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Mastery Issues and Teaching Approaches for the Electrical Technology Certificate Programme at Community Colleges on the Topic of Measuring Instruments

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Abstract: The teaching approach has a significant impact on a student's ability to master a course. The purpose of this study is to identify the level of competence and explore the teaching approaches used by community college lecturers for the Electrical Technology Certificate Programme for the topic of Measuring Instruments. This study employs a qualitative approach with an explanatory research design that includes interview data gathering procedures with eight lecturers who have taught electrical courses before. According to the findings, students' comprehension of the issue of measurement instruments is still at a modest level. While students must learn the concept of measuring instruments, it is a fundamental knowledge. Teaching and learning approach must be adjusted and improved to improve students' understanding. According to the data, the lecturers' teaching methods are also traditional. Lecturers are enthusiastic about implementing improvements to the teaching and learning process, such as the use of engaging learning modules to increase students' understanding and skills, particularly in the area of measurement instruments.

Keywords: Teaching approaches, mastery, measurement instruments, modules

1. Introduction

In Malaysia, skills institutions offer a variety of educational programmes at the university and college levels, including technical and vocational education. One of the technical institutions that provides human capital to fulfil the demands of the local industry is the Community College. Engineering, agriculture, trade, hospitality, and other technical and vocational sectors are among the programmes offered at Community Colleges. The relevant modules are designed per the job market requirements to ensure that students' skills are strengthened for them to become a quality skilled workforce to improve the national economy (Subari, Yusof & Ahmad, 2020). Higher education institutions in Malaysia, particularly technical and vocational education and training institutions (TVET), play an important role in accelerating change to bring the country's productivity, economy, and social indicators up to the standard of other developed countries. To compete worldwide, the Malaysian education system should focus on providing students with a high-quality and relevant curriculum that aligns with industrial needs. According to Hairi, Affandi, & Nasri (2019), effective teaching and curriculum delivery in the vocational training education system are crucial for human capital development to produce skilled and knowledgeable graduates and the workforce. Thus, vocational colleges, community colleges, technical colleges, and other training institutions must realize that they aim to develop and transfer knowledge in the practical and technical field and to also relate their educational efforts to social needs and improvement. Continuous improvement and enhancement in the educational system, particularly in technical and vocational colleges, can help students become more creative and innovative (Lam & Hassan, 2018). These efforts significantly affect the country's economic development and prosperity.

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TVET graduates, particularly those from polytechnics and community colleges, must have improved competencies and abilities to make a meaningful contribution (Hairi et al., 2019). The Department of Polytechnic Education and Community Colleges (JPPKK) is committed to ensuring that the programmes offered to satisfy the established standards and deliver graduates with applicable skills that fulfil employer needs. By 2025, the department's mission and purpose are to ensure that TVET institutions become leading providers of the high-quality education and training required by industry and society in the region. The Electrical Technology Certificate (SKE) is one of the study programmes available for SPM graduates to satisfy the requirements of the technology-based industry. The curriculum aims to provide students with electrical installation skills to fulfil industry needs and to expose students to real employment requirements (Shaari, Abdul Yamin, & Ahmad, 2021). The SKE Programme's learning and teaching approach consist of two parts; theory and practice. Theoretical knowledge is very crucial in learning, especially in science and engineering (Streveler et al., 2008). Students are encouraged to have a strong knowledge base in the necessary subjects to understand theories in particular. Basic knowledge can assist students in preparing for the next semester, which will demand more advanced abilities and knowledge in the available courses (Basar et al., 2020). All teaching sessions usually start with a theoretical approach to introduce all aspects of cognitive understanding that students need. Before they begin with a practical, they must have theoretical knowledge. One of the most significant parts of engineering education is practical sessions in laboratories or workshops, which prepare students with the necessary skills before entering the workforce (Krivickas & Krivikas, 2007). Quality teaching strategies or approaches for theory and practice require the wisdom of lecturers to make sure that students achieve effective learning outcomes (Nainan, Balakrishnan, & Mohamad Ali, 2020).

The efficacy of learning is influenced by the use of proper teaching aids as well as how a subject is presented. This is a critical issue because it has the potential to affect students' knowledge mastery. Students feel that a subject is difficult to understand because of the educator’s inability to deliver it effectively (Basar et al., 2020). Nonetheless, the students in the skills stream are essentially deficient in theoretical learning due to their lack of competency in cognitively formed skills (Jalani, 2015). This situation occurs mainly