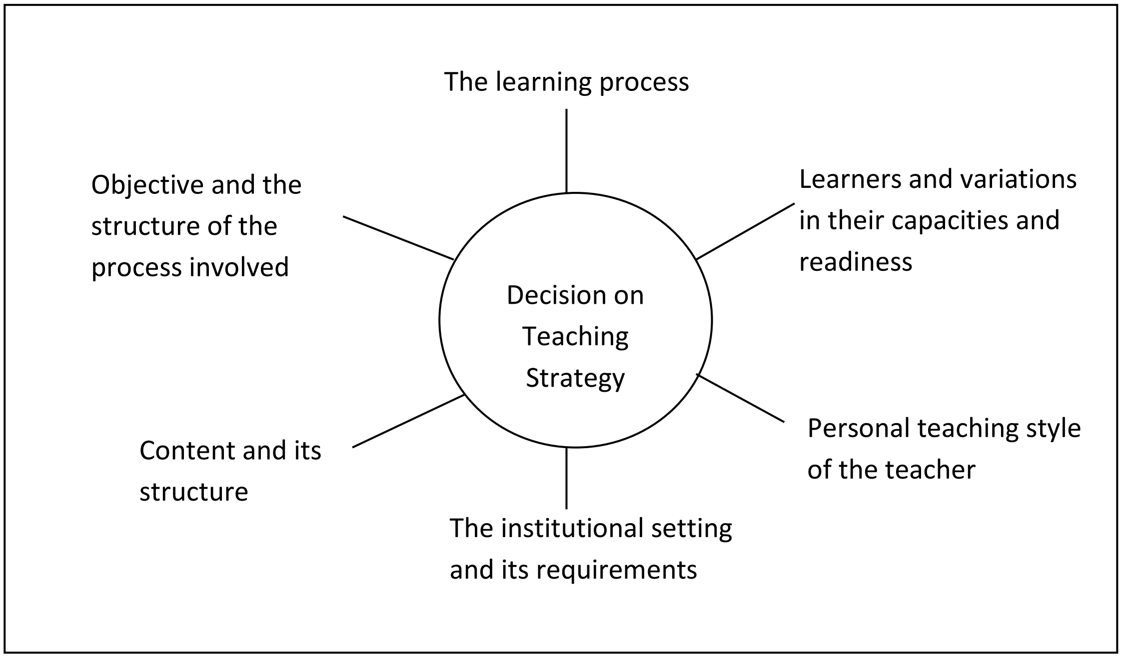

Figure 2. *Considerations in making decisions about teaching strategies (Taba, 1966).*

Influence Factors in Teaching Critical Thinking

Knowledge of critical thinking is one indicator of teachers' performance in critical thinking teaching strategies (Innabi & Sheikh, 2007). By having such knowledge, teachers can select doable strategies that engage students to think critically. Teachers who continually reflect on their own teaching may better understand and value critical thinking in education (Innabi & Sheikh, 2007). Critical thinking also develops with practice. For example King, Wood, and Mines (1990) revealed there were significant differences between graduate students and undergraduate students in regards to critical thinking. Graduate students were better in performing critical thinking. A study conducted by Onwuegbuzie (2001) indicated that levels of education influenced how people think critically and the study showed doctoral students have greater critical thinking skills compared to masters' students. Thinking may become critical and coherent as education is increased.

Types of Teaching Strategies That May Enhance Critical Thinking

Various teaching strategies can help promote critical thinking. Appropriate strategies to enhance critical thinking may relate school subjects and topics to practical situations the students deal with on a daily basis so that they can associate what they learn with what they experience (Ten Dam & Volman, 2004). Through teaching strategies, students should be encouraged to understand, discover, analyze, and synthesize issues or challenges (Krathwohl, 2002). Teachers need to master the subject matter as well as organize and construct their instructional practice (Grant, 1988). Alternative teaching strategies such as active learning (Duron et al., 2006), cooperative learning (Cooper, 1995), debate, role-play (Gratton, 2010), problem-based learning (Mimbs, 2005), questioning (Christenbury & Kelly, 1983), and writing (Green & Klug, 1990; Gunnick & Bernhardt, 2002) may encourage students' critical thinking processes.

Active Learning

Active learning is a student-centered approach. Bonwell and Eison (as cited in Keyser, 2000) pointed out that "active learning can be defined as anything that involves students in doing things and thinking about what they are doing" (p. 36). When using this approach, teachers facilitate activities that permit students to be responsible for their own actions and thinking during the learning process (Niemi, 2002). Students may not understand what they learn unless they experience it themselves, and active learning offers these opportunities (Duron et al., 2006). However, Neimi (2002) doubts the goals of active learning can be easily achieved when students steer their own learning process. Further, students need to have self-discipline to accomplish their learning goals based on time given by the teachers (Dewing, 2010). Hence, teachers must know how to select and facilitate strategies to assist students in the attainment of knowledge and skills. With active learning, students will be more self-directed in acquiring knowledge and skills and learn independently if they know how to utilize the approach correctly (Gunn, Richburg, & Smilkstein, 2007).

Cooperative Learning

Cooperative learning is a strategy that allows a small group of students to share thoughts, ideas, skills, and experiences to improve their learning process. It encourages students to be active participants in exploring what they are learning by asking questions and giving opinions, rather than taking notes and memorizing theories and facts (Hyslop-Margison & Armstrong, 2004). There is an argument that says cooperative learning is a form of active learning because it is a student-centered approach. However, Keyser (2000) claimed cooperative learning can encourage active engagement "but active learning is not cooperative" (p. 36). Hijzen, Boekaerts, and Vedder (2007) agreed that cooperative learning "does not automatically create a favorable condition for learning" (p. 674), because not every student gives the same responses and commitment to the task given by their teacher. Slavin (1996) suggests teachers should reward individual accomplishments in the task but not give rewards for the whole cooperative learning group, as teachers need to monitor students' learning and personal development individually.

Debate

Debate is also affirmed as an effective strategy to enhance students' critical thinking because it involves arguments and research (Greenstreet, 1993). In debate, students actively absorb information, evaluate their work, value others' points of view, and express their thoughts and opinions to their peers using credentialed sources (Kennedy, 2007). Simultaneously, debate helps develop students' oral communication skills (Bellon, 2000). In addition, students must hone research skills in finding evidence to support their arguments in both oral and written presentations (Green & Klug, 1990). Some possible negative aspects to debate are the concerns of unequal participation, and participants' struggles to overcome their nervousness during the process that leads to poor delivery (Dundes, 2001). For these reasons, debate across curricula must be used more often because there are positive benefits for students to build their self-confidence and become critical thinkers (Bellon, 2000).

Role-play

Role-play develops critical thinking because "students work together to resolve a potentially real situation" (Ertmer et al., 2010, p. 73). From role-play activities, students tend to accept other's views (Kienzler & Smith, 2003). Students may choose a role or be assigned a role (Devet, 2000). By playing a different role from their selves, students must change their reflections and contextual perspectives to consider those of another, of which they rarely experience (Ertmer et al., 2010). Students will recognize their learning potentials when verbalizing their insights using role-play (Kienzler & Smith, 2003). This simulation-based scenario activity can increase group participation and acceptance of others' ideas and opinions to solve problems (Ertmer et al., 2010). Role-play fosters students to actively participate with questioning and debriefing sessions (Devet, 2000). Consequently, role-play can broaden students' knowledge and improve their attitudes and skills (Kienzler & Smith, 2003).

Problem-based Learning (PBL)

Problem-based learning (PBL) is a student-centered approach that has been popularized by the medical field (Savery, 2006). PBL is a learning technique that "is well situated to helping students become active learners because it situates learning in real world problems and makes students responsible for their learning" (Hmelo-Silver, 2004, p. 236). Student-centered learning motivates students to think deeply, and teachers can facilitate these challenges (Azer, 2009). Barrows (1996) professed PBL can improve students' critical thinking and problem solving skills by creating a problem for students to explore solutions in small groups using teacher-facilitated learning. Hung (2009) stated that PBL is initiated when a problem is identified and students learn to be good investigators because PBL provides essential steps to solving problems.

Thus, hands-on learning activities are an important component in PBL (Beacham & Shambaugh, 2007). Conversely, PBL can only be a success if students already know how to "apply appropriate metacognitive and reasoning strategies" in their learning (Hmelo-Silver, 2004, p. 240). Successful implementation of PBL is possible in different contexts and curricula because PBL is a stand-alone process (Beacham & Shambaugh, 2007).

Questioning

To make questioning part of the culture of the teaching and learning process, teachers should start with asking students questions (Myrick & Yonge, 2002). Socratic questioning is an example of a critical thinking strategy that helps people to voice their inquiry (Innabi & El Sheikh, 2007). Questioning strategies encourage students to be active in classroom activities and to deepen their understanding (Weast, 1996). People ask questions when they face uncertainty. The level of questions people ask may indicate their capacity to evaluate their own learning (Myrick & Yonge, 2002). However, it is not easy to motivate people to ask questions because of the fear that it might be perceived as rude (Ikuenobe, 2001). Questioning gives students the opportunity to fill gaps in their learning. Questioning can happen when students receive new knowledge or seek clarifications (Ikuenobe, 2001) and allow students to gather in-depth and rich information (Myrick & Yonge, 2002). This strategy meets the criteria of what critical thinking should be in practice. Critical thinking involves inquiry processes and questioning characterizes critical thinking teaching strategies (Christenbury & Kelly, 1983).

Writing

Strong critical thinking and writing skills are a good combination to enhance students' ability to think critically (Green & Klug, 1990). Students who are critically literate and simultaneously able to express their thoughts in writing have the advantage of improving their reasoning skills (Hillocks, 2010). Through writing, critical thinking is expected to evolve empirical arguments and logical reasoning. An understanding of the components of critical thinking is important for demonstration of critical thinking through writing. Teachers should give proper ground rules and a rubric that guides critical thinking in writing (Green & Klug, 1990). Writing is suitable to be used across disciplines. Students' self-regulation and self-efficacy will also improve through writing (Hammann, 2005). Consequently, writing enhances learning by incorporating writing-to-learn (WTL) such as journal entries and reading responses, formal assignments (Gunnink & Bernhardt, 2002), persuasive writing (Hillocks, 2010), essay exams, and reports (Hammann, 2005).

Teachers may be concerned with the effort and time needed to assess critical thinking among a large number of student papers (Green & Klug, 1990). Students may have resistance to the use of writing skills when they do not believe that writing is important to understanding concepts (Hammann, 2005). Teachers must actively update the topics of the writing assignments to correspond with changes in career fields. Teachers play a role in supporting students' learning through writing by providing specific instructions, rubrics, questions, and explanations (Hillocks, 2010). Green and Klug (1990) suggested that students could collaborate on writing in small groups where they share ideas and suggestions and review their peers' work. In conclusion, writing offers many opportunities for students to become critical thinkers.

Teaching Critical Thinking within TVE Programs

The teaching and learning process can be exciting and engaging if teachers know how to deliver knowledge effectively and react positively to the situation (Hawley, 2007). Historically, critical thinking is assumed to be similar to higher-order thinking skills within the TVE system. However, perceptions are gradually changing because of an increased aware of the difference in the terms. Generally, TVE programs in the U.S. focus on market demands (Dennis & Hudson, 2007). In Malaysia, TVE programs are offered based on a joint effort among government, industries, and academia, which provides technical and vocational skills related to specific competencies (Haas, 1999). Commerce, hospitality, technology, design, and communication are clustered under TVE programs in Malaysia (Abd. Wahab et al., 2010). TVE programs are offered differently depending on an institution's aims and goals (Grosz, 1988).

Teaching critical thinking is not easy. For example, engineering disciplines integrate science and mathematics that involve problem solving and decision making (Pawley, 2009). Because engineering curricula requires a high level of content acquisition, engineering programs may have difficulty also embracing critical thinking (Huntzinger, Hutchins, Gierke, & Sutherland, 2007). Teaching strategies chosen for this purpose must emphasize important elements for engineering students to improve critical thinking, problem solving, and communication skills. Writing is an approach to consider because the nature of engineering tasks require students to report, communicate, and analyze engineering solutions to colleagues and society (Gunnink & Bernhardt, 2002). Practically, engineering students use numbers and apply formulas for engineering solutions. It does not mean they do not work with humans. Thus, collaborative learning is suited for engineering students to improve their teamwork abilities, public speaking, self-discipline, empathy, and responsibility (Göl & Nafalski, 2007). Collaborative learning may help engineering students resolve questions and identify steps to solve a problem systematically from a critical thinking perspective (Jacquez, Gude, Hanson, Auzenne, & Williamson, 2007). In the United States, prestigious university engineering programs, such as Stanford University, Purdue University, the University of Pittsburgh, Michigan Technological University, and Carnegie Mellon, incorporate problem-based learning to encourage critical thinking and self-directed learning through hands-on knowledge and skills (Huntzinger et al., 2007).

In addition to engineering, critical thinking is important to other academic disciplines. Critical thinking is vital for business students in decision-making, a key to management success (Smith, 2003). Problem-based learning, course content embedded learning (Braun, 2004), and writing (Smith, 2003) are all believed to enhance the critical thinking abilities of business students. Course-content embedded learning includes discussion, debate, and guided questioning (Braun, 2004). For example, in finance curricula, students can be encouraged to use critical thinking skills through writing and role-play strategies (Carrithers, Ling, & Bean, 2008).

Discussions and field trips are viable strategies used in hospitality and tourism programs, which integrate business and management components (Deale, O'Halloran, Jacques, & Garger, 2010). To impart knowledge content to Information Technology (IT) students, independent learning such as engaging in a workshop or hands-on experiences is suitable to work with data-handling software (Pratt, 1993). No matter in what programs teachers teach, all of these strategies can be used, providing they support students' critical thinking.

Summary

Thinking can be stimulated in many directions; either in positive or negative ways. Individuals need abilities of effective reasoning, analyzing, problem solving, and decision making in life and industry. Critical thinking has these elements. Within higher education, critical thinking is understood to be the most important skill for improved learning. Critical thinking is also needed for a variety of educational settings within TVE.

TVE curricula are designed to engage students with critical thinking and problem solving skills. Educational experts agree that critical thinking needs to be fostered, and scholars agree that it can be taught. However, thinking and learning to think critically are equally difficult. First, teachers must themselves be good critical thinkers. To better understand the concept of critical thinking, Bloom's taxonomy and metacognition are recommended topics to be explored. Teaching strategies such as: active learning, cooperative learning, debates, role-play, problem-based learning, questioning, and writing are recommended as ways to encourage students to become independent learners and problem solvers.

CHAPTER 3 : METHODOLOGY

This study examined the usage of critical thinking teaching strategies by polytechnic lecturers in Malaysia. This study used a quantitative approach. In this chapter, the methodology will be discussed providing a detailed description of the research design. It consists of the purpose of the study, research questions, research design, samples, instruments, tools, and analysis.

Purpose of the Research

The purpose of this study was to investigate the extent to which polytechnic lecturers in Malaysia incorporate critical thinking into their teaching strategies. Additionally, it explored the types of teaching strategies that are frequently used and looked at Malaysian polytechnic lecturers' perceptions of the effectiveness of critical thinking teaching strategies. External factors such as: highest level of education achieved, years of teaching experience, number of critical thinking workshops attended, and whether the instructor majored in engineering or non-engineering field were also considered for possible influences on lecturers' use and perceptions of critical thinking teaching strategies.

Design of Study

This study interpreted the data collected by quantitative, numerical expressions. In educational research, quantitative researchers view human behavior as regular and predictable (Johnson & Christensen, 2008). Quantitative research is initiated from previous research, existing theories and literature reviews, and involves a short duration to conduct a study (Creswell, 1994). In quantitative research, findings are obtained using a scientific method closely related to positivism and post-positivism as its typical philosophical paradigms (Gliner, Morgan, & Leech, 2009). Quantitative research tends to allow researchers to be independent in exploring their ideas on developing proper guidelines for their studies, and it seeks a reality that is objective, singular, and that can clarify existing theories (Creswell, 1994). Moreover, quantitative research applies deductive reasoning because it begins the idea of research with general concepts and moves to specific concepts (Keller & Keller, 2010).

A non-experimental design was employed in this study to explore the relationships and differences among frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies relative to the highest level of education, years of teaching experience, attendance at critical thinking workshops, and teaching major for the Malaysian polytechnic lecturers sampled. No control group was used. Open-ended questions were also included to obtain further information on additional strategies, expectations of students' learning, and critical thinking assessments.

In this study, a cross-sectional web-based survey using Qualtrics was administered to the participants. A survey is suggested for research with an attribute independent variable where no treatment is used to manipulate the variables in the research process (Gliner et al., 2009). A survey provides adequate data for numerical descriptions of participants' responses (Fowler, 2002). The quantitative data from the survey was analyzed to help answer the research questions with a descriptive, associational, and comparative nature, which are all basic approaches within non-experimental quantitative design (Gliner et al., 2009).

Population and Sample

The theoretical population for this study included lecturers from the polytechnic system in Malaysia. Twenty-seven public polytechnics in Malaysia were involved which offered 52 TVE programs at certificate, diploma, and advanced diploma levels (Abd. Wahab et al., 2010). The 27 polytechnics were located across 13 states and one federal territory in Malaysia. Shown in Figure 3, the participants were selected using stratified purposeful sampling from the theoretical population of polytechnic lecturers in Malaysia. As reported on August 15, 2011, the overall total of Malaysian polytechnic lecturers was 7,306 people (Department of Polytechnic Education, 2011). Polytechnic education in Malaysia is centralized by the Ministry of Higher Education.

The list of 5,952 lecturers from 27 Malaysian polytechnics was obtained from the Department of Polytechnic Education, Ministry of Higher Education, Malaysia in Microsoft Excel format. The list included full-time lecturers appointed by the Ministry of Higher Education who teach engineering and non-engineering programs and cross-disciplinary courses at the 27 polytechnics, polytechnic locations where the lecturers are assigned, and email addresses. The engineering programs comprised of civil, electrical, and mechanical disciplines; while non-engineering programs included three main clusters: information technology, design, and visual communication; commerce; and hospitality (Ministry of Higher Education, 2009). The lecturers who were in the cross-disciplinary group taught foundations and advanced levels of mathematics and computer science.

The population was stratified by the academic major in which the lecturers taught at the different polytechnics. Hence, for the purpose of a stratified purposeful sampling, a Malaysian polytechnic lecturer is defined as one who teaches engineering, non-engineering, or cross-disciplinary courses. The list from the Department of Polytechnic Education was sorted using color coding to segregate lecturers into three non-overlapping groups or stratas: engineering, non-engineering, and cross-disciplinary. Only lecturers from the group of engineering (3,625) and non-engineering lecturers (1,165) were selected as potential samples (4,790). Those who did not belong to either group, which was the cross-disciplinary lecturers (1,162), were excluded from this study because the study concentrated on lecturers who teach engineering and non-engineering courses.

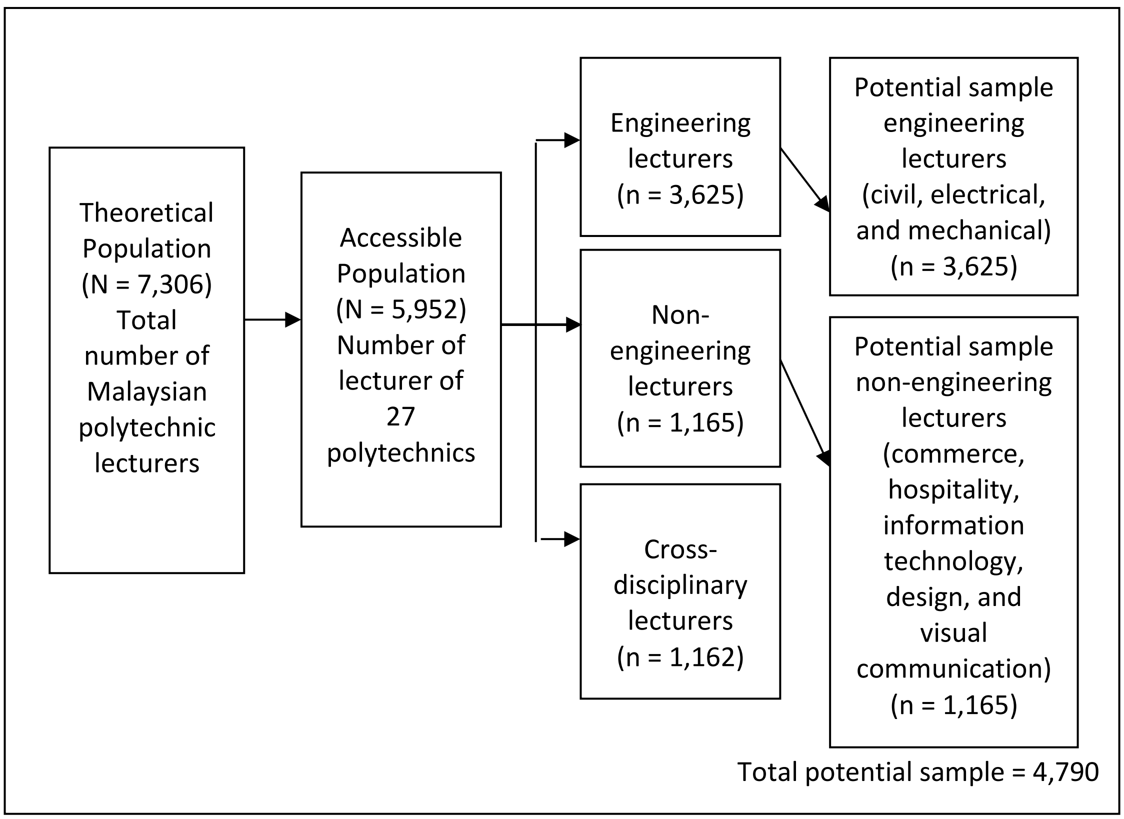

Figure 3. *Process of sampling of this study.*

Variables

Variables are important elements in a study and can be changed depending on conditions, situations, or characteristics of the participants (Gliner et al., 2009). In this study, independent variables and dependent variables were used. The independent and dependent variables are interchangeable and are determined by the research questions and data analysis. Three main variables included frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies. Also, years of teaching experience, highest level of education, critical thinking workshops attended, and teaching major were analyzed in this study.

Instrument

The survey instrument used for this study was taken from a previous study that looked at the perceptions of liberal arts faculty regarding critical thinking using the Delphi technique. Permission was gained from the original researcher (Barnhill, 2010) (see Appendix A). The survey was adapted and modified from 82 items to 58 items that were suitable to this study. The survey for this study comprised of three sections: (1) demographic data of participants, (2) critical thinking teaching strategies, and (3) open-ended questions (see Appendix B). The structure of the questionnaire was arranged in logical order to ensure people can easily respond to the research questions (Dillman, Smyth, & Christian, 2009).

The demographic data included gender, the highest level of education achieved, years of teaching experience, the number of critical thinking workshops attended, the length of industry experience, and teaching major. For section two, the original survey included 58 critical thinking teaching strategies with a five-point Likert-type scale of frequency of use: Never (1), Seldom (2), Sometimes (3), Frequently (4), and Almost Always (5). For this study, each of the critical thinking teaching strategies was assessed for the perceptions of effectiveness: Very Ineffective (1), Ineffective (2), Equally Ineffective and Effective (3), Effective (4), and Very Effective (5). Knowledge of critical thinking teaching strategy was given two levels: Insufficient (1) and Sufficient (2). Section three, composed of three open-ended questions, asked participants about additional strategies, expectations of students' learning, and critical thinking assessments.

Approval Procedure

Ethically, permission was required to conduct this study. The researcher requested permissions from the Institutional Review Board (IRB) of Colorado State University (see Appendix C); Department of Polytechnic Education, Ministry of Higher Education, Malaysia (see Appendix D); and the author of the original instrument. Voluntary informed consent was attached with the questionnaire to give a choice to the intended lecturers to participate in this study.

Pilot Testing

Before the instrument was administered to the participants, a pilot study was conducted to help the researcher to reduce any ambiguity for participants, as the survey was adapted from its original development in the United States for Malaysian polytechnic lecturers. Creswell (2008) stated, "A pilot test of a questionnaire or interview survey is a procedure in which a researcher makes changes in an instrument based on feedback from a small number of individuals who complete and evaluate the instrument" (p. 402). Prior to the pilot test, instrument translation was required because the participants of the planned study were Malay speakers. The Forward-back translation approach was used because "the original instrument can be adjusted in order to reduce language limitations as well as to make the original and the translated instrument as comparable as possible" (Chen, Holton, & Bates, 2005, p. 62). The survey was translated into Malay using a Qualtrics translation feature and the researcher (Malay fluent) checked and did needed corrections. The second phase of the English-Malay translation process was validated by Malaysian English teachers who were well versed in both English and Malay. During this process, the translators and researcher communicated regularly to ensure accuracy.

About forty cross-disciplinary lecturers were randomly selected for the pilot study to check the grammar and clarity of the questionnaire. Thirty participants are the minimum required to conduct a pilot study (Johanson & Brooks, 2009). The questionnaire was disseminated using Qualtrics. The duration of the pilot study was three weeks. The survey instrument's face validity was obtained from the feedback. Participants were also asked to check the appropriateness of the instruments' appearance using Qualtrics including color, font, font size, and layout.

Of the forty lecturers chosen, eleven completed the survey. The Cronbach's alphas were: .96 for frequency of use, .94 for perception of effectiveness, and .17 for knowledge of critical thinking teaching strategies. Participant feedback showed that the questionnaire took too long to complete and suggested reducing the number of teaching strategies in the survey. The process of reducing the original 82 strategies to 58 strategies was completed after a series of discussions with two critical thinking experts from American education. The survey appearance was appropriate with some small clarifications.

Validity and Reliability

The report from the original survey indicated that the process of Delphi techniques provided consensus of experts in the field. Delphi technique is basically used to determine content validation, based on opinions and reviews of a panel of experts (Sinha, Smyth, & Williamson, 2011). Thus, the original author evaluated the content validity of the survey. In addition, for this study, two experts in the critical thinking field within American education were selected to verify the content validity as well. Also, two experts in critical thinking within the Malaysian education system were chosen to test the content validity and translated the instrument into Malay before the actual survey was disseminated to Malaysian polytechnic lecturers.

Cronbach's alpha coefficient was used to measure the reliability of the instrument in this study. According to Gliem and Gliem (2003), Cronbach's alpha is a "measure of internal consistency reliability" for Likert-type scales (p. 83). The critical thinking teaching strategies section was composed of 58 teaching strategies. To identify related critical thinking strategies, factor analysis was performed. Factor analysis is used to determine the number of factors or theoretical constructs of an instrument (Gliner et al., 2009). As theory supported the development of original instruments, the researcher chose exploratory factor analysis (EFA) to validate the questionnaire.

Data Collection

The instrument was administered during the spring of 2012 after IRB approval was obtained from Colorado State University. Prior to the survey distribution, a pre-notification using email was delivered to participants to provide an introduction and some background for the study (see Appendix E). Qualtrics, an electronic delivery system, allowed participants to respond to the instrument. Later, the email survey with the consent letter was sent to invite participation (see Appendix F). The consent letter was combined with the instrument. Once the participants agreed to participate, they were welcome to answer the questionnaire. The data collection process took six weeks with one reminder sent by the researcher (see Appendix G). Thank you notes were sent after week 6 (see Appendix H). The survey included appeals to people to help in answering the items, providing an estimation of the time required, an explanation of confidentiality, showing positive regard, and offering verbal appreciation to increase motivation to respond to the questionnaire (Dillman et al., 2009). Once all feedback was received from the participants, the participants' surveys were coded into engineering and non-engineering lecturers for the data analysis.

Data Analysis Plan

Quantitative data were analyzed after the data collection was completed. The data management was conducted simultaneously with data collection. The data analysis started by importing the data file from Qualtrics into the Statistical Package for the Social Sciences (SPSS). To measure internal consistency of the questionnaire items, Cronbach's Alphas were used to measure the reliability of the instrument. It is recommended to have a minimum Cronbach alpha value of 0.70 to "provide good support for internal consistency reliability" (Morgan, Leech, Gloeckner, & Barrett, 2007, p. 129).

This study had three different types of research questions: descriptive, associational, and difference. Each research question of this study represents a different statistical analysis. Table 1 displays research question analyses for this study. First, frequencies, means, standard deviations, and rankings were used to analyze descriptive questions, which refer to research questions one and two (frequency of use and perception of effectiveness). Next, research questions three and four are associational questions analyzed using Pearson correlation coefficients, while research question five represents a difference question and was analyzed using ANOVA and independent sample t-tests. The difference question compares groups and "attempts to demonstrate that groups are not the same in the dependent variable" (Morgan et al., 2007, p. 5).

In addition, three open-ended questions were included in the questionnaire. For each open-ended question, coding was used to identify themes for the data analysis using thematic content analysis. There are three approaches to thematic content analysis: conventional, directed, and summative, which basically is used to emphasize descriptions of the responses (Hsieh & Shannon, 2005). The summative approach is suitable for this study. In the summative approach, word count is used to develop codes and themes based on descriptions and interpretations of participants' feedback (Hsieh & Shannon, 2005). Teaching major was chosen as an attribute to analyze open-ended questions.

Table 1

Data Analysis Plan

Research Questions	Types	Variables	Statistical Tools
1. What teaching strategies do Malaysian polytechnic lecturers use most frequently to encourage students to think critically?	Descriptive	Frequency of use (Interval/Scale)	Frequency Mean Standard Deviation Ranking-order
2. Which teaching strategies do Malaysian polytechnic lecturers perceive as effective in their teaching?	Descriptive	Perception of effectiveness (Interval/Scale)	Frequency Mean Standard Deviation Ranking-order
3. Is there an association between frequency of use and perception of effectiveness of teaching strategies by Malaysian polytechnic lecturers?	Associational	Frequency of use (Interval/Scale), Perception of effectiveness (Interval/Scale)	Pearson's Correlation Coefficient
4. Is there an association between frequency of use of teaching strategies and years of teaching experience of Malaysian polytechnic lecturers?	Associational	Frequency of use (Interval/Scale), Years of teaching experience (Interval/Scale)	Pearson's Correlation Coefficient
5. Is there an association between perception of effectiveness of teaching strategies and the highest level of education completed by of Malaysian polytechnic lecturers?	Associational	Perception of effectiveness (Interval/Scale), Highest level of education (Interval/Scale)	Pearson's Correlation Coefficient

6. Are there any differences for frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies by the number of critical thinking workshops attended by Malaysian polytechnic lecturers?	Difference	Critical thinking workshop attended (Interval/Scale), frequency of use (Interval/Scale), perception of effectiveness (Interval/Scale), and knowledge of critical thinking teaching strategies (Dichotomous)	Mean Standard Deviation One-way ANOVA
7. Are there differences for frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies by Malaysian polytechnic lecturers from engineering and non-engineering disciplines?	Difference	Teaching major-engineering and non-engineering (2 groups), frequency of use (Interval/Scale), perception of effectiveness (Interval/Scale), knowledge of critical thinking teaching strategies (Dichotomous)	Mean Standard Deviation Independent Samples t- Test
7a. Are there differences between Malaysian polytechnic lecturers within subcategories of engineering and non-engineering disciplines in regard to the frequency of use of teaching strategies?	Difference	Teaching within engineering and within non-engineering (More than 2 groups) and frequency of use (Interval/Scale),	Mean Standard Deviation One-way ANOVA

Summary

The purpose of this study is to assess the use of strategies by Malaysian polytechnic lecturers with respect to critical thinking. An existing instrument from Barnhill (2010), who studied teaching strategies for critical thinking, was used with some modifications to accommodate Malaysian participants. An online survey was employed to disseminate questionnaires to participants from 27 polytechnics in Malaysia. Data were analyzed using the appropriate statistical analysis for each research question developed for this study. It is hoped that the findings will assist to fill in some of the gaps to the lacking literature for this topic, specifically for Malaysian research studies in regards to critical thinking in TVE programs.

CHAPTER 4 : FINDINGS

This chapter provides the data analysis and findings. The purpose of this study is to explore types of teaching strategies Malaysian polytechnic lecturers incorporate to promote and improve students' critical thinking. This study used a non-experimental design using a web-based survey. This chapter is organized according to seven research questions and three open-ended questions of this study.

Data Collection and Response Rate

The web-based survey, Qualtrics, was used to distribute the survey and collect data from the intended participants. While Internet penetration rates are low in Malaysia, 61.7 percent as of December 31, 2011, the Internet was determined to be the most feasible means of contacting instructors for this study (Asia Marketing Research, Internet Usage, Population Statistics, & Facebook Information, 2012). The original list of participants' emails contained 4,790 entries, but 45 were duplicate emails. Participants were initially contacted by a pre-notification letter. About 216 (4.55%) emails were bounced back as undeliverable, with the total number of potential responses now at 4,529. The web-based survey with informed consent letter was sent on April 4, 2012 to 4,529 polytechnic lecturers in Malaysia. Five weeks after the release of the survey, one reminder letter was emailed to the participants who had not yet completed the survey. Later, a thank you letter was sent to convey the researcher's appreciation to participants who completed the survey after week six. The survey included seven items on demographics, 58 critical thinking teaching strategies with responses for each of (a) frequency of use, (b) perception of effectiveness, and (c) knowledge of critical thinking teaching strategies, together with three open-ended questions asking for additional teaching strategies, learning outcomes, and assessments in regard to critical thinking. At the end of the data collection process, variations were found in the responses by sections of the questionnaire. Prior to the statistical analysis, the data were screened. Exploratory Data Analysis (EDA) was performed to investigate the data obtained from respondents by checking occurrence problems such as missing values, outliers, and errors which could affect the statistical results.

Of the 4,529 lecturers in the sampling frame, 783 (17.29 %) clicked on the link of the web-based Critical Thinking Teaching Strategies survey, 668 (14.75%) completed the demographic section, 398 (8.79%) completed the frequency of use of the teaching strategies, 374 (8.26%) completed the perception of effectiveness of teaching strategies, 367 (8.10%) completed the knowledge of critical thinking teaching strategies, and 358 (7.90%) completed both demographics and the three teaching strategy sections. This 7.9 percent is within the acceptable response rates of email surveys, which is from five to twenty percent (Dillman et al., 2009). For the analysis, 358 responses were considered fully complete and were used in the analysis. Table 2 shows the numbers of responses and response rates referred by sections of the survey.

Table 2

Respondents and Response Rates Based on Total Number in Sampling Frame (N = 4,529)

Respondents who…	Number of Respondents	Response Rate: % surveys completed (4,529)
Clicked on web-based survey link	783	17.29
Completed		
--demographics section	668	14.75
--frequency of use	398	8.79
--perception of effectiveness	374	8.26
--knowledge of critical thinking teaching strategy	367	8.10
--demographics and teaching strategy sections	358	7.90

Sample Characteristics

This section discusses sample characteristics. A total of 668 Malaysian polytechnic lecturers were involved in completing the demographic section of the study. However, only 358 of those thoroughly answered both the demographics and teaching strategy sections, these respondents were used for the statistical analysis. Accordingly, the demographic characteristics of the group of 668 who answered the demographic questions and the group of 358 who answered both sections were comparable, indicating similarities between partial responses and complete responses.

The information presented in this section is intended to facilitate interpretation of the key demographics, which includes the variables of: (a) gender; (b) level of education; (c) years of teaching experience; (d) number of critical thinking workshops attended; (e) industry experience; (f) teaching major: engineering or non-engineering; (g) engineering which includes civil engineering, mechanical engineering, electrical engineering, or others (not on list provided); (h) non-engineering which includes information technology, design, and communication; commerce; hospitality; or others (not on list provided).

Gender

Overall, female participants outnumbered males. Table 3 reveals that most of the 668 responses were from females, 371 (55.50%), compared to 297 (44.50%) from males. Where 185 (51.70%) of the 358 respondents were females and 173 (48.30%) were males.

Table 3

Gender: Frequencies and Percentages (based on 668 and 358 responses)

Gender	668 responses		358 responses	
	number	%	number	%
Male	297	44.50	173	48.30
Female	371	55.50	185	51.70
Total	668	100.00	358	100.00

Level of Education

Table 4 illustrates frequencies and percentages for level of education, split into the two groups of demographics only and demographics and methods sections respondents. Of the demographics-only group, the majority (50%) of respondents hold master’s degrees, 45.70 percent had bachelor’s degrees, 3.70 percent have earned diplomas, and four (0.60%) have completed doctoral degrees. Among the group who responded to both sections, 188 (52.50%) obtained master’s degrees, 155 (43.30%) hold bachelor’s degrees, 13 (3.60%) had diplomas, and two (0.60%) were doctoral holders.

Table 4

Level of Education: Frequencies and Percentages (based on 668 and 358 responses)

Level of education	Demographics Only		Both Sections	
	number	%	number	%
Diploma	25	3.70	13	3.60
Bachelor	305	45.70	155	43.30
Master	334	50.00	188	52.50
Doctoral	4	0.60	2	0.60
Total	668	100.00	358	100.00

Years of Teaching Experience

Most of the participants (33.80%) in the demographics-only group have between six and ten years of teaching experience. Meanwhile, 7.20 percent of these respondents have worked for more than twenty years at Malaysian polytechnics. Among the group who answered both sections, the highest percentage (35.50%) of participants had between six and ten years of teaching experience, five percent of this group had taught over twenty years. Table 5 shows frequencies and percentages for years of teaching experience based on these two groups.

Table 5

Years of Teaching Experience: Frequencies and Percentages (based on 668 and 358 responses)

Teaching Experience (years)	Demographics Only		Both Sections	
	number	%	number	%
1-5	223	33.40	114	31.80
6-10	226	33.80	127	35.50
11-15	151	22.60	90	25.10
16-20	20	3.00	9	2.50
More than 20	48	7.20	18	5.00
Total	668	100.00	358	100.00

Critical Thinking Workshops Attended

Participants were asked to identify the number of critical thinking workshops attended. Table 6 shows the results. Of the demographics-only group, more than one-third of respondents (38.90%) had not attend any critical thinking workshops, 215 (32.20%) attended one critical thinking workshop, 113 (16.90%) attended two critical thinking workshops, 34 (5.10%) attended three critical thinking workshops, and 46 (6.90%) attended four or more critical thinking workshops. Among lecturers who responded to both sections, the data revealed that 124 (34.60%) of the respondents have attended no critical thinking workshop, 125 (34.90%) attended one, 60 (16.80%) attended two, 21 (5.90%) attended three, and 28 (7.80%) attended four or more critical thinking workshops.

Table 6

Critical Thinking Workshops Attended: Frequencies and Percentages (based on 668 and 358 responses)

Critical Thinking Workshops Attended	Demographics Only		Both Sections	
	number	%	number	%
None	260	38.90	124	34.60
1	215	32.20	125	34.90
2	113	16.90	60	16.80
3	34	5.10	21	5.90
4	46	6.90	28	7.80
Total	668	100.00	358	100.00

Industry Experience

Participants were asked about their years of industry experience. Table 7 indicates frequencies and percentages for industry experience based on both groups' responses. With regards to the demographics-only group responses, 172 of respondents reported they had not work or trained (25.70%) in any industry sectors. The most frequent years of experience were one to five years (36.40%) or less than one year of experience (32.30%). Similarly, in the both sections group responses the most frequent years of experience was 1 to 5 years (38.30%).

Table 7

Industry Experience: Frequencies and Percentages (based on 668 and 358 responses)

Industry Experience	Demographics Only		Both Sections	
	number	%	number	%
None	172	25.70	80	22.30
Less than 1 year	216	32.30	117	32.70
1-5 years	243	36.40	137	38.30
6-10 years	19	2.80	12	3.40
More than 10 years	18	2.70	12	3.40
Total	668	100.00	358	100.00

Teaching Major

Participants were asked to identify their teaching major and major disciplines. Among the demographics-only group, the majority of respondents (65.10%) were lecturers who teach engineering, compared to 34.90 percent from non-engineering. Within the engineering field: 181 (27.10%) were electrical engineering, 144 (21.60%) were mechanical engineering, 74 (11.10%) were civil engineering, and 36 (5.40%) were of another engineering discipline. Among the non-engineering group, 113 (16.90%) were from commerce, 80 (12.10%) teach information technology, design and visual communication, while 27 (4.00%) are in hospitality, and 13 (1.90%) represent other. See Table 8.

Table 8

Teaching Major and Disciplines: Frequencies and Percentages (based on 668 and 358 responses)

Teaching Major	Demographics Only		Both Sections	
	number	%	number	%
Engineering				
Electrical	181	27.10	87	24.30
Mechanical	144	21.60	82	22.90
Civil	74	11.10	41	11.50
Other	36	5.40	22	6.10
Total	435	65.10	232	64.80
Non-engineering				
Commerce	113	16.90	67	18.70
Information Technology, Design & Visual Communication	80	12.10	40	11.20
Hospitality	27	4.00	17	4.70
Other	13	1.90	2	0.60
Total	233	34.90	126	35.20

Among the both-sections group, a majority of the responses, 232 (64.80%) out of the group of 358, represent engineering lecturers compared to 126 (35.20%) non-engineering lecturers. Within the engineering discipline, most taught electrical engineering, 87 (24.30%), or mechanical engineering, 82 (22.90%). Among the non-engineering group, the two most commonly self-identified fields were commerce, 67 respondents (18.70%), or information technology, design and visual communication, which had 40 respondents (11.20%).

Descriptive of Three Main Variables

The following analysis is based on the 358 respondents who completed both demographics and critical thinking teaching strategies sections. The critical thinking teaching strategies section consisted of 58 strategies for introducing or improving students' critical thinking. For each strategy, respondents were asked about their experiences attempting to incorporate critical thinking into their teaching by: frequency of use, perception of effectiveness, and their knowledge of critical thinking teaching strategies. The subsequent phase of data analyses attempts to answer the main research questions utilizing the quantitative data and the three-open ended questions of this study. In short, frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies were the essential variables to explore critical thinking teaching strategies among Malaysian polytechnic lecturers.

Teaching Strategies: Use

Research Question 1: What teaching strategies do Malaysian polytechnic lecturers use most frequently to encourage students to think critically?

Participants were asked to rate how often they used each strategy on a five point Likert-type scale: Never (1), Seldom (2), Sometimes (3), Frequently (4), and Almost Always (5). Based on means, the analysis indicated the most frequently used critical thinking teaching strategy was ‘asks open-ended question’ (item 2), $M = 3.88$, $SD = 0.759$. The second highest mean was ‘uses questions that ask students to apply what they have learned previously to new situations’ (item 7), $M = 3.82$, $SD = 0.795$. The third was ‘uses small group discussions with specific tasks assigned’ (item 8), $M = 3.79$, $SD = 0.858$. Table 9 represents the frequency of use means of critical thinking teaching strategies. When two strategies had the same mean, the strategy with the smallest standard deviation was ranked higher.

Table 9

Ten Critical Thinking Teaching Strategies Ranking Highest by Frequency of Use Means (n = 358)

Item	Critical Thinking Teaching Strategies	Rank	*M*	*SD*
2	Asks open-ended questions.	1	3.88	0.759
7	Uses questions that ask students to apply what they have learned previously to new situations.	2	3.82	0.795
8	Uses small group discussions with specific tasks assigned.	3	3.79	0.858
4	Uses questions that ask students to analyze materials by making comparisons, identifying similarities and differences, and summarizing conclusions.	4	3.69	0.764
9	Uses writing assignment prompts for students to engage in textual analysis of literature.	5	3.69	0.890
58	Works in groups to solve problems that have multiple solutions.	6	3.66	0.973
3	Asks questions that provide opportunities for students to respond with critical thinking skills to assess a problem.	7	3.64	0.771
1	Asks questions and challenges students to consider all views. (Socratic Method)	8	3.63	0.780
5	Uses questions that ask students to reflect on their decision-making processes during the development of a project.	9	3.63	0.843
16	Creates an environment in which students may ask questions that exceed my immediate familiarity.	10	3.60	0.943

The critical thinking teaching strategy item that received the lowest mean score (58^{th} rank) for frequency of use was ‘uses structured controversy or debate’ (item 28), *M* = 2.77, *SD* = 1.082. The second lowest (57^{th}) was ‘identifies strengths and weaknesses of an author's thesis and argument(s)’ (item 39), *M* = 2.80, *SD* = 1.137. The third lowest was ‘asks students to form and test hypotheses about observed phenomena’ (item 50), *M* = 2.81, *SD* = 1.124. Table 10 represents the ten lowest mean scores ranked from 58^{th} to 49^{th} for frequency of use of critical thinking teaching strategies.

Table 10

Ten Critical Thinking Teaching Strategies Ranking Lowest by Frequency of Use Means (n = 358)

Item	Critical Thinking Teaching Strategies	Rank	*M*	*SD*
28	Uses structured controversy or debate.	58	2.77	1.082
39	Identifies strengths and weaknesses of an author's thesis and argument(s).	57	2.80	1.137
50	Asks students to form and test hypotheses about observed phenomena.	56	2.81	1.124
26	Uses research-based readings that are not "dumbed down" but rather present complex ideas in a coherent way.	55	2.85	1.047
44	Analyzes statistics (display average, correlation).	54	2.87	1.066
51	Asks students if insight from other disciplines can be incorporated in an analysis.	53	2.93	1.121
42	Uses close readings, i.e., develop students' thinking about reading.	52	2.96	1.036
45	Focuses on getting students to recognize an arguments' underlying logical structure rather than accepting it based on "authority" or other cues.	51	2.96	1.085
41	Creates a continuum of perspectives on an issue, with students asked to place their own views along the continuum and to articulate why they have chosen their stance and not that of another.	50	2.97	1.060
46	Models appropriate use of the concepts and language of probability.	49	2.98	1.042

Teaching Strategies: Perceptions

Research Question 2: Which teaching strategies do Malaysian polytechnic lecturers perceive as effective in their teaching?

Participants were asked to indicate how effective they perceived each critical thinking teaching strategy to be in their teaching using a five point Likert-type scale: Very Ineffective (1), Ineffective (2), Equally Ineffective and Effective (3), Effective (4), and Very Effective (5). Based on means, the analysis indicated that the most effective critical thinking teaching strategy the participants perceived was ‘uses small group discussions with specific tasks assigned' (item 8), *M* = 3.77, *SD* = 0.715. The second highest was 'uses questions that ask students to apply what they have learned previously to new situations' (item 7), *M* = 3.69, *SD* = 0.735. The third was 'works in groups to solve problems that have multiple solutions' (item 58), *M* = 3.63, *SD* = 0.815. Table 11 represents the highest mean scores for perception of effectiveness of critical thinking teaching strategies ranked from one to ten.

Table 11

Ten Critical Thinking Teaching Strategies Ranking Highest by Perception of Effectiveness Means (n = 358)

Item	Critical Thinking Teaching Strategies	Rank	*M*	*SD*
8	Uses small group discussions with specific tasks assigned.	1	3.77	0.715
7	Uses questions that ask students to apply what they have learned previously to new situations.	2	3.69	0.735
58	Works in groups to solve problems that have multiple solutions.	3	3.63	0.815
57	Uses student workshops on projects, i.e., students work together to provide feedback and suggestions for major projects.	4	3.56	0.810
2	Asks open-ended questions.	5	3.56	0.711
56	Uses cooperative learning-sharing in groups and working together to accomplish a goal.	6	3.55	0.851
4	Uses questions that ask students to analyze materials by making comparisons, identifying similarities and differences, and summarizing conclusions.	7	3.53	0.791
25	Uses in-class, announced quizzes on terms, vocabulary, and logic (examples for identification; underlining parts of claims or statements for them to identify as aspects of logic; and having them solve analogy or numerical problems).	8	3.53	0.736
6	Uses in-class, creative projects involving a variety of materials.	9	3.52	0.740
16	Creates an environment in which students may ask questions that exceed my immediate familiarity.	10	3.52	0.805

On the other side of the spectrum, the critical thinking teaching strategy item that received the lowest mean score for perception of effectiveness was ‘uses research-based readings that are not "dumbed down" but rather present complex ideas in a coherent way’ (item 26), *M* = 3.15, *SD* = 0. 822. The second lowest was ‘analyzes statistics (display average, correlation)’ (item 44), *M* = 3.15, *SD* = 0.817. The third lowest was ‘identifies strengths and weaknesses of an author's thesis and argument(s)’ (item 39), *M* = 3.17, *SD* = 0.876. Table 12 shows the lowest mean scores for perception of effectiveness of critical thinking teaching strategies ranked from 58th to 49th.

Table 12

Ten Critical Thinking Teaching Strategies Ranking Lowest by Perception of Effectiveness Means (n = 358)

Item	Critical Thinking Teaching Strategies	Rank	*M*	*SD*
26	Uses research-based readings that are not "dumbed down" but rather present complex ideas in a coherent way.	58	3.15	0.822
44	Analyzes statistics (display average, correlation).	57	3.15	0.817
39	Identifies strengths and weaknesses of an author's thesis and argument(s).	56	3.17	0.876
28	Uses structured controversy or debate.	55	3.17	0.858
50	Asks students to form and test hypotheses about observed phenomena.	54	3.18	0.829
51	Asks students if insight from other disciplines can be incorporated in an analysis.	53	3.18	.830
45	Focuses on getting students to recognize an arguments' underlying logical structure rather than accepting it based on "authority" or other cues.	52	3.20	0.817
46	Models appropriate use of the concepts and language of probability.	51	3.21	0.828
23	Uses peer reviews of writing.	50	3.23	0.799
40	Asks students to post thoughts that arise as they are reading assigned material, showing evidence or critical thought.	49	3.24	0.842

Validity Measurement

It is essential to examine validity of the construct to enhance the quality of an instrument (Clark & Watson, 1995). For this study, the construct validity of the original questionnaire is unknown. Thus, a multi-step process called exploratory factor analysis (EFA) was used to examine the constructs of the questionnaire and validate the constructs.

Exploratory Factor Analysis

For this study, exploratory factor analysis (EFA) was used to discover the numbers of factors, or constructs, from 58 teaching strategies. The results of the EFA were used to analyze the remaining research questions of this study. The analysis is appropriate for this study because the sample size is 358, which is considered a good size to be tested using EFA. A "rule of thumb" for the adequacy of sample sizes to run EFA is: 50 (very poor), 100 (poor), 200 (fair), 300 (good), 500 (very good), and 1,000 (excellent) (Comrey, 1973).

In this study, frequency of use was selected for the EFA because most of the research questions related to this variable. First, a principal component analysis was incorporated to assume all items are uncorrelated. Thus, a correlation matrix was analyzed. Second, principal axis factoring was used to compute how many items grouped to factor loadings selected by SPSS. The total variance explained by each factor, which is an eigenvalue, was set greater than one and Direct Oblim was selected for rotation. From this result, correlations were obtained between each item of the questionnaire. The Kaiser-Meyer Olkin (KMO) measure of sampling adequacy was 0.954. The minimal KMO to indicate items are predicted by a factor is 0.50, and if it measures greater than 0.70, the variables are highly correlated (Morgan, Leech, Gloeckner, & Barrett, 2013). The Bartlett's test of sphericity was also significant ($\chi^2(378) = 7{,}507.11$, $p < .005$).

After several steps of reducing items on factors selected, Parallel Analysis using Brian O'Connor SPSS Syntax was used to determine the numbers of factors retained. The results revealed the critical thinking teaching strategies had four factors with 25 items. The themes of these four factors describe essential concepts of the uses of these strategies that incorporate critical thinking into teaching practices. Factor 1 represents 'evaluates in practice,' ten items. Factor 2 has three items related to 'team skills'. The items loaded into factor 3 were called 'reflectively engages', five items. Factor 4 items clustered as 'challenges and questions', seven items. The labels of the four factors were inspired by the essential concepts of incorporating critical thinking into teaching (Timpson & Doe, 2008). Table 13 shows the results of the factor loadings for the 25 teaching strategies.

Table 13

Factor Loadings for Direct Oblimin Non-Orthogonal Four-Factor Solutions for the 25 Teaching Strategies (n = 358)

Item	Factor loading
Factor 1 (10 items): Evaluates in Practice	
Identifies strengths and weaknesses of an author's thesis and argument(s). (item 39)	.792
Asks students to post thoughts that arise as they are reading assigned material, showing evidence or critical thought. (item 40)	.657
Creates a continuum of perspectives on an issue, with students asked to place their own views along the continuum and to articulate why they have chosen their stance and not that of another. (item 41)	.650
Uses close readings, i.e., develop students' thinking about reading (item 42)	.715
Analyzes statistics (display average, correlation). (item 44)	.713

Focuses in getting students to recognize an arguments' underlying logical Structure rather than accepting it based on "authority" or other cues. (item 45)	.642
Models appropriate use of the concepts and language of probability. (item 46)	.680
Asks students to evaluate the different sources from which they draw information, e.g., on-line peer-reviewed journals vs Wikipedia vs. a website advocating for a particular point of view. (item 49)	.627
Asks students to form and test hypotheses about observed phenomena. (item 50)	.719
Asks students if insight from other disciplines can be incorporated in an analysis. (item 51)	.505
Factor 2 (3 items): Team Skills	
Uses cooperative learning-sharing in groups and working together to accomplish a goal. (item 56)	.806
Uses workshop students on projects, i.e., students work together to provide feedback and suggestions for major projects. (item 57)	.835
Works in groups to solve problems that have multiple solutions. (item 58)	.835
Factor 3 (5 items): Reflectively Engages	
Uses writing assignments with specific tasks or goals focusing on a particular kind of thinking or reflection. (item 31)	.602
Requires students to justify their positions with examples and evidence, both in verbal and written analysis. (item 32)	.646
Asks students to identify the strengths and weaknesses of their own arguments. (item 33)	.784
Asks students to evaluate evidence from multiple perspectives. (item 34)	.678
Engages students with controversial topics. (item 35)	.511
Factor 4 (7 items): Challenges and Questions	
Uses questions for students to analyze ethical choices in small group discussions and in written summaries. (item 12)	.544
Uses questions that ask students to describe orally or in written form data that are shown to them, e.g., interpretations of graphs and tables. (item 13)	.745
Uses questions for students to define the perspective that is revealed in a text and evaluate the impact of that perspective on the way the text is written. (item 14)	.700
Invites students to abstract from their observations, to think about the Implication of their ideas, and to generate these ideas across a range of specific contexts. (item 15)	.585
Analyzes primary source texts. (item 17)	.684
Uses an assessment/critical examination of scientific literature (item 19).	.535
Teaches quantitative skills. (item 20)	.636

The four factors extracted explain 61.17 percent of the variance. Table 14 shows the eigenvalues, percentage of variance, and cumulative percentage for the four factors.

Table 14

Eigenvalues, Percentage of Variance, and Cumulative Percentage for Four Factors of the 25-Item Critical Thinking Teaching Strategies Questionnaire (n = 358)

	Factor	Eigenvalue	% of variance	Cumulative %
1	Evaluates in Practice	13.510	48.25	48.25
2	Team Skills	1.508	5.39	53.64
3	Reflectively Engages	1.061	3.79	57.43
4	Challenges and Questions	1.047	3.73	61.17

Reliability

The internal consistency reliability among items in the questionnaire from this study is measured by Cronbach’s alpha. Cronbach’s alphas are reported before (58 items) and after (25 items), EFA was conducted. The Cronbach’s alpha for 58 items of frequency of use was 0.98 for perception of effectiveness ($\alpha = 0.98$), and knowledge of critical thinking teaching strategies ($\alpha = 0.99$).

The Cronbach’s alpha for the 25 items of frequency of use was found to be highly reliable ($\alpha = 0.96$), with ‘evaluates in practice’ (factor 1), ten items ($\alpha = 0.94$); ‘team skills’ (factor 2), three items ($\alpha = 0.91$); reflectively engages (factor 3), five items ($\alpha = 0.91$); and challenges and questions (factor 4), seven items ($\alpha = 0.88$). Cronbach’s alphas for the 25 items for both perceptions of effectiveness and knowledge of critical thinking teaching strategies were similar ($\alpha = 0.98$). According to Tavakol and Dennick (2011), Cronbach’s alphas may be high due to the numbers of participants and the number of items. The findings of this study indicated good values of internal consistency.

Teaching Strategies: Use and Perceptions

Research Question 3: Is there an association between frequency of use and perception of effectiveness of teaching strategies by Malaysian polytechnic lecturers?

Correlations were computed to assess if there is a significant relationship between frequency of use and perception of effectiveness of critical thinking strategies among Malaysian polytechnic lecturers. Frequency of use and perception of effectiveness were presented by the four factors previously described. The sums of means for both variables were measured for this analysis and both were normally distributed. Table 15 shows that these four factors were each significantly correlated. The four correlations are each significant at the 0.01 level (2-tailed). The guidelines for correlation coefficients are: 0 - .20 equals a negligible correlation, .20 - .40 equals a low correlation, .40 - .60 equals a moderate correlation, .60 - .80 equals a considerable correlation, and .80 - 1.00 equals a high correlation (Horowitz, 1981). The effect size of ‘team skills’ (factor 2) between frequency of use and perception of effectiveness of critical thinking teaching strategies was $r(358) = .71$, $p < .001$. Factors including ‘evaluates in practice’ ($r = .56$); ‘reflectively engages’ ($r = .57$); and ‘challenges and questions’ ($r = .48$) were determined to have moderate correlations according to Horowitz (1981). Direct positive relationship was found between frequency of use and perception of effectiveness for each of the four factors.

Table 15

Means, Standard Deviations, and Intercorrelations between Frequency of Use and Perception of Effectiveness of Critical Thinking Teaching Strategies

	Factor	*M*	*SD*	Perception of Effectiveness			
				1	2	3	4
Frequency of Use	1.Evaluates in Practice	2.94	0.86	.56**	-	-	-
	2.Teams Skills	3.51	0.94	-	.71**	-	-
	3.Reflectively Engages	3.32	0.84	-	-	.57**	-
	4.Challenges and Questions	3.27	0.71	-	-	-	.48**

Teaching Strategies: Use and Years of Teaching

Research Question 4: Is there an association between frequency of use of teaching strategies and years of teaching experience of Malaysian polytechnic lecturers?

Correlations were used to measure if there were significant relationships between frequency of use of critical thinking teaching strategies and years of teaching experience among lecturers. Teaching experience was negatively correlated with frequency of use of 'evaluates in practice' factor, $r(358) = -.15$, $p = .005$; and with frequency of use of the 'challenges and questions' factor, $r(358) = -.11$, $p = .035$. This means that lecturers with more teaching experience may use these strategies less than lecturers with fewer years teaching. See Table 16.

Table 16

Means, Standard Deviations, and Intercorrelations between Frequency of Use and Years of Teaching Experience

	Factor	*M*	*SD*	Years of Teaching Experience			
				1	2	3	4
Frequency of Use	1.Evaluates in Practice	2.79	0.80	-.15**	-	-	-
	2.Teams Skills	3.51	0.94	-	-.02	-	-
	3.Reflectively Engages	3.32	0.84	-	-	-.10	-
	4.Challenges and Questions	3.27	0.71	-	-	-	-.11*

*p < .05 **p < .01

Teaching Strategies: Perceptions and Level of Education

Research Question 5: Is there an association between perception of effectiveness of teaching strategies and the highest level of education completed by Malaysian polytechnic lecturers?

Of the 358 lecturers, their levels of education ranged from a diploma to PhD degrees. To indicate if there was an association between perceptions of effectiveness of critical thinking teaching strategies and highest level of education of lecturers, Pearson correlations were computed to examine the intercorrelations of the variables, where the assumption of linearity was not markedly violated. The results on Table 17 reveal there was no relationship between the two variables.

Table 17

Means, Standard Deviations, and Intercorrelations between Perception of Effectiveness and Highest Level of Education

	Factor	*M*	*SD*	Highest Level of Education			
				1	2	3	4
Perception of Effectiveness	1.Evaluates in Practice	3.22	0.65	.04	-	-	-
	2.Teams Skills	3.58	0.78	-	-.03	-	-
	3.Reflectively Engages	3.37	0.70	-	-	-.02	-
	2.Challenges and Questions	3.35	0.60	-	-	-	.06

Workshops Attended: Use, Perceptions, and Knowledge

Research Question 6: Are there any differences for frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies by the number of critical thinking workshops attended by Malaysian polytechnic lecturers?

This question was analyzed by the three variables: use, perceptions, and knowledge.

Workshops Attended and Use

A one-way between subjects ANOVA was conducted to compare the Malaysian polytechnic lecturers by the use of critical thinking teaching strategies. The results were presented by the four factors discovered by EFA: evaluates in practice (factor 1), team skills (factor 2), reflectively engages (factor 3), and challenges and questions (factor 4).

Results for Evaluates in Practice (factor 1)

The factor of ‘evaluates in practice’ consists of ten critical thinking teaching strategies. The results revealed that there were statistical differences among the five levels of critical thinking workshops attended on the use of nine of the teaching strategies as shown in Table 18. The nine strategies included: identify author’s thesis and argument (item 39), post thoughts (item 40), create perspectives on an issue (item 41), close readings (item 42), recognize arguments (item 45), models concepts and language of probability (item 46), evaluate different sources (item 49), form and test hypotheses (item 50), and incorporate other insights in analysis (item 51).

To measure the strength of the relationship, or effect size, for a between groups ANOVA, the formula (Brown, 2008) was used:

$$\eta^2 = \frac{\text{Treatment Sum of Squares (between groups)}}{\text{Total Sum of Squares}}$$

Effect size using eta squared (η^2) is interpreted as: small or smaller than typical for η^2 = .01; medium or typical for η^2 = .06; large or larger than typical for η^2 = .14; and much larger than typical for η^2 = .20 (Morgan et al., 2007).

Table 18

One-Way Analysis of Variance for Critical Thinking Workshops Attended on Frequency of Use of Critical Thinking Teaching Strategies (factor 1)

Frequency of Use (factor 1)	*SS*	*MS*	*F*(4, 353)	*p*	η^2
Identifies strengths and weaknesses of an author's thesis and argument(s). (item39)					
Between Groups	14.72	3.68	2.91	.022	.03
Within	446.80	1.27			
Asks students to post thoughts that arise as they are reading assigned material, showing evidence or critical thought. (item 40)					
Between Groups	19.15	4.79	4.51	.001	.05
Within	374.45	1.06			
Creates a continuum of perspectives on an issue, with students asked to place their own views along the continuum and to articulate why they have chosen their stance and not that of another. (item 41)					
Between Groups	22.32	5.58	5.20	.000	.06
Within	378.46	1.07			
Uses close readings, i.e., develop students' thinking about reading. (item 42)					
Between Groups	11.55	2.89	2.74	.029	.03
Within	371.90	1.05			
Analyzes statistics (display average, correlation). (item 44)					
Between Groups	9.92	2.48	2.21	.067	.02
Within	395.64	1.12			
Focuses in getting students to recognize an arguments' underlying logical structure rather than accepting it based on "authority" or other cues. (item 45)					
Between Groups	11.11	2.78	2.39	.050	.03
Within	409.42	1.16			
Models appropriate use of the concepts and language of probability. (item 46)					
Between Groups	17.80	4.45	4.25	.002	.05
Within	370.02	1.05			

Asks students to evaluate the different sources from which they draw information, e.g., on-line peer-reviewed journals vs Wikipedia vs. a website advocating for a particular point of view. (item 49)					
Between Groups	12.28	3.07	2.85	.024	.03
Within	379.84	1.08			
Asks students to form and test hypotheses about observed phenomena. (item 50)					
Between Groups	16.10	4.03	3.27	.012	.04
Within	434.98	1.23			
Asks students if insight from other disciplines can be incorporated in an analysis. (item 51)					
Between Groups	22.80	5.70	4.73	.001	.05
Within	425.59	1.21			

Table 19 shows the usage means, with the highest means for the nine teaching strategies from polytechnic lecturers who attended four or more critical thinking workshops: model concepts and language of probability (item 46), (*M* = 3.6); evaluate different sources (item 49), (*M* = 3.6); post thoughts (item 40), (*M* = 3.5); create a continuum of perspectives on an issue (item 41), (*M* = 3.5); close readings (item 42), (*M* = 3.4); recognize arguments (item 45), (*M* = 3.4); incorporate insights from other disciplines in an analysis (item 51), (*M* = 3.4); form and test hypotheses (item 50), (*M* = 3.3); and identify author's thesis and argument(s) (item 39), (*M* = 3.2). In the table's post hoc column, numbers of workshop groups without differences in their means of frequency of usage of the strategy were grouped (e.g., 0, 1, 2, 3), and when there were differences, the groups were separated by a semi-colon (4; 0, 1, 2, 3).

A post hoc Tukey HSD test was used with selected items in ‘evaluates in practice’ (factor 1) because variances were assumed to be similar (homogeneous) (Morgan et al., 2007). The results indicated there were no significant mean differences among the five levels of critical thinking workshops attended by lecturers with the strategy usage of ‘identify author's thesis and argument(s)’ (item 39). In contrast, the usage of the ‘close reading’ strategy (item 42) by lecturers who had attended four or more critical thinking workshops differed from the usage by those who never attended a workshop (0) (p = .029, $\eta^2 = .03$), but not from those attending one, two, or three workshops. The frequency of usage of ‘recognize arguments’ (item 45) by lecturers who had attended four or more critical thinking workshops differed from usage by those who never attended a workshop (0) (p = .043, $\eta^2 = .03$), but not from those attending one, two, or three workshops. The frequency of usage of ‘concepts and language of probability’ (item 46) by lecturers who had attended four or more critical thinking workshops differed from usage by those who never attended a workshop (0) (p = .003, $\eta^2 = .05$) or attended one workshop (p = .015), but not from those attending two or three workshops.

The frequency of usage of ‘evaluate different sources’ (item 49) by lecturers who had attended four or more critical thinking workshops differed from usage by those who never attended a workshop (0) (p = .012, $\eta^2 = .03$), but not from those attending one, two, or three workshops. The frequency of usage of ‘form and test hypotheses about observed phenomena’ (item 50) by lecturers who had attended four or more critical thinking workshops differed from usage by those who never attended a workshop (0) (p = .025, $\eta^2 = .04$), but not from those attending one, two, or four workshops. The effect size for each difference was small.

A Games-Howell post hoc test was used on selected strategies because variances were assumed to be dissimilar (heterogeneous) (Morgan et al., 2007). The Levene tests for these selected items were significant. The frequency of usage of ‘post thoughts’ (item

40) by lecturers who never attended any critical thinking workshops (0) differed from usage by those attending two (p = .028, η^2 = .05) or four or more workshops (p = .002), but not from those attending one or three workshops. The effect size was small. The frequency of usage of ‘creates a continuum of perspective’ (item 41) by lecturers who had attended four or more critical thinking workshops differed from usage by those who never attended a workshop (0) (p = .003, η^2 = .06), but not from those attending one, two, or three workshops. The effect size was medium. The frequency of usage of ‘incorporates insights from other disciplines in an analysis strategy’ (item 51) by lecturers who never attended any critical thinking workshops (0) differed from usage by those attending two (p = .020, η^2 = .05) or four or more workshops (p = .018), but not from those attending one or three workshops. The effect size was small.

Table 19

Frequency of Use Critical Thinking Teaching Strategies by Workshops Attended, Means and Standard Deviations (factor 1)

Frequency of Use (factor 1)	Critical Thinking Workshops Attended 0		1		2		3		4 or more		Post hoc
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Identifies strengths and weaknesses of an author's thesis and argument(s). (item 39)	2.6	1.0	2.8	1.1	3.0	1.3	2.9	1.1	3.2	1.1	0, 1, 2, 3, 4 or more
Asks students to post thoughts that arise as they are reading assigned material, showing evidence or critical thought. (item 40)	2.8	1.0	3.1	1.0	3.3	1.2	3.1	1.0	3.5	0.8	0; 1, 2, 3, 4 or more
Creates a continuum of perspectives on an issue, with students asked to place their own views along the continuum and to articulate why they have chosen their stance and not that of another. (item 41)	2.7	1.1	3.0	0.9	3.2	1.2	3.1	0.9	3.5	1.0	4 or more; 0, 1, 2, 3
Uses close readings, i.e., develop students' thinking about reading. (item 42)	2.8	1.1	2.9	1.0	3.1	1.1	3.1	1.0	3.4	1.0	4 or more; 0, 1, 2, 3

Focuses in getting students to recognize an argument's underlying logical structure rather than accepting it based on "authority" or other cues. (item 45)	2.8	1.0	3.0	1.0	3.1	1.3	2.8	1.1	3.4	1.1	4 or more; 0, 1, 2, 3
Models appropriate use of the concepts and language of probability. (item 46)	2.8	1.0	2.9	1.0	3.2	1.1	3.1	1.2	3.6	0.9	4 or more; 0, 1, 2, 3
Asks students to evaluate the different sources from which they draw information, e.g., on-line peer-reviewed journals vs Wikipedia vs. a website advocating for a particular point of view. (item 49)	2.9	0.9	3.1	1.5	3.1	1.2	2.9	1.2	3.6	0.9	4 or more: 0, 1, 2, 3
Asks students to form and test hypotheses about observed phenomena. (item 50)	2.6	1.1	2.8	1.1	3.0	1.2	2.5	1.0	3.3	1.0	4 or more; 0, 1, 2, 3
Asks students if insight from other disciplines can be incorporated in an analysis. (item 51)	2.6	1.1	3.0	1.0	3.2	1.2	3.0	0.9	3.4	1.2	0; 1, 2, 3, 4 or more

Results for Team Skills (factor 2)

The 'team skills' factor includes three critical thinking teaching strategies. The results showed there were statistically significant differences among the five levels of critical thinking workshops attended relative to the frequency of use of two of the teaching strategies as shown in Table 20. The two strategies were 'student workshops on projects' (57) and 'work in groups to solve problems' (item 58).

Table 20

One-Way Analysis of Variance for Critical Thinking Workshops Attended on Frequency of Use of Critical Thinking Teaching Strategies (factor 2)

Frequency of Use (factor 2)	*SS*	*MS*	*F*(4, 353)	*p*	η^2
Uses cooperative learning-sharing in groups and working together to accomplish a goal. (item 56)					
Between Groups	7.44	1.86	1.80	.129	.02
Within	365.05	1.03			
Uses student workshops on projects (i.e., students work together to provide feedback and suggestions for major projects). (item 57)					
Between Groups	16.40	4.10	3.83	.005	.04
Within	377.62	1.07			
Works in groups to solve problems that have multiple solutions. (item 58)					
Between Groups	13.683	3.41	3.72	.006	.04
Within	24.45	0.92			

Table 21 shows the usage means with the highest means for lecturers who attended four or more critical thinking workshops for the two teaching strategies: work in groups to solve problems that have multiple solutions (item 58), (*M* = 4.3); and students workshop for projects (i.e., students work together to provide feedback and suggestions for major projects) (item 57), (*M* = 4.0).

Post hoc Tukey HSD test was used on two strategies of ‘team skills’ (factor 2). The frequency of usage of ‘student workshops on projects’ (item 57) by lecturers who had attended four or more critical thinking workshops differed from usage by those who never attended a workshop (0) (p = .010, η^2 = .04), one (p = .023), or three workshops (p = .015), but not from those attending two workshops. The frequency of usage of ‘works in groups’ (item 58) by lecturers who had attended four or more critical thinking workshops differed from usage by those who never attended a workshop (0) (p = .005, η^2 = .04), or attended one (p = .021), or three workshops (p = .016), but not from those attending two workshops. Each effect size was small.

Table 21

Frequency of Use Critical Thinking Teaching Strategies by Workshops Attended, Means and Standard Deviations (factor 2)

Frequency of Use (factor 2)	Critical Thinking Workshops Attended 0		1		2		3		4 or more		Post hoc
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Uses workshop students on projects, i.e., students work together to provide feedback and suggestions for major projects. (item 57)	3.3	1.0	3.4	1.0	3.6	1.1	3.1	1.1	4.0	0.9	4 or more; 0, 1, 2, 3
Works in groups to solve problems that have multiple solutions. (item 58)	3.6	1.0	3.6	0.9	3.8	1.0	3.4	0.8	4.3	0.7	4 or more; 0, 1, 2, 3

Results for Reflectively Engages (factor 3)

The 'reflectively engages' factor is comprised of five critical thinking teaching strategies. The Table 22 shows there were statistically significant differences among the five levels of critical thinking workshops attended on the usage of all of the teaching strategies in this factor: 'writing assignments with specific tasks' (item 31), 'justify student positions with examples and evidence' (item 32), 'identify strengths and weaknesses of students' arguments' (item 33), 'evaluate evidence from multiple perspectives' (item 34), and 'engage students with controversial topics' (item 35).

Table 22

One-Way Analysis of Variance for Critical Thinking Workshops Attended on Frequency of Use of Critical Thinking Teaching Strategies (factor 3)

Frequency of Use (factor 3)	*SS*	*MS*	*F*(4, 353)	*p*	η^2
Uses writing assignments with specific tasks or goals focusing on a particular kind of thinking or reflection. (item 31)					
Between Groups	8.34	2.09	2.45	.046	.03
Within	301.02	0.85			
Requires students to justify their positions with examples and evidence, both in verbal and written analysis. (item 32)					
Between Groups	8.63	2.16	2.50	.042	.03
Within	304.40	0.86			
Asks students to identify the strengths and weaknesses of their own arguments. (item 33)					
Between Groups	19.18	4.79	4.98	.001	.05
Within	339.57	0.96			
Asks students to evaluate evidence from multiple perspectives. (item 34)					
Between Groups	20.683	5.17	5.59	.000	.06
Within	326.64	0.93			
Engages students with controversial topics. (item 35)					
Between Groups	12.24	3.06	2.84	.024	.03
Within	380.90	1.08			

Table 23 shows the usage means, with the highest means for lecturers who attended four or more critical thinking workshops for the five teaching strategies: ‘evaluate evidence from multiple perspectives’ (item 34), (*M* = 4.0); ‘writing assignments with specific tasks’ (item 31), (*M* = 3.9); ‘identify the strengths and weaknesses of students’ arguments’ (item 33), (*M* = 3.9); ‘justify student positions with examples and evidence’ (item 32), (*M* = 3.8); and ‘engage students with controversial topics’ (item 35), (*M* = 3.6).

The post hoc Tukey HSD test was used to analyze the selected items within the ‘reflectively engages’ factor. The frequency of usage of ‘identify students arguments’ (item 33) by lecturers who had attended four or more critical thinking workshops differed from usage by those who never attended a workshop (0) ($p = .001$, $\eta^2 = .05$), or attended one workshop ($p = .026$), but not from those attending two or three workshops. On the same strategy, lecturers who never attended a workshop (0) differed in usage from those attending two workshops ($p = .039$), but not from those attending one, three, or four or more workshops. The effect size was small. The frequency of usage of ‘evaluates multiple perspectives’ (item 34) lecturers who had attended four or more critical thinking workshops differed from usage by those who never attended a workshop (0) ($p = .000$, $\eta^2 = .06$), or attended one workshop ($p = .002$), but not from those attending two or three workshops. The effect size was medium. The frequency of usage of ‘engages students with controversial topics’ (item 35) by lecturers who had attended four or more critical thinking workshops differed from usage by those who never attended any workshops (0) ($p = .017$, $\eta^2 = .03$), but not from those attending one, two, or three workshops. The effect size was small.

The Games-Howell post hoc test was chosen to measure other selected items. The frequency of usage of ‘writing assignments with specific tasks’ (item 31) by lecturers who had attended four or more critical thinking workshops differed from usage by those who never attended a workshop (0) (p = .044, η^2 = .03), but not from those attending one, two, or three workshops. The frequency of usage of ‘justify students’ positions with examples and evidence’ (item 32) by lecturers who had attended four or more critical thinking workshops differed from usage by those who never attended a workshop (0) (p = .013, η^2 = .03), but not from those attending one, two, or three workshops. All effect sizes were small.

Table 23

Frequency of Use Critical Thinking Teaching Strategies by Workshops Attended, Means and Standard Deviations (factor 3)

Frequency of Use (factor 3)	Critical Thinking Workshops Attended										Post hoc
	0		1		2		3		4 or more		
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Uses writing assignments with specific tasks or goals focusing on a particular kind of thinking or reflection .(item 31)	3.3	0.9	3.6	0.9	3.6	1.2	3.5	0.9	3.9	0.8	4 or more; 0, 1, 2, ,3
Requires students to justify their positions with examples and evidence, both in verbal and written analysis. (item 32)	3.2	0.9	3.4	0.9	3.5	1.1	3.4	0.9	3.8	0.8	4 or more; 0, 1, 2, ,3
Asks students to identify the strengths and weaknesses of their own arguments. (item 33)	3.1	1.1	3.3	0.8	3.6	1.1	3.5	0.9	3.9	0.9	4 or more; 0, 1, 2, ,3 0; 1,2,3,4
Asks students to evaluate evidence from multiple perspectives. (item 34)	3.1	0.9	3.2	0.9	3.4	1.1	3.3	1.1	4.0	0.9	4 or more; 0, 1, 2, ,3
Engages students with controversial topics. (item 35)	2.9	1.0	3.1	1.0	3.2	1.2	3.1	1.0	3.6	1.1	4 or more; 0, 1, 2, ,3

Results for Challenges and Questions (factor 4)

The 'challenges and questions' factor is composed of seven critical thinking teaching strategies. The results indicated statistically significant differences among the five levels of critical thinking workshops attended by lecturers on three of these teaching strategies at $p < .05$. The three strategies were: 'analyze ethical choices in small group discussions' (item 12); 'students' observations across a range of specific contexts' (item 15); and 'quantitative skills' (item 20). See Table 24.

Table 24

One-Way Analysis of Variance for Critical Thinking Workshops Attended on Frequency of Use of Critical Thinking Teaching Strategies (factor 4)

Frequency of Use (factor 4)	*SS*	*MS*	$F(4, 353)$	*p*	η^2
Uses questions for students to analyze ethical choices in small group discussions and in written summaries. (item 12)					
Between Groups	11.05	2.76	3.63	.006	.04
Within	268.65	0.76			
Uses questions that ask students to describe orally or in written form data that are shown to them, e.g., interpretations of graphs and tables. (item 13)					
Between Groups	4.41	1.10	1.47	.212	.02
Within	265.09	0.75			
Uses questions for students to define the perspective that is revealed in a text and evaluate the impact of that perspective on the way the text is written. (item 14)					
Between Groups	5.47	1.37	1.64	.165	.02
Within	295.25	0.84			
Invites students to abstract from their observations, to think about the implication of their ideas, and to generate these ideas across a range of specific contexts. (item 15)					
Between Groups	21.70	5.43			
Within	290.36	0.82	6.60	.000	.07
Analyzes primary source texts. (item 17)					
Between Groups	4.75	1.19	1.43	.224	.02
Within	293.05	0.83			

Uses an assessment and critical examination of scientific literature. (item 19)					
Between Groups	3.42	0.85	0.79	.538	.01
Within	386.11	1.09			
Teaches quantitative skills. (item 20)					
Between Groups	9.07	2.27	2.42	.048	.03
Within	330.80	0.94			

Table 25 shows the usage means, with the highest means for lecturers who attended three or four or more critical thinking workshops for the ‘analyze ethical choices’ strategy (item 12), (M = 3.6). The highest usage means for the ‘students’ observations across a range of specific contexts’ strategy (item 15) were from those who attended two or four or more workshops (M = 3.6); and the ‘quantitative skills’ strategy (item 20) had highest usage mean from those who attended four or more workshops (M = 3.6).

The post hoc Tukey HSD test was chosen to analyze the three strategies under this factor. The frequency of usage of ‘analyze ethical choices’ (item 12) by lecturers who never attended any critical thinking workshops (0) differed from usage by those who attended two workshops (p = .039, η^2 = .04), but not from those attending one, three, or four or more workshops. The effect size was small. The frequency of usage of ‘students’ observations across a range of specific contexts’ (item 15) by lecturers who never attended a critical thinking workshop (0) differed from usage by those attending one (p = .037), two (p = .000), or four or more workshops (.005), but not from those attending three workshops with effect size of η^2 = .07. The effect size was medium. Conversely, there were no significant mean differences among the five levels of critical thinking workshops attended by lecturers on the usage of ‘quantitative skills’ strategy (item 20).

Table 25

Frequency of Use Critical Thinking Teaching Strategies by Workshops Attended, Means and Standard Deviations (factor 4)

Frequency of Use (factor 4)	Critical Thinking Workshops Attended										Post hoc
	0		1		2		3		4 or more		
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Uses questions for students to analyze ethical choices in small group discussions and in written summaries. (item 12)	3.2	0.9	3.3	0.7	3.5	1.0	3.6	0.8	3.6	1.0	0; 1, 2, 3, 4 or more
Invites students to abstract from their observations, to think about the implication of their ideas, and to generate these ideas across a range of specific contexts. (item 15)	3.0	1.0	3.3	0.9	3.6	0.9	3.4	0.7	3.6	1.0	0; 1, 2, 3, 4 or more
Teaches quantitative skills. (item 20)	3.1	1.0	3.2	0.9	3.4	1.0	3.2	1.0	3.6	1.3	0, 1, 2, 3, 4 or more

Workshops Attended and Perceptions

A one-way ANOVA was used to test for differences of perceptions on the effectiveness of critical thinking teaching strategies among Malaysian polytechnic lecturers who attended different numbers of critical thinking workshops. The five groups are: zero workshops, one workshop, two workshops, three workshops, or four or more workshops. The results were reported based on the four main factors previously described.

Results for Evaluates in Practice (factor 1)

The ten critical thinking teaching strategies within the 'evaluates in practice' factor were analyzed. An analysis of variance showed there were significant differences of the perceptions of six teaching strategies by the number of critical thinking workshops attended. The strategies were: 'identify author's thesis and argument' (item 39), 'post thoughts' (item 40), 'create perspectives on an issue' (item 41), 'models concepts and language of probability' (item 46), 'form and test hypotheses' (item 50), and 'incorporate insights from other disciplines in an analysis' (item 51). See Table 26.

Table 26

One-Way Analysis of Variance for Critical Thinking Workshops Attended on Perception of Effectiveness of Critical Thinking Teaching Strategies (factor 1)

Perception of Effectiveness (factor 1)	*SS*	*MS*	*F*(4, 353)	*p*	η^2
Identifies strengths and weaknesses of an author's thesis and argument(s). (item 39)					
Between Groups	7.58	1.90	2.51	.041	.03
Within	266.36	0.76			
Asks students to post thoughts that arise as they are reading assigned material, showing evidence or critical thought. (item 40)					
Between Groups	13.80	3.45	5.08	.001	.05
Within	239.54	0.68			

Creates a continuum of perspectives on an issue, with students asked to place their own views along the continuum and to articulate why they have chosen their stance and not that of another.(item 41)					
Between Groups	6.49	1.62	3.06	.017	.03
Within	187.30	0.53			
Uses close readings, i.e., develop students' thinking about reading (item 42)					
Between Groups	5.25	1.31	2.28	.061	.03
Within	203.47	0.58			
Analyzes statistics (display average, correlation) (item 44)					
Between Groups	4.28	1.07	1.61	.171	.02
Within	234.28	0.66			
Focuses in getting students to recognize an arguments' underlying logical structure rather than accepting it based on "authority" or other cues (item 45)					
Between Groups	4.56	1.14	1.72	.144	.02
Within	233.12	0.66			
Models appropriate use of the concepts and language of probability (item 46)					
Between Groups	8.13	2.03	3.03	.018	.03
Within	236.58	0.67			
Asks students to evaluate the different sources from which they draw information, e.g., on-line peer-reviewed journals vs Wikipedia vs. a website advocating for a particular point of view (item 49)					
Between Groups	4.52	1.13	2.00	.094	.02
Within	199.26	0.56			
Asks students to form and test hypotheses about observed phenomena (item 50)					
Between Groups	8.82	2.21	3.29	.011	.04
Within	236.38	0.67			
Asks students if insight from other disciplines can be incorporated in an analysis (item 51)					
Between Groups	8.13	2.03	3.02	.018	.03
Within	237.70	0.67			

Table 27 shows the perception means, with the highest perceptions of effectiveness for the ‘post thoughts’ strategy (item 40) from lecturers who attended two critical thinking workshops (*M* = 3.6). The table also indicates that the highest perception of effectiveness means were from lecturers who attended four or more workshops for the following strategies: ‘create perspectives on an issue’ (item 41), (*M* = 3.6); ‘models concepts and language of probability’ (item 46), (*M* = 3.5); ‘form and test hypotheses’ (item 50), (*M* = 3.5); and ‘incorporate other insights from other disciplines in analysis’ (item 51), (*M* = 3.5). The strategy of ‘identify strengths and weaknesses of an author’s thesis and argument(s)’ (item 39) had highest perception means from lecturers who attended two or four or more workshops (*M* = 3.4).

The post hoc Tukey HSD test was chosen to determine the differences between the perception means of selected critical thinking teaching strategies and workshop attended. The results found no significant mean differences among the five levels of critical thinking workshops attended by lecturers with their perceptions of ‘form and test hypotheses’ (item 50) and ‘incorporate other insights from other disciplines in an analysis’ (item 51).

Likewise, using the Games-Howell post hoc test, there were no significant mean differences with perception of effectiveness of ‘identify author's thesis and argument(s)’ (item39), ‘creates a continuum of perspectives on an issue’ (item 41), and ‘model concepts and language of probability’ (item 46) by the number of critical thinking workshops attended. Games-Howell post hoc tests were used to analyze the remaining strategies within the ‘evaluates in practice’ factor. Perceptions of the ‘post thoughts’ strategy (item 40) by lecturers who had attended two critical thinking workshops differed from perceptions of those who never attended a workshop (0) (p = .009, η^2 = .05), or attended one workshop (p = .007), but not from those attending three, or four or more workshops. The effect size was small.

Table 27

Perception of Effectiveness on Critical Thinking Teaching Strategies by Workshops Attended, Means and Standard Deviations (factor 1)

Perception of Effectiveness (factor 1)	Critical Thinking Workshops Attended 0		1		2		3		4 or more		Post hoc
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Identifies strengths and weaknesses of an author's thesis and argument(s). (item 39)	3.1	0.8	3.1	0.8	3.4	1.1	3.3	0.9	3.4	1.0	0, 1, 2, 3, 4 or more
Asks students to post thoughts that arise as they are reading assigned material, showing evidence or critical thought. (item 40)	3.1	0.8	3.1	0.8	3.6	1.0	3.2	0.8	3.5	0.9	2; 0, 1, 3, 4 or more
Creates a continuum of perspectives on an issue, with students asked to place their own views along the continuum and to articulate why they have chosen their stance and not that of another. (item 41)	3.2	0.7	3.3	0.7	3.4	0.9	3.1	0.7	3.6	0.8	0, 1, 2, 3, 4 or more
Models appropriate use of the concepts and language of probability. (item 46)	3.1	0.7	3.1	0.8	3.4	0.9	3.0	0.9	3.5	0.8	0, 1, 2, 3, 4 or more
Asks students to form and test hypotheses about observed phenomena. (item 50)	3.2	0.8	3.1	0.8	3.4	0.9	2.9	0.8	3.5	0.9	0, 1, 2, 3, 4 or more
Asks students if insight from other disciplines can be incorporated in an analysis. (item 51)	3.1	0.7	3.1	0.8	3.4	0.9	3.1	0.9	3.5	0.9	0, 1, 2, 3, 4 or more

Results for Team Skills (factor 2)

Analyses of variance of the three critical thinking teaching strategies included in the ‘team skills’ factor showed significant differences of perception of effectiveness of two teaching strategies, ‘student workshops on projects’ (item 57) and ‘work in groups to solve problems’ (item 58) by the number of workshops attended. See Table 28.

Table 28

One-Way Analysis of Variance for Critical Thinking Workshops Attended on Perception of Effectiveness of Critical Thinking Teaching Strategies (factor 2)

Perception of Effectiveness (factor 2)	*SS*	*MS*	*F*(4, 353)	*p*	η^2
Uses cooperative learning-sharing in groups and working together to accomplish a goal. (item 56)					
Between Groups	4.22	1.05	1.46	.213	0.02
Within	254.38	0.72			
Uses workshop students on projects, i.e., students work together to provide feedback and suggestions for major projects. (item 57)					
Between Groups	8.71	2.18	3.41	.009	0.04
Within	225.56	0.64			
Works in groups to solve problems that have multiple solutions. (item 58)					
Between Groups	9.74	2.44	3.78	.005	0.04
Within	227.59	0.65			

Table 29 shows the perception means, with the highest means for the two strategies of ‘work in groups to solve problems’ (item 58), (M = 4.0), and ‘student workshops on projects’ (item 57), (M = 3.8) from lecturers who attended four or more critical thinking workshops.

The post hoc Tukey HSD test was used to identify the differences between means perceptions of the two teaching strategies by workshops attended by lecturers on what they perceived. The perception of effectiveness of the strategy of using ‘student workshops on projects' (item 57) by lecturers who had attended three critical thinking workshops differed from the perceptions of those who attending two, or four or more workshops (with the same *p* value of .015 and effect sizes, $\eta^2 = .04$), but not from those who had never attended a workshop. Perceptions of the strategy to 'work in groups' (item 58) by lecturers who had attended four or more critical thinking workshops differed from perceptions of those who never attended a workshop ($p = .024$, $\eta^2 = .04$) or attended three workshops ($p = .006$), but not from those attending one or two workshops. Each effect size was relatively small.

Table 29

Perception of Effectiveness on Critical Thinking Teaching Strategies by Workshops Attended, Means and Standard Deviations (factor 2)

Perception of Effectiveness (factor 2)	Critical Thinking Workshops Attended										Post hoc
	0		1		2		3		4 or more		
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Uses workshop students on projects, i.e., students work together to provide feedback and suggestions for major projects (item 57)	3.5	0.8	3.6	0.8	3.7	0.9	3.1	0.8	3.8	0.9	3; 0, 1, 2, 4 or more
Works in groups to solve problems that have multiple solutions (item 58)	3.5	0.8	3.7	0.7	3.7	0.9	3.2	0.8	4.0	0.9	4 or more; 0, 1, 2, 3

Results for Reflectively Engages (factor 3)

The ‘reflectively engages’ factor was composed of five critical thinking teaching strategies. Using one-way ANOVA, statistical differences of the perceptions of effectiveness were found in these strategies: ‘identify strengths and weaknesses of students’ arguments’ (item 33) and ‘evaluate evidence from multiple perspectives’ (item 34) by the numbers of critical thinking workshops attended. See Table 30.

Table 30

One-Way Analysis of Variance for Critical Thinking Workshops Attended on Perception of Effectiveness of Critical Thinking Teaching Strategies (factor 3)

Perception of Effectiveness (factor 3)	*SS*	*MS*	*F*(4, 353)	*p*	η^2
Uses writing assignments with specific tasks or goals focusing on a particular kind of thinking or reflection. (item 31)					
Between Groups	5.34	1.34	2.24	.064	.03
Within	210.27	0.60			
Requires students to justify their positions with examples and evidence, both in verbal and written analysis. (item 32)					
Between Groups	5.23	1.31	2.17	.072	.02
Within	212.24	0.60			
Asks students to identify the strengths and weaknesses of their own arguments. (item 33)					
Between Groups	9.89	2.47	4.26	.002	.05
Within	204.92	0.58			
Asks students to evaluate evidence from multiple perspectives. (item 34)					
Between Groups	8.29	2.07	3.25	.012	.04
Within	225.48	0.64			
Engages students with controversial topics. (item 35)					
Between Groups	5.00	1.25	1.86	.116	.02
Within	236.79	0.67			

Table 31 shows the perception of effectiveness means, with the highest means for the strategies of 'identify strengths and weaknesses of students' arguments' (item 33), (M = 3.8), and 'evaluate evidence from multiple perspectives' (item 34), (M = 3.7) of the lecturers who attended four or more critical thinking workshops.

Post hoc Tukey HSD tests indicated differences between means on these two teaching strategies as well. Perceptions of the strategy 'identify strengths and weaknesses of students' arguments' (item 33) by lecturers who had attended four or more critical thinking workshops differed from perceptions of those who never attended a workshop ($p = .008$, $\eta^2 = .05$) or attended one workshop ($p = .040$), but not from those attending two or three workshops. On the same strategy, perceptions from the two workshops group differed from perceptions of those who never attended a workshop (0) ($p = .030$), but not from those attending one, three, or four or more workshops. The effect size was small. There were no significant mean differences on perception of effectiveness towards the strategy of 'evaluating evidence from multiple perspectives' (item 34) by the number of critical thinking workshops attended.

Table 31

Perception of Effectiveness on Critical Thinking Teaching Strategies by Workshops Attended, Means and Standard Deviations (factor 3)

Perception of Effectiveness (factor 3)	Critical Thinking Workshops Attended: 0		1		2		3		4 or more		Post hoc
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Asks students to identify the strengths and weaknesses of their own arguments (item 33)	3.3	0.7	3.3	0.7	3.6	0.9	3.3	0.9	3.8	0.8	4 or more; 0, 1, 2, 3 2; 0, 1, 3, 4 or more
Asks students to evaluate evidence from multiple perspectives (item 34)	3.2	0.7	3.3	0.7	3.5	1.0	3.3	0.9	3.7	0.9	0, 1, 2, 3, 4 or more

Results for Challenges and Questions (factor 4)

Seven critical thinking teaching strategies were in the 'challenges and questions' factor. One-way ANOVA was used to compare group means of the perceptions of effectiveness of selected critical thinking teaching strategies. Statistically significant differences were found by the number of workshops attended for the strategy of 'students' observations across a range of specific contexts' (item 15), but not for the other six strategies in the factor. See Table 32.

Table 32

One-Way Analysis of Variance for Critical Thinking Workshops Attended on Perception of Effectiveness of Critical Thinking Teaching Strategies (factor 4)

Perception of Effectiveness (factor 4)	*SS*	*MS*	*F*(4, 353)	*p*	η^2
Uses questions for students to analyze ethical choices in small group discussions and in written summaries. (item 12)					
Between Groups	4.26	1.07	2.29	.060	.03
Within	164.31	0.47			
Uses questions that ask students to describe orally or in written form data that are shown to them, e.g., interpretations of graphs and tables. (item 13)					
Between Groups	2.59	0.65	1.24	.296	.01
Within	184.69	0.52			
Uses questions for students to define the perspective that is revealed in a text and evaluate the impact of that perspective on the way the text is written. (item 14)					
Between Groups	3.55	0.89	1.47	.210	.02
Within	212.87	0.60			
Invites students to abstract from their observations, to think about the implication of their ideas, and to generate these ideas across a range of specific contexts. (item 15)					
Between Groups	9.98	2.50	4.00	.003	.04
Within	220.08	0.62			
Analyzes primary source texts. (item 17)					
Between Groups	2.65	0.66	1.09	.363	.01
Within	215.21	0.61			

Uses an assessment and critical examination of scientific literature. (item 19)					
Between Groups	2.96	0.74	1.09	.359	.01
Within	238.41	0.68			
Teaches quantitative skills. (item 20)					
Between Groups	4.01	1.00	1.66	.158	.02
Within	213.05	0.60			

Table 33 shows the perception means, with the highest means for the strategy of ‘students’ observations across a range of specific contexts’ (item 15) from lecturers who attended two critical thinking workshops (M = 3.7).

A post hoc Tukey HSD test indicated that perception of effectiveness of this same strategy by lecturers who attended two critical thinking workshops differed from perceptions of those who never attended a workshop (p = .003, η^2 = .04), or attended one workshop (p = .009), but not from those who attended three or four or more workshops. The effect size was small.

Table 33

Perception of Effectiveness on Critical Thinking Teaching Strategies by Workshops Attended, Means and Standard Deviations (factor 4)

Perception of Effectiveness (factor 4)	Critical Thinking Workshops Attended										Post hoc
	0		1		2		3		4 or more		
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Invites students to abstract from their observations, to think about the implication of their ideas, and to generate these ideas across a range of specific contexts. (item 15)	3.2	0.7	3.2	0.8	3.7	0.7	3.3	0.7	3.5	1.0	2; 0, 1, 3, 4 or more

Workshops Attended and Knowledge

This question required one-way between subjects ANOVA to assess significant differences between critical thinking workshops attended by Malaysian polytechnic lecturers and their knowledge of critical thinking teaching strategies (Insufficient = 1, Sufficient = 2). The findings are reported according to the same four factors.

Results for Evaluates in Practice (factor 1)

Out of ten strategies in the 'evaluates in practice' factor, significant differences were found on knowledge of eight critical thinking teaching strategies by the number of critical thinking workshops attended by lecturers. These strategies were: 'identify author's thesis and argument(s)' (item 39), 'post thoughts' (item 40), 'create perspectives on an issue' (item 41), 'close readings' (item 42), 'models concepts and language of probability' (item 46), 'evaluate different sources' (item 49), 'form and test hypotheses' (item 50), and 'incorporate insights from other disciplines' (item 51). See Table 34.

Table 34

One-Way Analysis of Variance for Critical Thinking Workshops Attended on Knowledge of Critical Thinking Teaching Strategies (factor 1)

Knowledge of Critical Thinking Teaching Strategies (factor 1)	*SS*	*MS*	*F*(4, 353)	*p*	η^2
Identifies strengths and weaknesses of an author's thesis and argument(s). (item 39)					
Between Groups	3.12	0.78	3.21	.013	.04
Within	85.97	0.24			
Asks students to post thoughts that arise as they are reading assigned material, showing evidence or critical thought. (item 40)					
Between Groups	3.79	0.95	3.94	.004	.04
Within	85.08	0.24			

Creates a continuum of perspectives on an issue, with students asked to place their own views along the continuum and to articulate why they have chosen their stance and not that of another. (item 41)					
Between Groups	4.19	1.05	4.34	.002	.05
Within	85.17	0.24			
Uses close readings, i.e., develop students' thinking about reading. (item 42)					
Between Groups	2.44	0.61	2.48	.044	.03
Within	87.05	0.25			
Analyzes statistics (display average, correlation). (item 44)					
Between Groups	1.77	0.44	1.79	.130	.02
Within	86.83	0.25			
Focuses in getting students to recognize an arguments' underlying logical structure rather than accepting it based on "authority" or other cues. (item 45)					
Between Groups	1.29	0.32	1.30	.270	.01
Within	87.66	0.25			
Models appropriate use of the concepts and language of probability. (item 46)					
Between Groups	3.27	0.82	3.34	.010	.04
Within	86.19	0.24			
Asks students to evaluate the different sources from which they draw information, e.g., on-line peer-reviewed journals vs Wikipedia vs. a website advocating for a particular point of view. (item 49)					
Between Groups	3.01	0.75	3.08	.016	.03
Within	86.36	0.25			
Asks students to form and test hypotheses about observed phenomena. (item 50)					
Between Groups	4.05	1.01	4.21	.002	.05
Within	85.04	0.24			
Asks students if insight from other disciplines can be incorporated in an analysis. (item 51)					
Between Groups	3.20	0.80	3.28	.012	.04
Within	86.07	0.24			

Table 35 shows the means for knowledge, with the highest means of 1.7 for lecturers who attended four or more critical thinking workshops for the following strategies: ‘create perspectives on an issue’ (item 41), ‘close readings’ (item 42), ‘models concepts and language of probability’ (item 46), ‘evaluate different sources’ (item 49), and ‘form and test hypotheses’ (item 50). The groups with the highest means for knowledge for the strategy of ‘post thoughts’ (item 40) were those who attended two or four or more critical thinking workshops (both $M = 1.7$). Those who attended two or four or more workshops also had the highest means ($M = 1.6$) for the strategies of ‘identify author's thesis and argument(s)’ (item 39), and ‘incorporate insights from other disciplines’ (item 51).

The post hoc Tukey HSD test was used for the strategy of ‘identify author's thesis and argument(s)’ (item 39) due to homogeneity of variances (omnibus F was not significant). Knowledge of this strategy by lecturers who had never attended a critical thinking workshop differed from knowledge by those who attended two workshops ($p = .014$, $\eta^2 = .04$) but not from those attending one, three, or four or more workshops. The effect size was small.

For the remaining strategies, Games-Howell post hoc tests were used because the Levene test indicated that the variances of seven teaching strategies were unequal (omnibus F were significant). There were no significant means differences on knowledge of ‘close reading’ (item 42) by the number of critical thinking workshops attended. In contrast, the knowledge for ‘post thoughts’ (item 40) by lecturers who attended two critical thinking workshops differed from knowledge of those who never attended a workshop ($p = .004$, $\eta^2 = .04$) or one workshop ($p = .050$), but not from those attending three or four or more workshops. The knowledge for ‘create perspectives on an issue’ (item 41) by lecturers who never attended a critical thinking workshop differed from knowledge of those who attended two (p = .022, η^2 = .05) or four or more workshops (p = .007), but not from those attending one or three workshops. The knowledge for ‘models concepts and language of probability’ (item 46) by lecturers who never attended a critical thinking workshop differed from knowledge who attended four or more workshops (p = .017, η^2 = .04), but not from those who attended one, two, or three workshops. The knowledge for ‘evaluate different sources’ (item 49) by lecturers who never attended a critical thinking workshop differed from knowledge who attended four or more workshops (p = .027, η^2 = .03), but not those who attended one, two, or three workshops. The knowledge for ‘form and test hypotheses’ (item 50) by lecturers who attended four or more critical thinking workshops differed from knowledge who never attended a workshop (p = .023, η^2 = .05) or three workshops (p = .043), but not from those attending one, or two workshops. The knowledge of ‘incorporate insights from other disciplines’ (item 51) by lecturers who never attended a critical thinking workshop differed from knowledge who attended two workshops (p = .041, η^2 = .04), but not from those attending one, three, or four or more workshops. All effect sizes were small.

Table 35

Knowledge of Critical Thinking Teaching Strategies by Workshops Attended, Means and Standard Deviations (factor 1)

Knowledge of Critical Thinking Teaching Strategies (factor 1)	Critical Thinking Workshops Attended 0		1		2		3		4 or more		Post hoc
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Identifies strengths and weaknesses of an author's thesis and argument(s). (item 39)	1.4	0.5	1.4	0.5	1.6	0.5	1.4	0.5	1.6	0.5	0; 1, 2, 3, 4 or more
Asks students to post thoughts that arise as they are reading assigned material, showing evidence or critical thought. (item 40)	1.5	0.5	1.5	0.5	1.7	0.5	1.5	0.5	1.7	0.5	2; 0, 1, 3, 4 or more
Creates a continuum of perspectives on an issue, with students asked to place their own views along the continuum and to articulate why they have chosen their stance and not that of another. (item 41)	1.4	0.5	1.5	0.5	1.6	0.5	1.4	0.5	1.7	0.5	0; 1, 2, 3, 4 or more
Uses close readings, i.e., develop students' thinking about reading. (item 42)	1.4	0.5	1.5	0.5	1.6	0.5	1.4	0.5	1.7	0.5	0, 1, 2, 3, 4 or more
Models appropriate use of the concepts and language of probability. (item 46)	1.4	0.5	1.5	0.5	1.6	0.5	1.5	0.5	1.7	0.5	0; 1, 2, 3, 4 or more

Asks students to evaluate the different sources from which they draw information, e.g., on-line peer-reviewed journals vs Wikipedia vs. a website advocating for a particular point of view. (item 49)	1.4	0.5	1.6	0.5	1.6	0.5	1.5	0.5	1.7	0.5	0; 1, 2 ,3, 4 or more
Asks students to form and test hypotheses about observed phenomena. (item 50)	1.4	0.5	1.5	0.5	1.6	0.5	1.3	0.5	1.7	0.5	4 or more; 0, 1, 2, 3
Asks students if insight from other disciplines can be incorporated in an analysis. (item 51)	1.4	0.5	1.5	0.5	1.6	0.5	1.4	0.5	1.6	0.5	0; 1, 2, 3, 4 or more

Results for Team Skills (factor 2)

One-way ANOVA was used to test knowledge of critical thinking teaching strategies within the 'team skills' factor among the number of critical thinking workshops attended by Malaysian polytechnic lecturers. Three teaching strategies were included in this analysis. The results found statistically significant differences for knowledge of each of the three strategies tested. These strategies were: 'cooperative learning-sharing' (item 56), 'student workshops on projects' (item 57), and 'work in groups to solve problems' (item 58). See Table 36.

Table 36

One-Way Analysis of Variance for Critical Thinking Workshops Attended on Knowledge of Critical Thinking Teaching Strategies (factor 2)

Knowledge of Critical Thinking Teaching Strategies (factor 2)	*SS*	*MS*	$F(4, 353)$	*p*	η^2
Uses cooperative learning-sharing in groups and working together to accomplish a goal. (item 56)					
Between Groups	3.42	0.85	3.64	.006	.04
Within	82.86	0.24			
Uses workshop students on projects, i.e., students work together to provide feedback and suggestions for major projects. (item 57)					
Between Groups	3.35	0.84	3.67	.006	.04
Within	80.50	0.23			
Works in groups to solve problems that have multiple solutions. (item 58)					
Between Groups	3.61	0.90	4.04	.003	.04
Within	78.90	0.22			

Table 37 shows the knowledge means, with the highest means of 1.8 for all three strategies by lecturers who attended four or more critical thinking workshops.

Games-Howell post hoc tests were used because the Levene test indicated that the variances of three teaching strategies were unequal (omnibus F were significant). The knowledge of critical thinking on the ‘cooperative learning-sharing’ strategy (item 56) by lecturers who never attended any critical thinking workshops differed from knowledge of those who attended two workshops (p = .036, η^2 = .04), but not from those who attended one, three, or four or more workshops. The effect size was small. The knowledge for ‘student workshops on projects’ strategy (item 57) by lecturers who never attended any critical thinking workshops differed from knowledge of those who attended one (p = .030, η^2 = .04) or two workshops (p = .044), but not from those attending three or four or more workshops. The effect size was small. The knowledge for ‘work in groups to solve problems’ strategy (item 58) by lecturers who never attended any critical thinking workshops differed from knowledge of those who attended one (p = .042, η^2 = .04) or four or more workshops (p = .010), but not from those attending two or three workshops. Again, the effect size was small.

Table 37

Knowledge of Critical Thinking Teaching Strategies by Workshops Attended, Means and Standard Deviations (factor 2)

Knowledge of Critical Thinking Teaching Strategies (factor 2)	Critical Thinking Workshops Attended 0		1		2		3		4 or more		Post hoc
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Uses cooperative learning-sharing in groups and working together to accomplish a goal. (item 56)	1.5	0.5	1.6	0.5	1.7	0.5	1.5	0.5	1.8	0.4	0; 1, 2, 3, 4 or more
Uses workshop students on projects, i.e., students work together to provide feedback and suggestions for major projects. (item 57)	1.5	0.5	1.7	0.5	1.7	0.5	1.5	0.5	1.8	0.4	0; 1, 2, 3, 4 or more
Works in groups to solve problems that have multiple solutions. (item 58)	1.5	0.5	1.7	0.5	1.7	0.5	1.5	0.5	1.8	0.4	0; 1, 2, 3, 4 or more

Results for Reflectively Engages (factor 3)

Statistically significant differences were found on knowledge of five critical thinking teaching strategies in 'reflectively engages' factor by the number of critical thinking workshops attended by Malaysian polytechnic lecturers. See Table 38.

Table 38

One-Way Analysis of Variance for Critical Thinking Workshops Attended on Knowledge of Critical Thinking Teaching Strategies (factor 3)

Knowledge of Critical Thinking Teaching Strategies (factor 3)	*SS*	*MS*	$F(4, 353)$	*p*	η^2
Uses writing assignments with specific tasks or goals focusing on a particular kind of thinking or reflection. (item 31)					
Between Groups	3.39	0.85	3.58	.007	.04
Within	83.99	0.24			
Requires students to justify their positions with examples and evidence, both in verbal and written analysis. (item 32)					
Between Groups	2.57	0.64	2.65	.033	.03
Within	85.45	0.24			
Asks students to identify the strengths and weaknesses of their own arguments. (item 33)					
Between Groups	3.73	0.93	3.87	.004	.04
Within	85.22	0.24			
Asks students to evaluate evidence from multiple perspectives. (item 34)					
Between Groups	4.56	1.14	4.80	.001	.05
Within	83.83	0.24			
Engages students with controversial topics. (item 35)					
Between Groups	3.08	0.77	3.14	.015	.03
Within	86.41	0.25			

Table 39 shows the knowledge means, with the highest means of 1.8 for lecturers who attended four or more critical thinking workshops on four of the five strategies: 'writing assignments with specific tasks' (item 31), 'justify students' positions with examples and evidence' (item 32), 'identify strengths and weaknesses of students' arguments' (item 33), and 'evaluate evidence from multiple perspectives' (item 34). The strategy 'engage students with controversial topics' (item 35) had the highest knowledge mean (*M* =1.7) from lecturers who attended two workshops.

The variances for each of the five teaching strategies in this factor were unequal (omnibus F was significant for each). Thus, Games-Howell post hoc tests were used to indicate differences between means of lecturers' knowledge of five critical thinking teaching strategies by the number of critical thinking workshops attended. Knowledge of the 'writing assignments with specific tasks' strategy (item 31) by lecturers who never attended a critical thinking workshop differed from knowledge of those who attended two (p = .012, η^2 = .04) or four or more (p = .044) workshops, but not from those attending one or three workshops. Knowledge of the strategy 'justify students' positions with examples and evidence' (item 32) by lecturers who never attended any critical thinking workshops differed from knowledge of those who attended four or more workshops (p = .044, η^2 = .03), but not from those attending one, two, or three workshops. Knowledge of the strategy 'identify strengths and weaknesses of students' arguments' (item 33) by lecturers who never attended a workshop differed from knowledge of those who attended two (p = .023, η^2 = .04) or four or more (p = .015) workshops, but not from those attending one or three workshops. Knowledge of the strategy 'evaluate evidence from multiple perspectives' (item 34) by lecturers who never attended a critical thinking workshop differed from knowledge of those who attended two (p = .002, η^2 = .05) or four or more (p = .015) workshops, but not from those attending one or three workshops. Knowledge of the strategy 'engage students with controversial topics' (item 35) by lecturers never attending any workshops differed from knowledge of those who attended two workshops (p = .009, η^2 = .03), but not from those attending one, three, or four workshops. The effect sizes for each strategy were small.

Table 39

Knowledge of Critical Thinking Teaching Strategies by Workshops Attended, Means and Standard Deviations (factor 3)

Knowledge of Critical Thinking Teaching Strategies (factor 3)	Critical Thinking Workshops Attended: 0		1		2		3		4 or more		Post hoc
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Uses writing assignments with specific tasks or goals focusing on a particular kind of thinking or reflection. (item 31)	1.5	0.5	1.6	0.5	1.7	0.5	1.5	0.5	1.8	0.4	0; 1, 2, ,3, 4 or more
Requires students to justify their positions with examples and evidence, both in verbal and written analysis. (item 32)	1.5	0.5	1.6	0.5	1.7	0.5	1.6	0.5	1.8	0.4	0; 1, 2, ,3, 4 or more
Asks students to identify the strengths and weaknesses of their own arguments. (item 33)	1.4	0.5	1.5	0.5	1.7	0.5	1.6	0.5	1.8	0.4	0; 1, 2, ,3, 4 or more
Asks students to evaluate evidence from multiple perspectives. (item 34)	1.4	0.5	1.6	0.5	1.7	0.5	1.5	0.5	1.8	0.4	0; 1, 2, ,3, 4 or more
Engages students with controversial topics. (item 35)	1.4	0.5	1.5	0.5	1.7	0.5	1.4	0.5	1.6	0.5	0; 1, 2, 3, 4 or more

Results for Challenges and Questions (factor 4)

The seven teaching strategies of the 'challenges and questions' factor were tested using one-way ANOVA. The results found significant differences of knowledge by Malaysian polytechnic lecturers attending different numbers of critical thinking workshops on five of the seven strategies. These strategies were: 'analyze ethical choices in small group discussions' (item 12), 'question students to define the perspective of a text' (item 14), 'students' observations across a range of specific contexts' (item 15), 'analyze primary source texts' (item 17), and 'quantitative skills' (item 20). See Table 40.

Table 40

One-Way Analysis of Variance for Critical Thinking Workshops Attended on Knowledge of Critical Thinking Teaching Strategies (factor 4)

Knowledge of Critical Thinking Teaching Strategies (factor 4)	*SS*	*MS*	*F*(4, 353)	*p*	η^2
Uses questions for students to analyze ethical choices in small group discussions and in written summaries. (item 12)					
Between Groups	2.91	0.77	2.98	.019	.03
Within	86.12	0.24			
Uses questions that ask students to describe orally or in written form data that are shown to them, e.g., interpretations of graphs and tables. (item 13)					
Between Groups	1.96	0.49	2.13	.077	.02
Within	81.37	0.23			
Uses questions for students to define the perspective that is revealed in a text and evaluate the impact of that perspective on the way the text is written. (item 14)					
Between Groups	3.94	0.98	4.10	.003	.04
Within	84.76	0.24			

Invites students to abstract from their observations, to think about the implication of their ideas, and to generate these ideas across a range of specific contexts. (item 15)					
Between Groups	4.55	1.14	4.77	.001	.05
Within	84.23	0.24			
Analyzes primary source texts. (item 17)					
Between Groups	4.04	1.01	4.20	.002	.05
Within	84.91	0.24			
Uses an assessment and critical examination of scientific literature. (item 19)					
Between Groups	2.32	0.58	2.35	.054	.03
Within	87.14	0.25			
Teaches quantitative skills. (item 20)					
Between Groups	2.71	0.68	2.77	.027	.03
Within	86.56	0.25			

Table 41 shows the highest knowledge means of 1.8 for the strategies of ‘question students to define the perspective of a text’ (item 14) and ‘students’ observations across a range of specific contexts’ (item 15) of lecturers who attended four or more workshops. Two other strategies shared the highest means of 1.7 by lecturers in the two, or four or more workshops groups. These strategies were ‘analyze ethical choices in small group discussions’ (item 12) and ‘quantitative skills’ (item 20). The strategy, ‘analyze primary source texts,’ (item 17) had the highest knowledge mean (M = 1.7) from those who attended two workshops.

Differences of knowledge means for these five strategies were measured by the Games-Howell post hoc test. The knowledge of critical thinking teaching strategies on ‘question students to define the perspective of a text’ (item 14) by lecturers who never attended any critical thinking workshops differed from knowledge of those who attended two (p = .011, η^2 = .04) or four or more (p = .015) workshops, but not from those attending one or three workshops. Knowledge of the strategy ‘students’ observations across a range of specific contexts' (item 15) by lecturers never attending any workshops differed from knowledge of those who attended two (p = .025, η^2 = .05) or four or more (p = .002) workshops, but not from those attending one or three. Knowledge of the strategy 'analyze primary source texts' (item 17) by lecturers never attending a workshop differed from knowledge of those who attended two workshops (p = .002, η^2 = .05), but not from those attending one, three, or four or more workshops. All effect sizes were small. No significant differences were found for the strategies 'analyze ethical choices in small group discussions' (item 12) or 'quantitative skills' (item 20).

Table 41

Knowledge of Critical Thinking Teaching Strategies by Workshops Attended, Means and Standard Deviations (factor 4)

Knowledge of Critical Thinking Teaching Strategies (factor 4)	Critical Thinking Workshops Attended 0		1		2		3		4 or more		Post hoc
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Uses questions for students to analyze ethical choices in small group discussions and in written summaries. (item 12)	1.4	0.5	1.5	0.5	1.7	0.5	1.6	0.5	1.7	0.5	0, 1, 2, 3, 4 or more
Uses questions for students to define the perspective that is revealed in a text and evaluate the impact of that perspective on the way the text is written. (item 14)	1.4	0.5	1.5	0.5	1.7	0.5	1.6	0.5	1.8	0.4	0; 1, 2, 3, 4 or more
Invites students to abstract from their observations, to think about the implication of their ideas, and to generate these ideas across a range of specific contexts. (item 15)	1.4	0.5	1.5	0.5	1.7	0.5	1.7	0.5	1.8	0.4	0; 1, 2, ,3, 4 or more
Analyzes primary source texts. (item 17)	1.5	0.5	1.5	0.5	1.7	0.4	1.4	0.5	1.6	0.5	0; 1, 2, 3, 4 or more
Teaches quantitative skills. (item 20)	1.5	0.5	1.5	0.5	1.7	0.5	1.5	0.5	1.7	0.5	0, 1, 2, 3, 4 or more

Comparing Engineering and Non-engineering Lecturers: Use, Perceptions, and Knowledge

Question 7: Are there differences for frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies by Malaysian polytechnic lecturers from engineering and non-engineering disciplines?

An independent samples t-test was conducted to compare these three variables--frequency of use, perception of effectiveness, and knowledge of teaching strategies--between engineering and non-engineering lecturers. The analysis was conducted based on the four factors previously discussed. The effect size for each strategy was calculated using the difference between the two groups' means divided by standard deviation. Typical effect sizes for this type of calculation are: .20 as small, .50 as medium, and .80 as large (Cohen, 1992).

Engineering and Non-engineering and Use

There were no significant differences between engineering and non-engineering lecturers in the first factor, 'evaluates in practice', regarding the frequency of use for these teaching strategies (See Table 42). Likewise, no significant differences were found in the frequency of use of teaching strategies in the 'team skills' factor (factor 2) (See Table 43). This indicated that both engineering and non-engineering lecturers may have similar pattern of usage.

Table 42

Group Differences for Frequency of Use on Critical Thinking Strategies, Engineering and Non-engineering (factor 1)

Frequency of Use Measure (factor 1)	Engineering (n = 232)		Non-engineering (n = 126)		*t*(356)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Identifies strengths and weaknesses of an author's thesis and argument(s). (item 39)	2.81	1.13	2.77	1.15	.36	.722	.04
Asks students to post thoughts that arise as they are reading assigned material, showing evidence or critical thought. (item 40)	3.01	1.05	3.08	1.05	.61	.543	.06
Creates a continuum of perspectives on an issue, with students asked to place their own views along the continuum and to articulate why they have chosen their stance and not that of another. (item 41)	2.92	1.09	3.07	1.01	1.27	.204	.13
Uses close readings, i.e., develop students' thinking about reading. (item 42)	2.93	1.04	3.02	1.03	.85	.398	.09
Analyzes statistics (display average, correlation). (item 44)	2.88	1.09	2.85	1.03	.22	.827	.02
Focuses on getting students to recognize an arguments' underlying logical structure rather than accepting it based on "authority" or other cues. (item 45)	2.94	1.13	3.02	1.00	.67	.503	.07
Models appropriate use of the concepts and language of probability. (item 46)	2.94	1.07	3.05	1.00	.94	.350	.09

Asks students to evaluate the different sources from which they draw information, e.g., on-line peer-reviewed journals vs Wikipedia vs. a website advocating for a particular point of view. (item 49)	3.05	1.08	3.11	1.00	.51	.609	.05
Asks students to form and test hypotheses about observed phenomena. (item 50)	2.78	1.14	2.86	1.10	.58	.560	.06
Asks students if insight from other disciplines can be incorporated in an analysis. (item 51)	2.91	1.11	2.98	1.15	.64	.525	.07

Table 43

Group Differences for Frequency of Use on Critical Thinking Strategies, Engineering and Non-engineering (factor 2)

Frequency of Use Measure (factor 2)	Engineering (n = 232)		Non-engineering (n = 126)		*t*(356)	*p*	Cohen's *D*
	M	*SD*	*M*	*SD*			
Uses cooperative learning-sharing in groups and working together to accomplish a goal. (item 56)	3.47	1.02	3.40	1.02	0.58	.566	.06
Uses student workshops on projects, i.e., students work together to provide feedback and suggestions for major projects. (item 57)	3.49	1.06	3.34	1.04	1.26	.210	.13
Works in groups to solve problems that have multiple solutions. (item 58)	3.69	1.00	3.61	0.92	0.73	.467	.08

‘Reflectively engages’ (factor 3) did show statistical differences between engineering and non-engineering lecturers on frequency of use for two teaching strategies: ‘identify strengths and weaknesses of students’ arguments’ (item 33), (p = .029), and ‘engage students with controversial topics’ (item 35), (p = .048). See Table 44. Inspection of the means indicated that the average usage of the ‘identify strengths and weaknesses of students’ arguments’ strategy (item 33) for engineering lecturers (M = 3.26) was lower than the mean (M = 3.50) for non-engineering lecturers. The difference between means was 0.24 points. The effect size was small (d = .23). Additionally, the average usage of the ‘controversial topics’ strategy (item 35) for engineering lecturers (M = 3.01) was lower than the mean (M = 3.24) for non-engineering lecturers. The difference between means was 0.23 points. The effect size was small (d = .21).

Regarding ‘questions and challenges’ (factor 4), Table 45 shows that engineering lecturers were significantly different from non-engineering lecturers on the frequency of use of ‘question students to define the perspective of a text’ (item 14), (p = .042). The average frequency of use for engineering lecturers (M = 3.20) was lower than the mean (M =3.40) for non-engineering lecturers. The difference between means was 0.20 points. The effect size was small (d = .21).

Table 44

Group Differences for Frequency of Use on Critical Thinking Strategies, Engineering and Non-engineering (factor 3)

Frequency of Use Measure (factor 3)	Engineering (n = 232)		Non-engineering (n = 126)		*t*(356)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Uses writing assignments with specific tasks or goals focusing on a particular kind of thinking or reflection. (item 31)	3.51	0.96	3.54	0.88	0.30	.763	.03
Requires students to justify their positions with examples and evidence, both in verbal and written analysis. (item 32)	3.35	0.94	3.46	0.93	1.07	.284	.11
Asks students to identify the strengths and weaknesses of their own arguments. (item 33)	3.26	1.02	3.50	0.98	2.19	.029	.23
Asks students to evaluate evidence from multiple perspectives. (item 34)	3.20	1.00	3.38	0.95	1.68	.094	.18
Engages students with controversial topics. (item 35)	3.01	1.06	3.24	1.02	1.98	.048	.21

Table 45

Group Differences for Frequency of Use on Critical Thinking Strategies, Engineering and Non-engineering (factor 4)

Frequency of Use Measure (factor 4)	Engineering (n = 232)		Non-engineering (n = 126)		*t*(356)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Uses questions for students to analyze ethical choices in small group discussions and in written summaries. (item 12)	3.26	0.92	3.42	0.81	1.61	.108	.17
Uses questions that ask students to describe orally or in written form data that are shown to them, e.g., interpretations of graphs and tables. (item 13)	3.49	0.91	3.52	0.80	0.34	.736	.04
Uses questions for students to define the perspective that is revealed in a text and evaluate the impact of that perspective on the way the text is written. (item 14)	3.20	0.94	3.40	0.87	2.04	.042	.21
Invites students to abstract from their observations, to think about the implication of their ideas, and to generate these ideas across a range of specific contexts. (item 15)	3.25	0.94	3.33	0.94	0.69	.493	.07
Analyzes primary source texts. (item 17)	3.28	0.90	3.24	0.94	0.42	.678	.04
Uses an assessment and critical examination of scientific literature. (item 19)	3.13	1.00	2.94	1.13	1.60	.110	.17
Teaches quantitative skills. (item 20)	3.24	0.95	3.17	1.03	0.65	.515	.07

Engineering and Non-engineering Lecturers' Perceptions

There were no significant differences between engineering and non-engineering lecturers in their perceptions of effectiveness of teaching strategies in the first three factors: 'evaluates in practice', 'team skills', and 'reflectively engages' (See Tables 46, 47, and 48).

However, 'challenges and questions' (factor 4) has statistically significant differences between the two lecturer groups' perceptions of effectiveness toward two teaching strategies: 'question students to define the perspective of a text' (item 14), (p = .015), and 'students' observations across a range of specific contexts' (item 15), (p = .032). The results are illustrated in Table 49. The average perception of effectiveness for the 'question students to define the perspective of a text' strategy (item 14) from engineering lecturers (M = 3.27) was lower than the mean (M = 3.48) from non-engineering lecturers. The difference was 0.21 points. The effect size was small (d = .26). The perception of effectiveness for 'students' observations across a range of specific contexts' (item 15) from engineering lecturers (M = 3.25) was lower than the score (M = 3.44) from non-engineering lecturers. The difference between means was 0.19 points. The effect size was small (d = .23).

Table 46

Group Differences for Perception on Effectiveness of Critical Thinking Strategies, Engineering and Non-engineering (factor 1)

Perception of Effectiveness (factor 1)	Engineering (n = 232)		Non-engineering (n = 126)		*t*(356)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Identifies strengths and weaknesses of an author's thesis and argument(s). (item 39)	3.16	0.90	3.17	0.83	0.11	.911	.01
Asks students to post thoughts that arise as they are reading assigned material, showing evidence or critical thought. (item 40)	3.20	0.88	3.32	0.77	1.28	.202	.14
Creates a continuum of perspectives on an issue, with students asked to place their own views along the continuum and to articulate why they have chosen their stance and not that of another. (item 41)	3.22	0.79	3.34	0.64	1.44	.151	.15
Uses close readings, i.e., develop students' thinking about reading. (item 42)	3.23	0.79	3.34	0.71	1.28	.200	.14
Analyzes statistics (display average, correlation). (item 44)	3.13	0.82	3.21	0.81	0.90	.369	.10
Focuses in getting students to recognize an arguments' underlying logical structure rather than accepting it based on "authority" or other cues. (item 45)	3.19	0.87	3.22	0.70	0.33	.740	.03
Models appropriate use of the concepts and language of probability. (item 46)	3.20	0.84	3.22	0.81	0.26	.794	.03

Asks students to evaluate the different sources from which they draw information, e.g., on-line peer-reviewed journals vs Wikipedia vs. a website advocating for a particular point of view. (item 49)	3.26	0.78	3.34	0.71	0.94	.350	.10
Asks students to form and test hypotheses about observed phenomena. (item 50)	3.18	0.86	3.19	0.77	0.15	.881	.02
Asks students if insight from other disciplines can be incorporated in an analysis. (item 51)	3.16	0.84	3.22	0.81	0.64	.525	.07

Table 47

Group Differences for Perception on Effectiveness of Critical Thinking Strategies, Engineering and Non-engineering (factor 2)

Perception of Effectiveness (factor 2)	Engineering (n = 232)		Non-engineering (n = 126)		*t*(356)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Uses cooperative learning-sharing in groups and working together to accomplish a goal. (item 56)	3.57	0.89	3.52	0.78	0.56	.574	.06
Uses student workshops on projects, i.e., students work together to provide feedback and suggestions for major projects. (item 57)	3.56	0.86	3.55	0.72	0.19	.850	.02
Works in groups to solve problems that have multiple solutions. (item 58)	3.62	0.87	3.65	0.71	-0.35	.724	-.04

Table 48

Group Differences for Perception on Effectiveness of Critical Thinking Strategies, Engineering and Non-engineering (factor 3)

Perception of Effectiveness (factor 3)	Engineering (n = 232)		Non-engineering (n = 126)		*t*(356)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Uses writing assignments with specific tasks or goals focusing on a particular kind of thinking or reflection. (item 31)	3.40	0.80	3.48	0.74	1.02	.309	.12
Requires students to justify their positions with examples and evidence, both in verbal and written analysis. (item 32)	3.36	0.80	3.45	0.74	1.05	.296	.11
Asks students to identify the strengths and weaknesses of their own arguments. (item 33)	3.33	0.79	3.48	0.75	1.78	.076	.19
Asks students to evaluate evidence from multiple perspectives. (item 34)	3.29	0.84	3.42	0.75	1.48	.141	.16
Engages students with controversial topics. (item 35)	3.25	0.84	3.37	0.79	1.27	.207	.13

Table 49

Group Differences for Perception on Effectiveness of Critical Thinking Strategies, Engineering and Non-engineering (factor 4)

Perception of Effectiveness (factor 4)	Engineering (n = 232)		Non-engineering (n = 126)		*t*(356)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Uses questions for students to analyze ethical choices in small group discussions and in written summaries. (item 12)	3.34	0.70	3.45	0.67	1.42	.158	.15
Uses questions that ask students to describe orally or in written form data that are shown to them, e.g., interpretations of graphs and tables. (item 13)	3.43	0.73	3.56	0.71	1.71	.088	.18
Uses questions for students to define the perspective that is revealed in a text and evaluate the impact of that perspective on the way the text is written. (item 14)	3.27	0.81	3.48	0.70	2.44	.015	.26
Invites students to abstract from their observations, to think about the implication of their ideas, and to generate these ideas across a range of specific contexts. (item 15)	3.25	0.77	3.44	0.84	2.15	.032	.23
Analyzes primary source texts. (item 17)	3.25	0.79	3.22	0.77	0.37	.711	.04
Uses an assessment and critical examination of scientific literature. (item 19)	3.30	0.81	3.27	0.84	0.30	.762	.03
Teaches quantitative skills. (item 20)	3.33	0.78	3.43	0.78	1.12	.263	.12

Engineering and Non-engineering Lecturers' Knowledge

There were no significant differences between engineering and non-engineering lecturers of their knowledge of critical thinking teaching strategies when analyzed using the four factors (See Tables 50, 51, 52, and 53).

Table 50

Group Differences for Knowledge of Critical Thinking Teaching Strategies, Engineering and Non-engineering (factor 1)

Knowledge of Critical Thinking Teaching Strategies (factor 1)	Engineering (n = 232)		Non-engineering (n = 126)		*t*(356)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Identifies strengths and weaknesses of an author's thesis and argument(s). (item39)	1.48	0.50	1.44	0.50	0.84	.404	.09
Asks students to post thoughts that arise as they are reading assigned material, showing evidence of critical thought. (item 40)	1.56	0.50	1.51	0.50	0.95	.343	.09
Creates a continuum of perspectives on an issue, with students asked to place their own views along the continuum and to articulate why they have chosen their stance and not that of another. (item 41)	1.49	0.50	1.47	0.50	0.34	.735	,04
Uses close readings, i.e., develop students' thinking about reading. (item 42)	1.50	0.50	1.49	0.50	0.14	.886	.01
Analyzes statistics (display average, correlation). (item 44)	1.46	0.50	1.43	0.50	0.59	.555	.06
Focuses in getting students to recognize an arguments' underlying logical structure rather than accepting it based on "authority" or other cues. (item 45)	1.49	0.50	1.41	0.49	1.35	.177	.14
Models appropriate use of the concepts and language of probability. (item 46)	1.51	0.50	1.45	0.50	1.01	.311	.11

Asks students to evaluate the different sources from which they draw information, e.g., on-line peer-reviewed journals vs Wikipedia vs. a website advocating for a particular point of view. (item 49)	1.52	0.50	1.52	0.50	0.12	.906	.01
Asks students to form and test hypotheses about observed phenomena. (item 50)	1.49	0.50	1.43	0.50	1.06	.290	.11
Asks students if insight from other disciplines can be incorporated in an analysis. (item 51)	1.49	0.50	1.45	0.50	0.63	.532	.07

Table 51

Group Differences for Knowledge of Critical Thinking Teaching Strategies, Engineering and Non-engineering (factor 2)

Knowledge of Critical Thinking Teaching Strategies (factor 2)	Engineering (n = 232)		Non-engineering (n = 126)		*t*(356)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Uses cooperative learning-sharing in groups and working together to accomplish a goal. (item 56)	1.59	0.49	1.6	0.49	0.01	.994	.00
Uses student workshops on projects, i.e., students work together to provide feedback and suggestions for major projects. (item 57)	1.65	0.48	1.58	0.50	1.32	.188	.14
Works in groups to solve problems that have multiple solutions. (item 58)	1.66	0.48	1.60	0.49	1.05	.296	.11

Table 52

Group Differences for Knowledge of Critical Thinking Teaching Strategies, Engineering and Non-engineering (factor 3)

Knowledge of Critical Thinking Teaching Strategies (factor 3)	Engineering (n = 232)		Non-engineering (n = 126)		*t*(356)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Uses writing assignments with specific tasks or goals focusing on a particular kind of thinking or reflection. (item 31)	1.61	0.49	1.54	0.50	1.24	.217	.13
Requires students to justify their positions with examples and evidence, both in verbal and written analysis. (item 32)	1.56	0.50	1.58	0.50	0.42	.672	.04
Asks students to identify the strengths and weaknesses of their own arguments. (item 33)	1.54	0.50	1.54	0.50	0.02	.987	.00
Asks students to evaluate evidence from multiple perspectives. (item 34)	1.56	0.50	1.54	0.50	0.45	.651	.05
Engages students with controversial topics. (item 35)	1.51	0.50	1.49	0.50	0.38	.707	.04

Table 53

Group Differences for Knowledge of Critical Thinking Teaching Strategies, Engineering and Non-engineering (factor 4)

Knowledge of Critical Thinking Teaching Strategies (factor 4)	Engineering (n = 232)		Non-engineering (n = 126)		*t*(356)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Uses questions for students to analyze ethical choices in small group discussions and in written summaries. (item 12)	1.55	0.50	1.51	0.50	0.79	.429	.08
Uses questions that ask students to describe orally or in written form data that are shown to them, e.g., interpretations of graphs and tables. (item 13)	1.64	0.48	1.62	0.49	0.35	.724	.04
Uses questions for students to define the perspective that is revealed in a text and evaluate the impact of that perspective on the way the text is written. (item 14)	1.53	0.50	1.57	0.50	0.67	0.50	.07
Invites students to abstract from their observations, to think about the implication of their ideas, and to generate these ideas across a range of specific contexts. (item 15)	1.54	0.50	1.56	0.50	0.30	.762	.03
Analyzes primary source texts. (item 17)	1.56	0.50	1.49	0.50	1.31	.189	.12
Uses an assessment and critical examination of scientific literature. (item 19)	1.52	0.50	1.43	0.50	1.68	.093	.18
Teaches quantitative skills. (item 20)	1.56	0.50	1.47	0.50	1.60	.113	.17

Subcategories of Engineering and Non-engineering and Use

Question 7a: Are there differences between Malaysian polytechnic lecturers within subcategories of engineering and non-engineering in regard to the frequency of use of critical thinking teaching strategies?

To answer this question, the lecturers were divided into two groups: within engineering disciplines (civil, electrical, and mechanical), and within non-engineering disciplines (information technology, design, and visual communication; commerce and hospitality). The ‘other’ groups from both disciplines were excluded due to insufficient responses to run analysis (‘other’ in engineering = 22, ‘other’ in non-engineering = 2). At least 30 responses are required to do comparison analysis (Gliner et al., 2009). One-way ANOVA was used to test the frequency of use of critical thinking teaching strategies among the three sub-groups with engineering analyzed across the four factors. An independent samples t-test was conducted for sub-groups within non-engineering because two groups were combined for this analysis due to insufficient participant numbers in the ‘hospitality’ group (17 responses). Commerce and hospitality disciplines were combined because the hospitality program is related to entrepreneurial business. In general, hospitality programs are focused on business and service-oriented operations (Slattery, 2002).

Subcategories of Engineering and Use

Among the 25 teaching strategies, some usage differences among civil, electrical, and mechanical lecturers were found. In ‘evaluates in practice’ (factor 1) one strategy showed statistical differences: ‘models concepts and language of probability’ (item 46). See Table 54.

Table 54

One-Way Analysis of Variance for Groups within Engineering Disciplines on Frequency of Use (factor 1)

Frequency of Use (factor 1)	SS	MS	F(2, 207)	*p*	η^2
Models appropriate use of the concepts and language of probability. (item 46)					
Between Groups	8.21	4.12	3.89	.022	.04
Within	218.57	1.06			

Table 55 shows the usage means, with the highest means for this strategy from mechanical lecturers ($M = 3.1$). The post hoc Tukey HSD test was used due to homogeneity of variances (omnibus F was not significant). The result showed the use of this strategy (item 46) by mechanical lecturers differed from usage by electrical lecturers ($p = .023$, $\eta^2 = .04$), but not from civil lecturers, a small effect size.

Table 55

Frequency of Use by Groups within Engineering Disciplines (factor 1)

Frequency of Use (factor 1)	Groups within Engineering Disciplines Civil (n = 41)		Electrical (n = 87)		Mechanical (n = 82)		Post hoc
	M	*SD*	*M*	*SD*	*M*	*SD*	
Models appropriate use of the concepts and language of probability (item 46)	2.7	1.1	2.7	1.1	3.1	1.0	Mechanical; Civil, Electrical

Subcategories of Non-engineering and Use

Two strategies within ‘challenges and questions’ (factor 4) showed significant statistical differences between non-engineering subcategories: ‘analyze primary source texts’ (item 17), (p = .013) and ‘quantitative skills’ (item 20), (p = .017). See Table 56.

Inspection of the two groups’ means indicated that the frequency of use of ‘analyze primary source texts’ (item 17) was lower for information technology, design, and visual communication lecturers (M = 2.93) than the mean (M = 3.37) for the combined group of commerce and hospitality lecturers. The difference between means was 0.44 points. The effect size was medium (d = .50).

The average frequency of use of ‘quantitative skills’ (item 20) was lower for information technology, design, and visual communication lecturers (M = 2.85) than the mean (M = 3.32) for the combined group of commerce and hospitality lecturers. The difference between means was 0.47 points. The effect size was small (d = .40).

Table 56

Group Differences for Frequency of Use between IT, Design, and Visual Communication and Combined Groups of Commerce and Hospitality (factor 4)

Frequency of Use (factor 4)	IT, Design, and Visual Communication (n = 40)		Combined Commerce and Hospitality (n = 84)		*t*(122)	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Analyzes primary source texts. (item 17)	2.93	1.02	3.37	0.86	2.52	.013	.50
Teaches quantitative skills. (item 20)	2.85	0.98	3.32	1.03	2.42	.017	.40

Open-ended Questions

Three semi-structured, open-ended questions were on the questionnaire to encourage Malaysian polytechnic lecturers to explore their thoughts and opinions on the usage of alternative teaching strategies, learning outcomes, and assessment of critical thinking. Thematic content analysis was used to analyze responses to these open-ended questions by coding and identifying themes by the frequency of words and values expressed by the participants.

Additional Strategies

On open-ended question 1, lecturers were asked to list additional teaching strategies that they incorporated into their teaching, which were not included in the 58 strategies of the questionnaire. Of the 358 responses, 125 lecturers (engineering = 74, non-engineering = 51) replied to this question. Thirty-seven lecturers said none (engineering = 27, non-engineering = 10), and 12 further explained strategies they taught were included on the questionnaire (engineering = 7, non-engineering = 5). Sixty-one percent of those providing responses (engineering = 40, non-engineering = 36) listed teaching strategies they used to infuse critical thinking.

There was a diversity of teaching strategies listed by engineering and non-engineering lecturers and eleven themes were developed: student engagement, deeper learning, work in groups, technical abilities, awareness, experiential learning, case and problem-based learning, conceptual learning, application into business, discovery, and creativity. The themes and strategies were detailed in Table 57.

‘Experiential learning’ was determined to be the theme with the most additional strategies listed by lecturers with fifteen (engineering = 7, non-engineering = 8). This theme involved field trips, role-play, games, debate, lab activity, and debrief.

The next most cited theme was ‘case and problem-based learning’ including case studies, problem-based learning, and problem solving, listed by 14 lecturers (engineering = 8, non-engineering = 6). Nine lecturers (engineering = 6, non-engineering = 3) chose cooperative, collaboration, and discussions or demonstrations to ‘work in groups’ to motivate their students to think critically. ‘Discovery’, such as research and projects, was used by nine lecturers (engineering = 6, non-engineering = 3). ‘Deeper learning’, involving WH questions (who, what, when, where, and how?) and drill and practice activities were listed by eight lecturers (engineering = 4, non-engineering = 4). Regarding ‘student engagement’, six lecturers (engineering = 3, non-engineering = 3) encouraged students to think critically by giving more student-centered activities. ‘Technical abilities’ teaching strategies were used by seven lecturers (engineering = 4, non-engineering = 3) to allow students to do exploration through technical skills, hands-on, and technology activities. The theme of ‘awareness’ involving mind mapping, reflective thinking, and negative thinking categorized strategies used by three lecturers (engineering = 2, non-engineering = 1). There were three themes of learning listed by non-engineering lecturers: ‘application into business concepts’ (3), ‘conceptual learning’ (1), and ‘creativity’ (1).

Table 57

Responses from Engineering and Non-engineering Lecturers for Additional Critical Thinking Teaching Strategies (Open-ended Question 1)

Themes	Engineering (n = 40)	Non-engineering (n = 36)
Experiential Learning		
a. Field trips/outdoor activities/ industrial visit/community activity	2	3
b. Role-play	0	2
c. Games/local riddles/ fun teaser/ singing and entertainment/puzzles	2	2
d. Debate	1	0
e. Lab activity	1	0
f. Debrief	1	1
Subtotal = 15	**7**	**8**
Case and problem-based learning		
a. Case studies	2	3
b. Problem-based learning	3	3
c. Problem solving	3	0
Subtotal = 14	**8**	**6**
Work in groups		
a. Cooperative	1	0
b. Collaboration	1	1
c. Discussions/demonstrations in groups	4	2
Subtotal = 9	**6**	**3**
Discovery		
a. Research	1	0
b. Project- engineering/graphic/IT	5	3
Subtotal = 9	**6**	**3**
Deeper learning	3	3
a. WH questions	0	1
b. Drill and practice	1	0
Subtotal = 8	**4**	**4**
Students engagement		
a. Share opinions, values, knowledge and give alternatives	3	2
b. Student-centered learning	0	1
Subtotal = 6	**3**	**3**
Technical abilities		
a. Technical skills	3	0
b. Hands-on	0	2

c. Use technology/virtual reality	1	1
Subtotal = 7	**4**	**3**
Awareness		
a. Mind mapping	0	1
b. Reflective journal	1	0
c. Negative thinking	1	0
Subtotal = 3	**2**	**1**
Application into business		
a. Blue Ocean Strategy	0	1
b. SWOT analysis	0	2
Subtotal = 3	**0**	**3**
Conceptual learning		
a. Interpretive method	0	1
Subtotal = 1	**0**	**1**
Creativity		
a. Think out of the box	0	1
Subtotal = 1	**0**	**1**

Expectations for Students Learning

On open-ended question two, lecturers were asked to give opinions on their expectations for their students' learning in regard to critical thinking. Of 358 lecturers, 124 (engineering = 68, non-engineering = 56) responded to this question. Based on the participants' responses, the development of the themes was inspired by Bloom's Taxonomy of cognitive and affective domains (Blooms, 1984) and were discussed according to a top-to-bottom hierarchy.

Based on Table 58, 64 lecturers (engineering = 37, non-engineering = 27) agreed that students should achieve higher-order thinking (evaluation, synthesis, and analysis) as learning outcomes to develop or improve their critical thinking. Twenty-one lecturers (engineering = 12, non-engineering = 9) suggested comprehension and application (lower-order thinking) are sufficient to recognize that students are developing their critical thinking.

Also, lecturers seemed to use the affective domain of Bloom's Taxonomy as their standard of expectation for students' learning in accordance to critical thinking. Thirty-nine lecturers (engineering = 19, non-engineering = 20) responded that emotional factors and attitudes such as an internalized value system, value (understand and act), response, and awareness are essentials to becoming critical thinkers.

Table 58

Responses from Engineering and Non-engineering Lecturers about Expectations for Students Learning of Critical Thinking (Open-ended Question 2)

Themes	Engineering (n = 68)	Non-engineering (n = 56)
Cognitive Domain (Bloom's Taxonomy)		
a. Evaluation	11	11
b. Synthesis	21	13
c. Analysis	5	3
d. Application	6	8
e. Comprehension	6	1
Subtotal = 85	**49**	**36**
Affective Domain (Bloom's Taxonomy)		
a. Internalize value system	3	2
b. Value (understand and act)	16	12
c. Response	0	5
d. Receive (awareness)	0	1
Subtotal = 39	**19**	**20**

Critical Thinking Assessment

On open-ended question three, lecturers were asked to share their experiences in assessing students' development or to improve students' critical thinking. Of the 358 participants, 187 responded to this question. These responses divided into two themes: 'types of assessment' and 'areas of assessment for critical thinking'. Both are shown in Table 59. About 120 lecturers (engineering = 82, non-engineering = 38) described the forms of assessment used to foster and assess students' critical thinking outcomes. The most frequency listed were assignment/ reflective journal/case study; rubric/Outcome-based education (OBE) rubric/learning outcomes; observation/participation; quizzes/tests/final examinations; and presentations/interviews. In addition, 67 lecturers (engineering = 35, non-engineering = 32) referred to 'areas of assessment for critical thinking' such as evaluation and communication skills.

Table 59

Responses from Engineering and Non-engineering Lecturers for Critical Thinking Assessment (Open-ended Question 3)

Themes	Engineering (n = 117)	Non-engineering (n = 70)
Types of assessments		
a. Assignment/reflective journal/case study	9	7
b. Rubric/OBE rubric/learning outcomes	14	11
c. Report/lab report	3	3
d. Observation/participation	9	2
e. Quizzes/tests/final examinations	23	3
f. Practical work/lab experiments/lab practical/site visit	6	1
g. Presentations/interviews	8	9
h. Group work	7	1
i. Students' performances and quality of work	3	1
Subtotal = 120	**82**	**38**
Areas of assessment for critical thinking		
a. Evaluation/evaluating information/thinking consumer	20	20
b. Analysis	2	2
c. Communication skills	7	8
d. Explanation	6	2
Subtotal = 67	**35**	**32**

Summary

This study used a non-experimental design relying on Qualtrics, a web-based survey, to reach participants with the instrument. The survey included seven items on demographics; 58 critical thinking teaching strategies with responses for: (a) frequency of use, (b) perception of effectiveness, and (c) knowledge of critical thinking strategies; together with three open-ended questions asking about additional teaching strategies, learning outcomes, and evaluations in regard to critical thinking. The analysis was based on 358 respondents who completed the both demographics and critical thinking teaching strategies of the survey. The analysis included ranking, exploratory factor analysis (EFA), one-way ANOVAs, and independent sample t-tests.

Of the 58 strategies, the most frequently used critical thinking teaching strategy was ‘asks open-ended questions’ and the least frequently used strategy was ‘research-based readings’. The most effective strategy perceived by lecturers was ‘small group discussions with specific tasks assigned’ while the least effective was, again, ‘research-based readings’. Table 60 summarizes the overall findings from the quantitative data, and Figure 4 illustrates the findings from the open-ended questions.

Table 60

Summarization for Quantitative Findings

No	Research Questions	Analysis	Findings
1	What teaching strategies do Malaysian polytechnic lecturers use most frequently to encourage students to think critically?	Mean, Standard Deviation, Ranking	Frequency of use of 58 strategies: highest ranked - open-ended question (item 2), *M* = 3.88, *SD* = 0.759 lowest ranked - debate (item 28), *M* = 2.77, *SD* = 1.082
2	Which teaching strategies do Malaysian polytechnic lecturers perceived as effective in their teaching?	Mean, Standard Deviation, Ranking	Perceptions of 58 strategies: most effective - small group discussions (item 8), *M* = 3.77, *SD* = 0.715 less effective - research-based readings (item 26), *M* = 3.15, *SD* = 0.822
3	Is there an association between frequency of use and perception of effectiveness of teaching strategies by Malaysian polytechnic lecturers?	Mean, Standard Deviation, Pearson's Correlation, Exploratory Factor Analysis (EFA)	EFA results: reduced to 25 items with 4 factors: 'evaluates in practice' (factor 1), 'team skills' (factor 2), 'reflectively engages' (factor 3), 'and challenges and questions' (factor 4) All factors were related
4	Is there an association between frequency of use of teaching strategies and years of teaching experience of Malaysian polytechnic lecturers?	Mean, Standard Deviation, Pearson's Correlation, EFA	Significant relationships on: 'evaluates in practice' (factor 1) 'challenges and questions' (factor 4)
5	Is there an association between perception of effectiveness of teaching strategies and the highest level of education completed by Malaysian polytechnic lecturers?	Mean, Standard Deviation, Pearson's Correlation, EFA	Not related

6	Are there any differences for frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies by the number of critical thinking workshops attended by Malaysian polytechnic lecturers?	Mean, Standard Deviation, EFA ANOVA	Frequency of use: those who attended four or more critical thinking workshops differed from other groups: Factor 1: post thoughts (item 40), create a continuum of perspectives (item 41), close reading (item 42), recognize arguments (item 45), concepts and language of probability (item 46), evaluate different sources (item 49), form and test hypotheses about observed phenomena (item 50), incorporate insights from other disciplines in an analysis (item 51) Factor 2: workshop students on projects (item 57), work in groups (item 58) Factor 3: writing assignments with specific tasks (item 31), justify students positions with examples and evidence (item 32), identify students' arguments (item 33), evaluate evidences from multiple perspectives (item 34), engage students with controversial topics (item 35) Factor 4: Students' observations across range of specific contexts (item 15) Perceptions of effectiveness: those who attended two critical thinking workshops differed from other groups: Factor 1: post thoughts (item 40) Factor 2: workshop students on projects (item 57) Factor 3: identify strengths and weaknesses of students' arguments (item 33) Factor 4: students' observation across a range of

			specific contexts (item 15) Knowledge: those who never attended critical thinking workshop differed from other groups: Factor 1: identify author's thesis and argument(s) (item 39) Factor 2: cooperative learning-sharing (item 56), workshop students on projects (item 57), work in groups to solve problems (item 58) Factor 3: writing assignments with specific tasks (item 31), justify students' positions with examples and evidence (item 32), identify strengths and weaknesses of students' arguments (item 33), evaluate evidence from multiple perspectives (item 34), engage students with controversial topics (item 35) Factor 4: define and evaluate the impacts of perspectives on a text (item 14), students' observation across a range of specific contexts (item 15), analyze primary source text (item 17)
7	Are there differences in frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies by Malaysian polytechnic lecturers from engineering and non-engineering disciplines?	Mean, Standard Deviation, independent t test, ANOVA	Frequency of use: No differences on factors 1 and 2 Differences found: Factor 3: identify strengths and weaknesses on students' arguments (item 33), engage students with controversial topics (item 35)

Factor 4: define perspectives that are revealed in a text (item 14)
Perceptions of effectiveness:
No differences on factors 1, 2, and 3
Differences found:
Factor 4: define perspectives that are revealed in a text (item 14), invite students to abstract from their observations (item 15)
Knowledge:
no differences on all factors.
Subcategories engineering, on factor 1:
mechanical lecturers used model concepts and language of a probability strategy (item 46) more frequently than electrical lecturers
Subcategories non-engineering on factor 4:
commerce and hospitality used analyze primary source texts (item 17) and quantitative skills (item 20) strategies more frequently than information technology, design, and visual communication lecturers

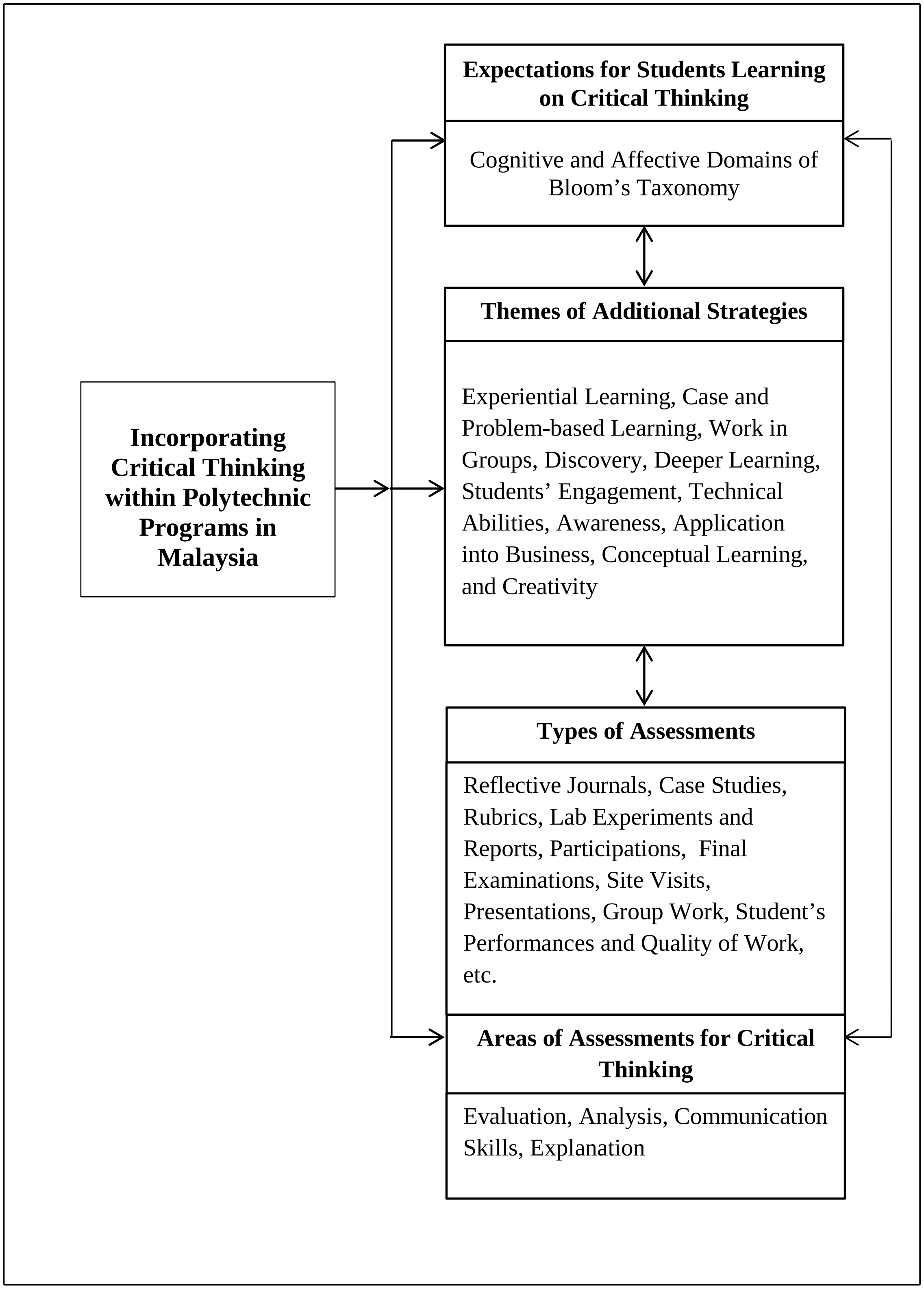

Figure 4. *Findings from open-ended questions.*

CHAPTER 5 : DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

This chapter summarizes the study's findings and recommendations. The purpose of this study was to investigate the extent to which polytechnic lecturers in Malaysia incorporate critical thinking teaching strategies. The questionnaire was distributed using a web-based survey to lecturers from 27 polytechnics in Malaysia. The findings of this study illustrated the frequency of use of critical thinking teaching strategies of Malaysian polytechnic lecturers, their perceptions of effectiveness of critical thinking strategies, and their knowledge of critical thinking strategies. The discussion in this chapter is organized by the research questions, followed by limitations and recommendations for further studies.

Summary

This study used a non-experimental design and was conducted during the spring of 2012. The web-based survey was delivered using Qualtrics to 4,529 lecturers at 27 Malaysian polytechnics. The questionnaire comprised seven demographic questions, 58 five-point-Likert type (use and effectiveness) and dichotomous type (knowledge) items regarding critical thinking teaching strategies, and three open-ended questions asking about additional strategies, expectations for students learning, and critical thinking assessment.

Six hundred and sixty-eight lecturers completed the demographic questions only, while 358 lecturers completed both demographics and teaching strategies items. The surveys of lecturers who filled out both sections were used for further analysis. These lecturers were shown to be representative of the larger group who only filled out the demographics section. The response rate was 7.9 percent, adequate for an Internet survey, based on the work of Dillman et al. (2009) who suggested an adequate response rate for web-based surveys is between five and twenty percent of the population. The duration of data collection was six weeks, which included an email pre-notification, a questionnaire with consent, one email reminder, and an email thank you letter, as per the approved IRB protocol. The data were analyzed using frequencies, percentages, means, standard deviations, exploratory factor analysis (EFA), independent sample t-tests, and one-way ANOVAs. From the findings, the Cronbach's alphas for 58 strategies were 0.98 for frequency of use and perception of effectiveness, and 0.99 for knowledge of critical thinking teaching strategies. These statistics demonstrate a high internal reliability.

EFA indicated four factors which included 25 strategies: 'evaluates in practice' (factor 1), 'team skills' (factor 2), 'reflectively engages' (factor 3), and 'challenges and questions' (factor 4). The EFA results were based on the frequency of use variable. The Cronbach's alphas for the 25 items were 0.96 for frequency of use and 0.98 for each perception of effectiveness and knowledge of critical thinking teaching strategies. The Cronbach's alphas for each of the four factors were 'evaluates in practice', ten items (α = 0.94); 'team skills', three items (α = 0.91); 'reflectively engages', five items (α = 0.91); and 'challenges and questions', seven items (α = 0.88).

For research questions one and two, of the 58 critical thinking strategies that were examined, the 'open-ended question' strategy was rated as the most frequently used, while 'small group discussions with specific tasks assigned' was the strategy perceived as the most effective by lecturers. Question three's findings revealed there were significant relationships between frequency of use and perceptions of effectiveness for the four factors. There were significant relationships found regarding question four, between frequency of use and years of teaching experience, on factors one and four ('evaluates in practice' and 'challenges and questions', respectively). However, for research question five, no significant relationships between perception of effectiveness and highest level of education were found.

Research question six looked at frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies as related to critical thinking workshops attended by lecturers (five groups-- zero, one, two, three, or four or more workshops attended). Lecturers who attended four or more critical thinking workshops differed in frequency of strategy usage from the other groups, those who attended two critical thinking workshops differed in perception of effectiveness from the other groups, and those who never attended any critical thinking workshops differed in knowledge from the other groups.

Question seven looked at differences between engineering and non-engineering lecturers. Differences were found in frequency of use for the following strategies: 'identify strengths and weaknesses of students' arguments' (item 33) and 'engage students with controversial topics' (item 35) of factor 3; and 'question students to define the perspective of a text' (item 14) of factor 4. There were perception differences on both items 14 and 15 of factor 4, 'question students to define the perspective of a text' and 'students' observations across a range of specific contexts', respectively. For knowledge of critical thinking teaching strategies, there were no differences between engineering and non-engineering lecturers on 25 teaching strategies. Within engineering lecturers, there were usage differences between electrical and mechanical lecturers on the 'model concepts and language of probability' strategy (item 46). Among non-engineering lecturers, there were usage differences between the information technology, design, and visual communications lecturers, and the combined group of commerce and hospitality lecturers on the frequency of use of ‘analyzing primary source texts’ (item 17) and ‘quantitative skills’ (item 20) strategies.

For the findings from the open-ended questions, ‘experiential learning’ was the theme describing the most listed additional strategies. ‘Cognitive and affective’ domains were the themes used to determine students’ learning outcomes. ‘Types of assessments’ and ‘areas of assessments for critical thinking’ were considered to assess students’ critical thinking.

Discussion of the Findings

Seven main research questions with one sub-question were addressed in this study. Frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies were the central variables in the research questions. These questions are discussed in order.

Discussion on Use of Teaching Strategies

Research Question 1: What teaching strategies do Malaysian polytechnic lecturers use most frequently to encourage students to think critically?

The findings from rank ordering the items by means of frequency of use indicated that, among the 58 critical thinking strategies of this study, lecturers rated ‘open-ended questioning’ as the most frequently used strategy. A study by Nesbitt and Cliff (2008) explained that open-ended questions have structural advantages in the learning process, such as making connections with life experiences, developing creative ideas and suggestions, and promoting critical thinking. Moreover, almost two-thirds of the top ten strategies most frequently used were associated with questioning with different objectives. People may ask questions because they have different levels of understanding, which may cause them to explore further. Teacher questioning facilitates students to identify reasoning that may be logical and coherent before making their decisions, which is a good practice of critical thinkers (Christenbury & Kelly, 1983). In reference to Bloom's taxonomy, there are types and levels of questioning that teachers can practice to increase students' inquiry. As discussed in Chapter Two, Bloom's taxonomy classifies the level of questioning as it relates to learning objectives. These learning objectives are developed using the taxonomy to guide teachers usage of activities and assessments of the subject matter to facilitate learning (Taba, 1966).

Another notable finding from this research question was that 'debate' was the least used of the 58 strategies. However, the difference of the means between the most and the least used strategies by rank-order was small (1.1). Despite being ranked as the least used strategy by lecturers, 'debate' should not be abandoned because some evidence suggests the importance of debate in critical thinking. Including, the participants of Scott's (2008) study agreed that besides advancing communication skills, critical thinking could be improved by debate.

In addition to research question one, the first open-ended question asked for additional critical thinking strategies used. Of the 125 lecturers who answered the question, the theme of 'experiential learning' included twelve percent of the strategies they listed. Included in this theme were: field trips, industrial visits, role-plays, games, local riddles, fun teasers, puzzles, debates, lab activities, and debriefs. Even though 'debate' was listed as the least used strategy by ranking, when responding to this open-ended question, lecturers listed this strategy. The findings showed that there might be a difference in the approach to debate used by lecturers compared to the wording of the item in the questionnaire related to debate. The results indicated lecturers used most of the teaching strategies discussed in Chapter Two such as debate, role-play (Gratton, 2010), and active learning (Duron et al., 2006) by integrating student-centered approaches.

Discussion on Perceptions of Teaching Strategies

Research Question 2: Which teaching strategies do Malaysian polytechnic lecturers perceive as effective in their teaching?

The findings from rank ordering indicated that, among the 58 critical thinking strategies, lecturers perceived ‘small group discussions’ was the most effective strategy listed in the study. Similarly, literature discussed in Chapter Two found that group work promotes student-centered learning that allows students to be more autonomous in developing integrative discussions and interactions among peers (Hyslop-Margison & Armstrong, 2004). Moreover, the ranking shows that five of the top ten strategies lecturers perceived to be effective in their teaching involved group activities. A study conducted by Gokhale (1995), who examined students in Industrial Technology at Western Illinois University, indicated students who were organized in criterion-based groups gained critical thinking skills through discussion and demonstrated the ability to solve problems. From the researcher’s own experience as a former polytechnic lecturer, class size may influence lecturers’ ability or willingness to incorporate such activities into their teaching.

Lecturers perceived ‘research-based reading’ as the least effective strategy. Additionally, eight of the ten least effective strategies related to research components such as analysis and hypotheses. Lecturers’ perceptions of incorporating research-based activities may be due to the program levels offered by polytechnics, and perhaps the initial level of critical thinking ability of polytechnic students. For example, the King et al.’s (1990) study indicated that graduate students’ critical thinking scores were higher than undergraduate students. To support the implementation of research-based strategies, Rosenshine (2012) suggested ten principles that can be used as guidelines for any level of education including:

> Begin a lesson with a short review of previous learning, present new material in small steps with student practice after each step, ask a large number of questions and check the responses of all students, provide models, guide student practice, check for student understanding, obtain a high success rate, provide scaffolds for difficult tasks, require and monitor independent practice, and engage students in weekly and monthly review (p. 12).

Discussion on Frequency of Use and Perception of Effectiveness

Research Question 3: Is there an association between frequency of use and perception of effectiveness of teaching strategies by Malaysian polytechnic lecturers?

For this and the remaining research questions, the discussions of the findings were based on EFA results. EFA determined four factors consisting of 25 strategies, thus, reducing 58 items of the questionnaire. The EFA structurally simplified the analysis process of this study. Generally, the four factors were labeled based on the concepts of teaching critical thinking: ‘evaluates in practice’ (10 items), ‘team skills’ (3 items), ‘reflectively engages’ (5 items), and ‘challenges and questions’ (7 items).

The frequency of use of these 25 strategies by lecturers had relationships with their perceptions of the strategies’ effectiveness. The lecturers may perceive a strategy is effective after they have tried the strategy and discovered it commensurate with students’ learning. It is a complex process to decide whether a strategy is effective. Nevertheless, in practical applications, when evaluating the effectiveness of critical thinking strategies, some considerations should include: framing some questions in accordance to identification of outcome variables, designing and selecting assessment instruments and ecologically valid indicators, doing multiple comparison groups, considering time of testing, identifying classroom strategies that engender critical thinking, and attending to issues in educational measurements (Halpern, 2001). Perceptions of a strategy’s effectiveness are related to many factors including learning objectives and types of assessments incorporated in curriculum.

Accordingly, open-ended questions two and three asked lecturers about their expectations of students’ learning and critical thinking assessments. To perceive if a strategy is effective, lecturers’ responses fit the cognitive and affective domain themes. Of 124 responses to open-ended question two, 69 percent of lecturers listed expectations in the ‘cognitive domain’ and 31 percent in the ‘affective domain’ when they identified what students should accomplish to improve their critical thinking. These findings further support the idea of Halpern (2001) who considered that students’ outcomes are used to determine if a strategy is to be effective for critical thinking.

To decide if a strategy is effective for developing students' critical thinking, an assessment of students' abilities to think critically is required. Critical thinking assessment can be classified in various ways depending on the learning outcomes of a course and what strategies are used in teaching. According to Ennis (1993), critical thinking assessments should have equal emphasis with implementation strategies.

One hundred and eighty-seven lecturers provided useful information in regard to critical thinking assessments. Sixty-four percent of lecturers incorporated rubrics, quizzes, tests, final examinations, presentations, and lab experiments to assess students' critical thinking. Thirty-six percent of lecturers assessed students' critical thinking using evaluation, analysis, communication skills, and explanation. In short, the selection and use of assessments by lecturers may depend on types of teaching strategies they chose and their expectations for students' learning to think critically. An effective critical thinking assessment should "address the dual problem of whether students can think more critically and, if they can, whether they actually use their critical-thinking skills without specific prompting" (Halpern, 2001, p. 273). To assess students' critical thinking, Ennis (1993) strongly suggested considering the following before selecting the assessment:

> Diagnose the levels of students' critical thinking, give students feedback about their critical thinking process, motivate students to be better at critical thinking, inform teachers about the success of their effort to teach students to think critically, do research about critical thinking, instructional questions, and issues, provide help in deciding whether a student should enter an educational program, and provide information for holding schools accountable for the critical thinking process of their students (pp. 180-181).

Discussion on Frequency of Use and Years of Teaching Experience

Research Question 4: Is there an association between frequency of use of teaching strategies and years of teaching experience of Malaysian polytechnic lecturers?

The findings of this research question indicated relationships between years of teaching experience and two of the teaching strategy factors: ‘evaluates in practice’ (factor 1) and ‘challenges and questions’ (factor 4). The findings seem to be consistent with other research, which found repeated experience can increase the familiarity with the usage of critical thinking (Willingham, 2008). In short, lecturers’ usage of critical thinking strategies was reflected by their own experiences. Experience may cause changes toward the teachers’ thinking about teaching strategies. For example, when teachers are asked to discuss a case study strategy, teachers who have experience in the strategy attempt to promote metacognition and elaborate new ideas to improve their teaching, while the less experienced teachers want more clarification on implementing the strategy (Levin, 1995). Teachers’ decisions to use a strategy may also depend on students’ behaviors when they repeat the use of the same strategies (Levin, 1995). Also, a belief that students lack independent thinking in any situation may cause teachers to resist putting effort and time to promote critical thinking (Willingham, 2008). To consistently value critical thinking, goals and objectives should be revised and clarified regularly by teachers to ensure critical thinking expectations will be met (Ennis, 1997). To conclude, lecturers’ experiences may have a positive or negative effect on the usage of critical thinking teaching strategies.

Discussion on Perception of Effectiveness and Level of Education

Research Question 5: Is there an association between perception of effectiveness of teaching strategies and the highest level of education completed by Malaysian polytechnic lecturers?

This study asked for the highest level of education completed; it did not ask which college or university where the lecturers earned their credentials. The analysis indicated there was no relationship between perception of effectiveness of teaching strategies and level of education. The level of education does not relate to lecturers' perceptions of critical thinking strategies as effective or not in developing students' critical thinking.

Lecturers may presume the 25 teaching strategies are effective because these strategies have been regularly and consistently used at every educational level in Malaysian or international universities at which they studied. With such experiences, it is possible that lecturers have developed preconceptions of the effectiveness of the teaching strategies based on if they were exposed to such strategies when they were students. If this is the case, then it is even more reasonable to introduce these strategies to students; they may become teachers. Critical thinking can be perceived differently when people have varied knowledge, experience, and practice in demonstrating reflective thinking (Willingham, 2008). To further explore this question, similar studies should assess lecturers' critical thinking and explore how they perceive assessment of the attainment of critical thinking skills in different ways.

Discussion on Critical Thinking Workshops Attended with Use, Perceptions, and Knowledge

Research Question 6: Are there any differences for frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies by the number of critical thinking workshops attended by Malaysian polytechnic lecturers?

This question asked participants about the number of critical thinking workshops attended, not about the level or content of these workshops. For this section, differences in lecturers' responses to the number of critical thinking workshops attended were addressed using three variables: use, perceptions, and knowledge of critical thinking teaching strategies.

Use of Teaching Strategies

These findings addressed the frequency of use of teaching strategies related to critical thinking workshops attended by lecturers. It is interesting to note that lecturers who attended four or more critical thinking workshops used critical thinking teaching strategies more frequently than other groups on 17 of 25 strategies, some of these include: 'students' observations across range of specific contexts' (item 15), 'identify students' arguments' (item 33), 'post thoughts' (item 40), and 'student workshops on projects' (item 57). The findings may indicate that the workshops organized for lecturers covered some of the 25 strategies of this study. However, there are other strategies that can be used by teachers without training (Willingham, 2008).

Perception of Effectiveness

Lecturers who attended two critical thinking workshops differed in perceptions from other groups on the following strategies: 'students' observations across range of specific contexts' (item 15), 'identify students' arguments' (item 33), 'post thoughts' (item 40), and 'workshop students on projects' (item 57). These findings are supported by research of Joshi, Pradhan and Dixit (2003) who found that workshop participants changed teaching practices as they developed new knowledge and skills by attending workshops. These findings were an unexpected because four of 25 strategies showed statistically significant differences. It is also unclear why the group who attended two workshops perceived effectiveness as greater effectiveness compared to the group who attended four or more workshops. This may suggest that some workshop formats conducted by polytechnics may be insufficient, the workshop content may have been at introductory levels, or the workshop instructors may have had insufficient knowledge of critical thinking to motivate lecturers to implement some strategies.

Knowledge of Critical Thinking Teaching Strategies

The findings indicated that most lecturers who never attended a workshop had less knowledge of the teaching strategies compared to those who have attended one or more workshops. The findings of the current study are consistent with those of Joshi et al. (2003) who found that knowledge developed by their research participants who had attended workshops was similar to this study. However, some further improvements on the workshops conducted by Malaysian polytechnics in regard to critical thinking are suggested. Questionnaires given at the end of workshop sessions could be used to gain information from the participants on advantages and disadvantages of skill development and learning and on workshop improvement.

Together, the findings of the three variables related to critical thinking workshops attended showed that workshops may increase the use, perceptions, and knowledge of critical thinking teaching strategies. The most interesting finding was that use, perceptions, and knowledge differences occurred on the same strategies: ‘students’ observations across range of specific contexts’ (item 15), ‘identify students’ arguments’ (item 33), ‘post thoughts’ (item 40), and ‘student workshops on projects’ (item 57). Guskey (2002) suggested professional development such as workshops could change “teachers’ classroom practices, attitudes, and beliefs” (p. 381). Workshops may encourage teachers to challenge their own thinking through interactions, discussions, and brainstorms with their colleagues to build their inquiry expertise (Gupta & Kashiri, 2007). In short, workshops are a strategy to improve critical thinking for teachers.

Some recommendations are required to improve the workshops conducted by Malaysian polytechnics, such as segregating the knowledge level of teachers’ critical thinking by incorporating beginner, intermediate, and advanced levels to better match the content needs of participants. The workshop organizers should choose workshop speakers or facilitators who have expert knowledge of critical thinking to develop participants’ content knowledge critically and effectively. Various strategies and activities as peer feedback, coaching (Timpson & Doe, 2008), and mini-grants (Timpson & Broadbent, 1995) incorporated in the workshops sustain and increase polytechnic lecturers’ knowledge and implementation of critical thinking.

Discussion on Engineering and Non-engineering with Use, Perceptions, and Knowledge

Research Question 7: Are there differences for frequency of use, perception of effectiveness, and knowledge of critical thinking teaching strategies by Malaysian polytechnic lecturers from engineering and non-engineering disciplines?

The findings indicated that non-engineering lecturers used the strategies of 'questioning students to define the perspective of a text' (item 14), 'identifying strengths and weaknesses of students' arguments' (item 33), and 'engaging students with controversial topics' (item 35) more frequently than engineering lecturers. Non-engineering lecturers perceived the strategies of 'questioning students to define the perspective of a text' (item 14) and 'students' observations across a range of specific contents' (item 15) to be more effective than engineering lecturers.

Research Question 7a: Are there differences between Malaysian polytechnic lecturers within subcategories of engineering and non-engineering in regard to the frequency of use of critical thinking teaching strategies?

This research question detailed the findings within engineering (civil, electrical, or mechanical) and within non-engineering (information technology, design, and visual communication, commerce, or hospitality). Within engineering lecturers, mechanical lecturers used the 'model concepts and language of probability' strategy (item 46) more frequently than electrical lecturers. Within non-engineering lecturers, responses of commerce and hospitality lecturers were combined. Commerce and hospitality lecturers used the strategies of 'analyzing primary source texts' (item 17) and 'quantitative skills' (item 20) more frequently than did information technology, design, and visual communication lecturers.

The findings showed that different disciplines may use different strategies due to different goals and learning objectives of a program (research questions 9 and 9a). In addition, King et al. (1990) claimed that students' critical thinking varied by academic discipline. For example, engineering programs specify conceptual dimensions of the technology content relevant to engineering (Waks, 1994). From the researcher's experiences of teaching, engineering programs integrate engineering, science, and mathematics that require conceptual learning to acquire engineering knowledge and skills. In contrast, finance programs focus on solving ill-structured problems such as dealing with costs, sales, profits, inventory, and accounts that require multiple levels of challenging questions (Carrithers et al., 2008). The differences of means by engineering and non-engineering lecturers were small. Thus, teaching major did not impact lecturers as to the use of teaching strategies, some small differences were found.

Although engineering and non-engineering are different, some courses integrate content from both disciplines, which may influence the selection of teaching strategies. For example, small group discussions, work projects, and seminars were used to teach liberal education undergraduate students about engineering because these were appropriate to the critical and interpretive skill needs of engineering content (Ettouney, 1994).

Additional Findings

The findings obtained from open-ended questions provided significant information. An 'affective domain' theme was identified as related to students' outcomes to demonstrate critical thinking. Based on responses to expectations of students' learning, lecturers wanted their students to accept other students' viewpoints, collaborate in groups with good understanding and behavior, and understand their own thinking when voicing creative ideas and reasons. Emotional stability can impact critical thinking, particularly when making judgments and decisions, as skepticism and bias are often involved in the process (Elder, 1997). In other words, cognitive and emotional processes are intertwined in the learning process. To help in controlling, organizing, and managing feelings in teaching and learning, emotional intelligence is a reliable model to be incorporated (Salovey & Mayer, 1990). Emotional intelligence should be nurtured in optimizing critical thinking (Elder, 1997). A study conducted by Stedman and Andenoro (2007) revealed that students' critical thinking dispositions were influenced by emotional intelligence. There may be advantages to incorporating emotional intelligence with critical thinking. Emotional intelligence skills include "managing emotions so as to attain specific goals; understanding emotions, emotional language, and the signals conveyed by emotions; using emotions to facilitate thinking; and perceiving emotions accurately in oneself and others" (Mayer, Salovey, & Caruso, 2008, p. 507). By empowering students with emotional intelligence in thinking, they may learn to better control their own thoughts, reasons, and behaviors to handle the complexity of their learning (Timpson & Doe, 2008) and develop empathy for understanding others and their thinking.

Another important finding from the open-ended questions was related to students' hands-on experiences. Engineering and non-engineering lecturers used hands-on activities to incorporate critical thinking consistent with the long term focus on preparation for Technical and Vocational Education (TVE) occupations. TVE programs focus on apprenticeships and the curriculum is student-oriented, where students are trained to become skilled workers (Finch & Crunkilton, 1999). Hands-on learning develops students' technical abilities and allows student involvement, exploration, and experience of their own learning to retain information (Timpson & Doe, 2008). Malaysian polytechnics should consider incorporating emotional intelligence and hands-on learning for all polytechnic programs to achieve students' fullest potentials on critical thinking and preparation as skilled workers.

Discussion and Implications on Curriculum

The curricula should provide teachers with knowledge, skills, abilities, behaviors, beliefs, and values they identify as main predictors of students' learning achievement (Tyler, 1949). TVE curricula attempt to cover such proficiencies. Simultaneously, TVE curricula and the labor market demands specific skills and competencies of critical thinking (Rudd, 2007). The findings showed Malaysian polytechnic curricula have encompassed critical thinking within TVE programs, but there is an opportunity for improvements.

There were mixed responses from lecturers, some claimed that polytechnic students are "spoon fed" learners. One of the lecturers stated, "Students failed to think critically because they have a lack of experiences in critical thinking activities. Maybe they are lazy to think and they always depend on lecturer's answers". Another lecturer said, "I hope students can give feedback in class but many of them do not think out of the box. They prefer sit, listen, and wait". On the other hand, other lecturers' statements revealed that not many critical thinking strategies were used within polytechnic programs. Student outcomes are reflected in the teachers' abilities and skills in valuing and incorporating critical thinking into their teaching (Ennis, 1997).

To some degree, student success is a reflection of the teachers' knowledge and skills. A structured framework with a combination of discovery learning, active and experiential learning, conceptual learning, cooperative learning, and creativity can be used to guide and facilitate both teachers and students to understand, demonstrate, sharpen, and sustain critical thinking (Timpson & Doe, 2008). As a result, the analysis and discussions from this study could feasibly be used for TVE curricula refinements and clarifications about critical thinking.

Limitations of the Study

Despite the substantive findings reported here, there were constraints and limitations that influenced the results of this study. The first limitation related to response rate. The response rate of 7.9 percent met the recommended range for web surveys, as five to twenty percent. However, the response rate could be improved if there were a decrease in the number of items of the questionnaire. With this, the page numbers of the screen of Qualtrics would be reduced. Also, the survey should be disseminated to accessible population and specifically distinguish teaching major of respondents. In addition, the questionnaire for this study was distributed less than two months before polytechnic final exams, which may have also affected the response rate of this study. The response rate may also have been influenced by server connection failures within the polytechnic system, which made three campuses impossible to access for distribution the survey.

Information on personal teaching style, values, and beliefs about critical thinking could be included to understand participants' responses in the questionnaire. A question about critical definitions also could be asked to measure lecturers' critical thinking in general. Another item that could be improved is the category of 'other' within engineering and non-engineering that could allow a space for lecturers to self-identify their teaching major.

Gender and industry experience were not analyzed in relation to frequency of use, perception of effectiveness, and knowledge. To predict frequency of use of strategies, perception of effectiveness and knowledge could be analyzed. Concept mapping could be used as an alternative approach to analyze open-ended responses.

Researchers' Self-reflection

The researcher began the dissertation with a belief that critical thinking is an important part of the teaching and learning process and reflected on her own ability to incorporate critical thinking in teaching. The researcher was surprised to learn that there are many contradicting critical thinking perspectives. The critical thinking literature, responses from lecturers to the questionnaire, in-depth research and training received from CSU, and intellectual discourse with colleagues have all contributed to her increased knowledge, insights, viewpoints, and a commitment to critical thinking. The researcher is committed to returning to Malaysia and contributing to polytechnic lecturers' understanding and use of critical thinking in their professional lives for the benefit of students.

Conclusion

Important information gained in this study may prove useful for the Malaysian polytechnic system. Findings indicated that Malaysian polytechnic lecturers do have awareness and knowledge about incorporating critical thinking into their teaching as articulated in the Malaysian Qualification Framework (MQF) guideline to encourage critical thinking in learning. However, the findings show that critical thinking should be strengthened within TVE programs and offered more by Malaysian polytechnics.

Expectations for students' learning by critical thinking should be aligned with the use of teaching strategies and assessments to optimize student critical thinking.

Malaysian polytechnics should be responsive to this challenge and reformulate the existing curricula to improve the use, perceptions, and knowledge of critical thinking teaching strategies. One important intervention would be offering a series of critical thinking workshops. These should be organized according to lecturers' knowledge of critical thinking. In particular, the content of these workshops should emphasize the importance of critical thinking and the relationships among critical thinking, emotional intelligence, and student learning outcomes.

These results indicate a need to strengthen the usage of active hands-on learning for both engineering and non-engineering majors, as exploration and problem solving are main components within all polytechnic programs. To continue helping lecturers improve their critical thinking strategies, some assessments that link critical thinking to content knowledge are proposed. The intention of this dissertation was to provide useful information to strengthen the quality of polytechnic programs in Malaysia and to promote and encourage critical thinking from the perspectives from the lecturers and the researcher.

Recommendations

This section makes recommendations with ideas to promote intellectual growth and enhance critical thinking to accommodate Malaysian policy makers and policy actors, especially at the Ministry of Higher Education, such as lecturers, administrators, leaders at the ministry level, curriculum developers, and others. In addition, other recommendations are designed for practitioners and researchers for the use of this research to explore other aspects of critical thinking teaching strategies.

Implications for Practitioners

Critical thinking should be promoted as a part of learning. Critical thinking should be promoted in higher education and emphasized at primary and secondary levels. Critical thinking is developed through prolonged experiences and requires patience and perseverance. Thus, the implementation of a critical thinking policy would be most successful if each and every one in the system were involved and supportive. Promotion of critical thinking should be a continuous improvement mission, not relegated to short-term projects. Critical thinking gives advantages to formal education and to the lifelong learning process. Critical thinking is an essential skill in 21st century education and is a continuous challenge for educational programs around the world.

Therefore, the Ministry of Higher Education in Malaysia should consider introducing and developing Malaysian educational organizations to improve critical thinking at the tertiary education level and to promote critical thinking through workshops and conferences. Annual or international critical thinking conferences should be organized to sustain and broaden these efforts of critical thinking development within Malaysian higher institutions. By supporting these efforts, academia's capabilities to promote critical thinking can be increased. Research on critical thinking should continue. Making connections with others through collaborating and programming are other ways to optimize the knowledge transfer and use of critical thinking. Although there are collaborations between higher education institutions and industry in Malaysia, a focused plan of action for critical thinking should be emphasized.

At Malaysian polytechnics, clarifications and broader delineation of critical thinking are needed to emphasize the teaching of critical thinking. Even though the polytechnic system is centralized by the Ministry of Higher of Education, lecturers should be given more freedom and flexibility in their teaching because critical thinking is dynamic and flexible. For example, it is important to increase choices of strategies using critical thinking and allow learning in depth rather than coverage of all topics.

Noting that 70% of lecturers attended no or 1 workshop, critical thinking workshops should be offered to all Malaysian polytechnic lecturers, depending on their level of critical thinking knowledge: beginner, intermediate, or advanced levels. Based on findings from this study, the researcher recommends a framework for critical thinking workshops as shown on Figure 5.

Lecturers who attended critical thinking workshops should be recognized and appointed as facilitators or volunteers to conduct peer-coaching critical thinking programs within their disciplines. Motivational communication and recognition could help encourage a long-term commitment to critical thinking programs. Other well-developed professional development programs related to critical thinking may be organized regularly to provide more inputs to new and senior lecturers including trainings, colloquiums, and conferences.

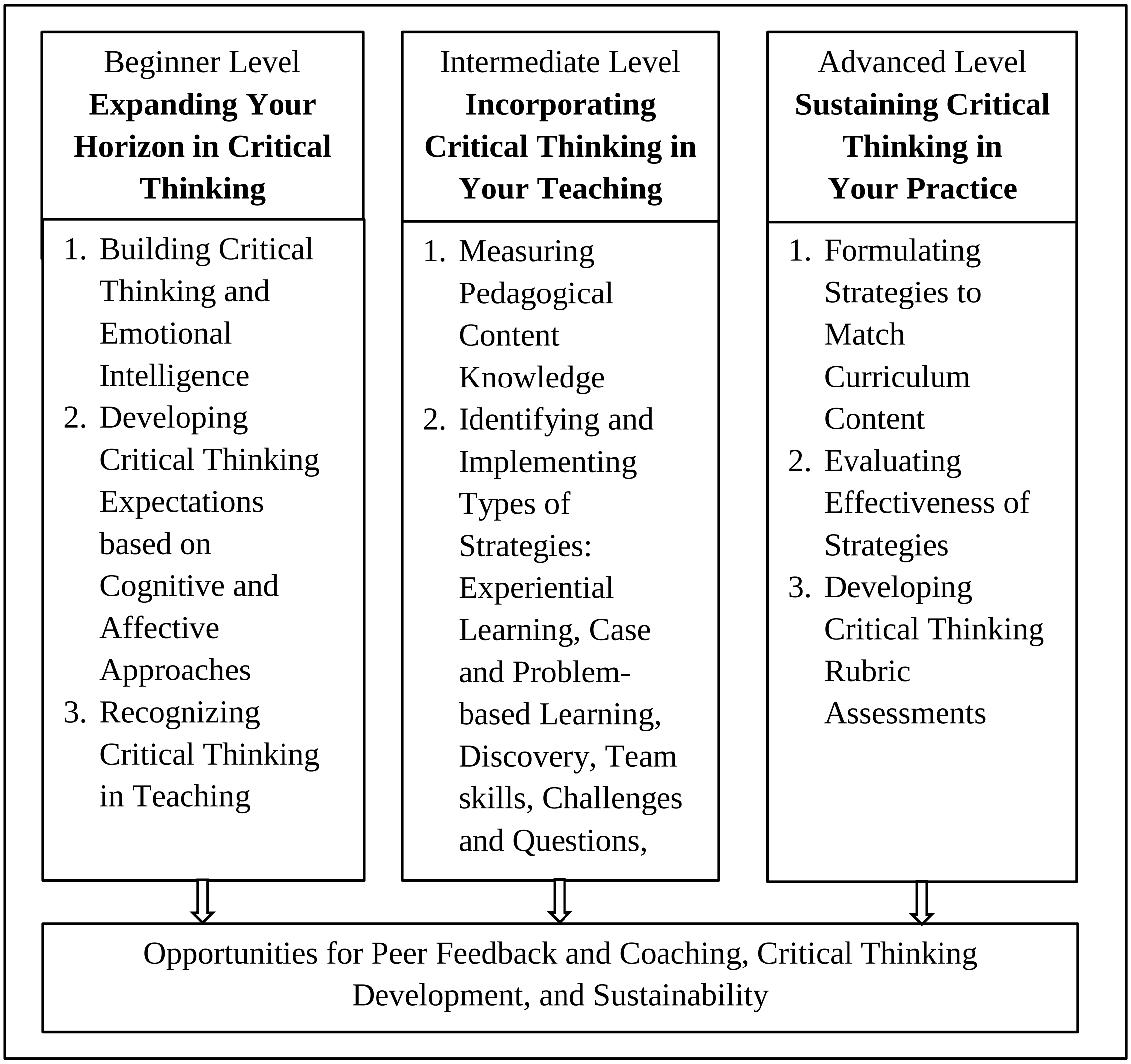

Figure 5. *A suggested framework by the researcher based on this study for Malaysian polytechnics critical thinking professional development workshops.*

Teaching and learning institutes could be introduced to each polytechnic to formulate the best practices for incorporating critical thinking into teaching. Assessments of critical thinking knowledge, emotional intelligence, and pedagogical content knowledge generally should be used to measure lecturers' professional capabilities. To provide structured support to lecturers' teaching of critical thinking, guest speakers who have extensive experience with critical thinking can be invited to motivate and inspire lecturers to implement the strategies, especially in experimental laboratories and with hands-on learning. Teaching materials should be expanded beyond textbooks and power point presentations so teachers/lecturers know how to optimize their usage of electronic media, movies, music, or other forms of educationally based entertainment and technology with proper monitoring, supervising, and integrating into courses.

Even though this study did not include students as participants, all the recommendations are equally beneficial to students as. To be independent critical thinkers, students should be able to ask challenging and critical questions, engage their minds, work in groups, and voice their opinions and thoughts. Guidance and instruction to become effective at these learning processes should be incorporated in educational experiences.

Implications for Researchers

More comprehensive research should be carried out to educate people on what critical thinking means to education and the work world. For those who want to replicate or improve upon this study, consideration should be given to using the 25 teaching strategies identified in the four factors found in this study. Researchers can refer to Barnhill's (2010) original strategies if wanting to review a comprehensive list of 82 strategies. The strategies may be applicable to higher institutions in Malaysia or other countries. However, refinements are needed if this study is to be used with teachers at primary or secondary levels because many of these strategies are appropriate for tertiary education. Open-ended questions of this study could be included for explanation of the usage and assessments.

Regardless of popular demand for cognitive intelligence research in education, little attention has been given to emotional intelligence in teaching and learning. Findings in this study revealed affective dimensions. A study of emotional intelligence and critical thinking should be done to explore the extent to which emotional intelligence influences teachers' and students' critical thinking.

Outcomes and feedback from policy makers, leaders, curriculum developers, and students regarding critical thinking teaching strategies can be explored to obtain additional information on promotion of critical thinking within tertiary education in Malaysia. Assessing pedagogical content knowledge to compare lecturers' content knowledge with knowledge of critical thinking strategies will inform TVE programs and higher education strategic planning. A full qualitative research design could explore deeper implications of critical thinking in education from a variety of educational stakeholders' perspectives.

To conclude, everyone within Malaysian education should be committed to critical thinking. A strategic plan that defines goals, directions, and decisions about critical thinking should be developed for implementation on national, regional, and international levels. Considering the United Nations Educational, Scientific, and Cultural Organization (UNESCO, 2001), "the needs and aspirations of individuals, technical and vocational education should: (a) permit the harmonious development of personality and character, and foster spiritual and human values, the capacity for understanding, judgment, *critical thinking* [emphasis added], and self-expression" (para. 17).

In general, critical thinking can be successful if lecturers at higher institutions are committed to conducting ongoing research that includes industry people, policy makers, curriculum developers, educators, students, and others who can provide feedback and support. By integrating these groups, critical thinking can be integrated in any curriculum within Malaysian higher education more effectively and consistently.

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Appendix A

Permission Letter from Original Author

Hotmail (171) Messenger SkyDrive | MSN

New | Reply Reply all Forward | Delete Junk Sweep ▾ Mark as ▾ Mov

Re: Request for Permission- Nor Lisa Sulaiman Colorado State University

Back to messages |

To see messages related to this one, group messages by conversation.

JBarnhil CT Arkansas Faculty 16/4/2011

To lisa sulaiman Reply

Lisa,
I apologize for my delayed response. You may use the questionnaire as stated in your attached permission letter giving full credit to myself as the author.
Best wishes on your dissertation research!
Jane Barnhill, Ed. D.

Appendix B

Questionnaire

English

Hello,

I am a doctoral student in educational program at Colorado State University in the United States of America. My dissertation is to explore types of teaching strategies that are used to infuse critical thinking within Technical and Vocational Education (TVE) programs in Malaysia. The information gained from the questionnaire will be used to develop a better understanding about polytechnic lecturer's knowledge on critical thinking within their teaching at polytechnics.

For your information, all of the answers you provide in this survey will be kept confidential. The survey data will be reported in a summary form and will not identify any individual person.

Please take your time to answer this survey. It takes 15 to 20 minutes to complete. You can begin the survey and return to it after a rest. Please respond to all of most items. It is okay to skip a few responses.

This survey has been adapted from the work of Edith Jane Barnhill, Ph.D. with her permission.

<< >>

English

Part One: Demographic Survey

Please answer this demographic survey. This part will ask you about your gender, highest level of education, years of teaching experience, numbers of attending critical thinking workshop, length of indusry experience, the major and program you teach at polytechnic institution. Kindly select one response for each.

I am a...

- Male
- Female

My highest level of education is...

- Diploma
- Bachelor
- Master
- Doctoral

I have been teaching at polytechnic for...

- 1-5 years
- 6-10 years
- 11-15 years
- 16-20 years
- more than 20 years

As a lecturer, I have attended...

- 0 critical thinking workshop
- 1 critical thinking workshop
- 2 critical thinking workshops
- 3 critical thinking workshops
- 4 or more critical thinking workshops

The length of my industry experience is...

- None
- less than 1 year
- 1-5 years
- 6-10 years
- More than 10 years

The major I teach in is...

Engineering	Non-engineering
○	○

[<<][>>]

English

Part Two: Teaching Strategy

Please answer the items based upon your teaching experience in a polytechnic institution. For each of the listed teaching strategies, first respond to the frequency with which you use the strategy in your teaching (from Never to Almost Always) to encourage students' critical thinking. Next, please respond indicating your perception of how effective (from Very Ineffective to Very effective) the strategy in in advancing students' critical thinking. Finally, please respond based on your knowledge of critical thinking (from Insufficient to Sufficient) for each teaching strategy listed.

To encourage critical thinking, I use teaching strategy that...

	Frequency of Use					Perception of Effectiveness					My knowledge of this critical thinking teaching strategy is	
	Never	Seldom	Sometimes	Frequently	Almost Always	Very Ineffective	Ineffective	Equally Ineffective and Effective	Effective	Very Effective	Insufficcient	Sufficient
1. asks questions and challenge students to consider all views (Socratic Method)												
2. asks open-ended question												
3. asks questions that provide opportunities for students to respond with critical thinking skills to assess a problem												
4. uses questions that ask students to analyze materials by making comparisons, identifying similarities and differences, and summarizing conclusions												
5. uses questions that ask students to reflect on their decision-making processes during the development of a project												
	Never	Seldom	Sometimes	Frequently	Almost Always	Very Ineffective	Ineffective	Equally Ineffective and Effective	Effective	Very Effective	Insufficcient	Sufficient
6. uses in-class, creative projects involving a variety of materials												
7. uses questions that ask students to apply what they have learned previously to new situations												
8. uses small group discussions with specific tasks assigned												
9. uses writing assignment prompts for students to engage in textual analysis of literature												
10. uses structured writing assignments that require students to employ critical thinking skills												

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English

Part Two: Teaching Strategy

Please answer the items based upon your teaching experience in a polytechnic institution. For each of the listed teaching strategies, first respond to the frequency with which you use the strategy in your teaching (from Never to Almost Always) to encourage students' critical thinking. Next, respond indicating your perception of how effective (from Very Ineffective to Very effective) the strategy in in advancing students' critical thinking. Finally, please respond based on your knowledge of critical thinking (from Insufficient to Sufficient) for each teaching strategy listed.

To encourage critical thinking, I use teaching strategy that...

	Frequency of Use					Perception of Effectiveness					My knowledge of this critical thinking teaching strategy is	
	Never	Seldom	Sometimes	Frequently	Almost Always	Very Ineffective	Ineffective	Equally Ineffective and Effective	Effective	Very Effective	Insufficient	Sufficient
11. uses the process writing approach for major assignments where students receive feedback on drafts and parts of their projects												
12. uses questions for students to analyze ethical choices in small group discussions and in written summaries												
13. uses questions that ask students to describe orally or in written form data that are shown to them, e.g., interpretations of graphs and tables												
14. uses questions for students to define the perspective that is revealed in a text and evaluate the impact of that perspective on the way the text is written												
15. invites students to abstract from their observations, to think about the implication of their ideas, and to generate these ideas across a range of specific contexts												
	Never	Seldom	Sometimes	Frequently	Almost Always	Very Ineffective	Ineffective	Equally Ineffective and Effective	Effective	Very Effective	Insufficient	Sufficient
16. creates an environment in which students may ask questions that exceed my immediate familiarity												
17. analyzes primary source texts												
18. exposes students to new kinds of texts (broadly interpreted to include musical, cinematic, visual, digital) from cultural contexts that differ from those of the student												
19. uses an assessment and critical examination of scientific literature												
20. teaches quantitative skills												

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English

Part Two: Teaching Strategy

Please answer the items based upon your teaching experience in a polytechnic institution. For each of the listed teaching strategies, first respond to the frequency with which you use the strategy in your teaching (from Never to Almost Always) to encourage students' critical thinking. Next, respond indicating your perception of how effective (from Very Ineffective to Very effective) the strategy in in advancing students' critical thinking. Finally, please respond based on your knowledge of critical thinking (from Insufficient to Sufficient) for each teaching strategy listed.

To encourage critical thinking, I use teaching strategy that...

	Frequency of Use					Perception of Effectiveness					My knowledge of this critical thinking teaching strategy is	
	Never	Seldom	Sometimes	Frequently	Almost Always	Very Ineffective	Ineffective	Equally Ineffective and Effective	Effective	Very Effective	Insufficient	Sufficient
21. talks about decision-making processes during demonstrations												
22. gives examples of sloppy/un-critical thinking and having discussions of how one could approach the issue more rigorously												
23. uses peer reviews of writing												
24. demonstrates how approaches can vary, and the value of searching multiple media and multiple examples												
25. uses in-class, announced quizzes on terms, vocabulary, and logic (examples for identification; underlining parts of claims or statements for them to identify as aspects of logic; and having them solve analogy or numerical problems)												
	Never	Seldom	Sometimes	Frequently	Almost Always	Very Ineffective	Ineffective	Equally Ineffective and Effective	Effective	Very Effective	Insufficient	Sufficient
26. uses research-based readings that are not "dumbed down" but rather present complex ideas in a coherent way												
27. uses discussion oriented, seminar style instruction												
28. uses structured controversy or debate												
29. uses discussion of case studies in both large and small groups												
30. asks students to interpret, scientific language in their own words												

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English

Part Two: Teaching Strategy

Please answer the items based upon your teaching experience in a polytechnic institution. For each of the listed teaching strategies, first respond to the frequency with which you use the strategy in your teaching (from Never to Almost Always) to encourage students' critical thinking. Next, respond indicating your perception of how effective (from Very Ineffective to Very effective) the strategy in in advancing students' critical thinking. Finally, please respond based on your knowledge of critical thinking (from Insufficient to Sufficient) for each teaching strategy listed.

To encourage critical thinking, I use teaching strategy that...

	Frequency of Use					Perception of Effectiveness					My knowledge of this critical thinking teaching strategy is	
	Never	Seldom	Sometimes	Frequently	Almost Always	Very Ineffective	Ineffective	Equally Ineffective and Effective	Effective	Very Effective	Insufficient	Sufficient
31. uses writing assignments with specific tasks or goals focusing on a particular kind of thinking or reflection	○	○	○	○	○	○	○	○	○	○	○	○
32. requires students to justify their positions with examples and evidence, both in verbal and written analysis	○	○	○	○	○	○	○	○	○	○	○	○
33. asks students to identify the strengths and weaknesses of their own arguments	○	○	○	○	○	○	○	○	○	○	○	○
34. asks students to evaluate evidence from multiple perspectives	○	○	○	○	○	○	○	○	○	○	○	○
35. engages students with controversial topics	○	○	○	○	○	○	○	○	○	○	○	○
	Never	Seldom	Sometimes	Frequently	Almost Always	Very Ineffective	Ineffective	Equally Ineffective and Effective	Effective	Very Effective	Insufficient	Sufficient
36. introduces topics and discussion on levels of complexity and system interrelationships	○	○	○	○	○	○	○	○	○	○	○	○
37. asks students to consider ethical and technical issues of material presented	○	○	○	○	○	○	○	○	○	○	○	○
38. asks students to articulate an argument that would come from a point of view other than the students' own	○	○	○	○	○	○	○	○	○	○	○	○
39. identifies strengths and weaknesses of an author's thesis and argument(s)	○	○	○	○	○	○	○	○	○	○	○	○
40. asks students to post thoughts that arise as they are reading assigned material, showing evidence or critical thought	○	○	○	○	○	○	○	○	○	○	○	○

<< >>

English

Part Two: Teaching Strategy

Please answer the items based upon your teaching experience in a polytechnic institution. For each of the listed teaching strategies, first respond to the frequency with which you use the strategy in your teaching (from Never to Almost Always) to encourage students' critical thinking. Next, respond indicating your perception of how effective (from Very Ineffective to Very effective) the strategy in in advancing students' critical thinking. Finally, please respond based on your knowledge of critical thinking (from Insufficient to Sufficient) for each teaching strategy listed.

To encourage critical thinking, I use teaching strategy that...

	Frequency of Use					Perception of Effectiveness					My knowledge of this critical thinking teaching strategy is	
	Never	Seldom	Sometimes	Frequently	Almost Always	Very Ineffective	Ineffective	Equally Ineffective and Effective	Effective	Very Effective	Insufficient	Sufficient
41. creates a continuum of perspectives on an issue, with students asked to place their own views along the continuum and to articulate why they have chosen their stance and not that of another												
42. uses close readings, i.e., develop students' thinking about reading												
43. reviews and analyzes an area of topic												
44. analyzes statistics (display average, correlation)												
45. focuses in getting students to recognize an arguments' underlying logical structure rather than accepting it based on "authority" or other cues												
	Never	Seldom	Sometimes	Frequently	Almost Always	Very Ineffective	Ineffective	Equally Ineffective and Effective	Effective	Very Effective	Insufficient	Sufficient
46. models appropriate use of the concepts and language of probability												
47. models a wide variety of examples of critical thinking												
48. demonstrates mathematical problem solving												
49. asks students to evaluate the different sources from which they draw information, e.g., on-line peer-reviewed journals vs Wikipedia vs. a website advocating for a particular point of view												
50. asks students to form and test hypotheses about observed phenomena												

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English

Part Two: Teaching Strategy

Please answer the items based upon your teaching experience in a polytechnic institution. For each of the listed teaching strategies, first respond to the frequency with which you use the strategy in your teaching (from Never to Almost Always) to encourage students' critical thinking. Next, respond indicating your perception of how effective (from Very Ineffective to Very effective) the strategy in in advancing students' critical thinking. Finally, please respond based on your knowledge of critical thinking (from Insufficient to Sufficient) for each teaching strategy listed.

To encourage critical thinking, I use teaching strategy that...

	Frequency of Use					Perception of Effectiveness					My knowledge of this critical thinking teaching strategy is	
	Never	Seldom	Sometimes	Frequently	Almost Always	Very Ineffective	Ineffective	Equally Ineffective and Effective	Effective	Very Effective	Insufficient	Sufficient
51. asks students if insight from other disciplines can be incorporated in an analysis												
52. asks students to apply a particular theoretical framework, approach, or related set of terms and concepts to a primary source and to consider the results												
53. asks students to identify a real-world problem align with possible solutions and evaluate how each addresses key issues, and how each perhaps falls short												
54. asks students to take evidence and apply it to a problem in order to produce a theory or use it to evaluate an existing theory or solution to the problem												
	Never	Seldom	Sometimes	Frequently	Almost Always	Very Ineffective	Ineffective	Equally Ineffective and Effective	Effective	Very Effective	Insufficient	Sufficient
55. convinces others of the truth of a claim based on supporting facts and evidence using persuasive techniques												
56. uses cooperative learning-sharing in groups and working together to accomplish a goal												
57. uses workshop students on projects, i.e., students work together to provide feedback and suggestions for major projects												
58. works in groups to solve problems that have multiple solutions												

<< >>

English

Now that we have explored the teaching strategies used and we are pleased to invite you to share your perspectives of critical thinking. Short one or the sentence responses will be very helpful. Thank you.

Please list any critical thinking teaching strategies you incorporate in your teaching which are not listed from item 1 to 58.

When using critical thinking teaching strategies, please explain your expectations for students learning.

How do you assess your students to determine they are developing/improving their critical thinking skills?

Thank you for your participation. I really appreciate it.
If you have any further question, please do not hesitate to contact me at
nls182@hotmail.com
Have a nice and productive day!

<< >>

Appendix C

Permission Letter from Institutional Review Board (IRB) of Colorado State University

Colorado State University

Research Integrity & Compliance Review Office
Office of Vice President for Research
Fort Collins, CO 80523-2011
(970) 491-1553
FAX (970) 491-2293

DATE: April 3, 2012

TO: William Timpson, Education
Nor Lisa Sulaiman, Education

Janell Barker

FROM: Janell Barker, IRB Coordinator
Research Integrity & Compliance Review Office

TITLE: Incorporating Critical Thinking: Teaching Strategies in Malaysian Technical & Vocational Education (TVE) Programs

IRB ID: 040-13H **Review Date:** April 3, 2012

The Institutional Review Board (IRB) Coordinator has reviewed this project and has declared the study exempt from the requirements of the human subject protections regulations as described in 45 CFR 46.101(b)(2): Research involving the use of educational tests,....survey procedures, interview procedures or observation of public behavior, unless: a) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects.

The IRB determination of exemption means that:

- **You do not need to submit an application for annual continuing review.**
- **You must carry out the research as proposed in the Exempt application**, including obtaining and documenting (signed) informed consent if stated in your application.
- **Any modification of this research should be submitted to the IRB Coordinator through an email prior to implementing any changes**, to determine if the project still meets the Federal criteria for exemption. If it is determined that exemption is no longer warranted, then an IRB protocol will need to be submitted and approved before proceeding with data collection.
- **Please notify the IRB Coordinator if any problems or complaints of the research occur.**

Please note that you must submit all research involving human participants for review by the IRB. **Only the IRB may make the determination of exemption**, even if you conduct a similar study in the future.

Appendix D

Permission Letter from Department of Polytechnic Education, Malaysia

Re: Nor Lisa Sulaiman: Mohon kebenaran untuk mengedar borang kaji selidik kepada pensyarah politeknik

From: **mohlis jaafar** (mjfaryip@gmail.com)
Sent: Saturday, 19 Nov, 2011 11: 36 PM
To: lisa sulaiman (nls182@hotmail.com)

Salam pn lisa. Saya masij ingat. Saya tiada halangan. However whatever findings have to be shared with jpp. Tq

Re: Nor Lisa Sulaiman: Permission to distribute questionnaire to polytechnic lecturers

Salam Puan Lisa. I still remember. I have no rejection. However whatever findings have to be shared with jpp. Thank you.

Appendix E

Pre-notification Letter

Colorado State University

School of Education
1588 Campus Delivery
Fort Collins, Colorado 80523-1588

Pre-notification letter

Dear honorable polytechnic lecturer,

The reason you were sent this message is to invite you to participate in a research study because of your knowledge of the polytechnic profession. The topic of this study is "Incorporating critical thinking: Teaching strategies in technical and vocational education (TVE) programs". The purpose of this study is to investigate if polytechnic lecturers incorporate critical thinking in teaching strategies and to determine their perceptions of the effectiveness of critical thinking teaching strategies. This study is being conducted by Nor Lisa Sulaiman, a former polytechnic lecturer and a doctoral student in Educational Leadership, Renewal, and Change program, and Prof. William M. Timpson Ph.D. from Colorado State University, Fort Collins, Colorado, U.S.A.

A few days from now, you will receive a web-based survey regarding to this topic. The survey will take about 15 to 20 minutes. You do not need to answer any question that you prefer not to answer. All information provided will be kept strictly confidential. I hope you will enjoy this opportunity to share your experience of incorporating critical thinking in your teaching. This is a great opportunity for where your rendered input and opinions may eventually benefit your own teaching practices and institution. Please take some time to complete the questionnaire as best you can.

Once again, please look for the survey in the next few days. If you have questions about this survey, you may contact Nor Lisa Sulaiman at norlisa@lamar.colostate.eduor nls182@hotmail.com.

Thank you in advance for your help.

Sincerely,

Nor Lisa Sulaiman

William M. Timpson

Colorado State University, U.S.A.

Appendix F

Informed Consent Letter

School of Education
1588 Campus Delivery
Fort Collins, Colorado 80523-1588

Informed Consent Cover Letter

Incorporating Critical Thinking: Teaching Strategies in Malaysian Technical and Vocational Education (TVE) Programs

Dear honorable polytechnic lecturer,

You are invited to participate in a study of assessing critical thinking teaching strategies among Malaysian polytechnic lecturers. You were selected as a possible participant with the permission of Department of Polytechnic Education, Ministry of Higher Education because we believe you can contribute your knowledge to this research that may eventually benefit your own teaching practices and institution. We hope to learn of your experience of using critical thinking in your teaching.

This study is being conducted by Nor Lisa Sulaiman, a former polytechnic lecturer, and currently a doctoral student in Educational Leadership, Renewal, and Change program at Colorado State University, with Prof. William M. Timpson, Ph.D. from Colorado State University, U.S.A.

You are encouraged to complete the survey, which includes demographic data and items for critical thinking teaching strategies such as frequency of use, perception of effectiveness, and knowledge. Your return of this survey is implied consent. Participation and completion of this study will take about 15 to 20 minutes.

The information obtained will only be used to characterize the sample. No benefits accrue to you for answering the survey, but your responses will be used to help Malaysian TVE educators, practitioners, and policy makers make initiatives to enhance and foster critical thinking within polytechnic programs.

Any information that is obtained in connection with this study will remain confidential and your identification will not be disclosed. All data will be processed by Qualtrics, the survey provider; no identification information will be provided to the researchers or be linked to your name or email by the survey provider. In any report we might publish, no information will include any information that will make it possible to identify an individual participant or specific organization.

Your participation in this study is entirely voluntary. Your decision whether or not to participate will not affect your current job and will not prejudice your future relationships with polytechnic you work at. If at any point you feel that you would like to withdraw from the study, you are free to discontinue participation or to skip any questions at any time by simply close the survey and exit from the URL or send it.

Your rights as a volunteer participant have been explained and if you have any questions, please contact Nor Lisa Sulaiman at norlisa@lamar.colostate.edu or nls182@hotmail.com, or Prof. William M. Timpson, Ph.D. at william.timpson@colostate.edu. You may also can contact the Research Integrity and Compliance Review Office (RICRO) at Colorado State University: Janell Barker, Human Research Administrator, +1 (970) 491-1655. You may print an email to keep for your records.

If you decide to participate, please check the box below indicating you understand and agree with the information provided in this consent form.

☐ Yes, I agree to be in the study

Thank you for your time and consideration.

Sincerely,

Nor Lisa Sulaiman

Prof. William M. Timpson, Ph.D.

Colorado State University, U.S.A.

Appendix G

Reminder Letter

School of Education
1588 Campus Delivery
Fort Collins, Colorado 80523-1588

Gentle Reminder Letter

Dear respectful polytechnic lecturer,

This is a friendly reminder to please take a moment to fill out this survey questionnaire regarding incorporating critical thinking teaching strategies in Malaysian technical and vocational education (TVE) programs.

Three weeks ago, you received an e-mail and link to our survey (https://csuedu.qualtrics.com/SE/?SID=SV_e3uu2fdbxGd4VZq). If you have filled out the survey, thank you very much for your time and kind cooperation. If you have not had a chance to take the survey yet, we would appreciate if you could complete the survey because only you can tell us your experience incorporating critical thinking in your teaching. This message has gone to everyone in the selected sample population. Since no personal data is retained with the surveys for reasons of confidentiality, we are unable to identify whether or not you have already completed the survey.

We are sincerely looking forward to receiving your feedback. Your participation is essential to further research in this topic. Thank you for your time and participation in this survey.

Regards,

Nor Lisa Sulaiman

norlisa@lamar.colostate.edu/ nls182@hotmail.com

Prof. William M. Timpson, Ph.D.

william.timpson@colostate.edu

Colorado State University, U.S.A.

Appendix H

Thank You Letter

Colorado State University

School of Education
1588 Campus Delivery
Fort Collins, Colorado 80523-1588

Thank You Letter

Dear polytechnic lecturer,

Thank you for participating in our critical thinking teaching strategies survey. We really appreciate you taking your valuable time to share your thoughts and feedback. Your contribution to this research is invaluable for improving teaching and learning in Malaysian polytechnic. Your input will be used to help identifying the usage of critical thinking teaching strategies among polytechnic lecturers, and to continue our research in future.

If you would like to contact us about the content of this survey and to get the research summary, you can do so by emailing norlisa@lamar.colostate.edu or nls182@hotmail.com. You also can contact Prof. William M. Timpson, Ph.D. at william.timpson@colostate.edu.

If you have not yet answer the survey, you can do so by following the link
https://csuedu.qualtrics.com/SE/?SID=SV_e3uu2fdbxGd4VZq

Yours sincerely,

Nor Lisa Sulaiman

Prof. William M. Timpson, Ph.D.

Colorado State University, U.S.A.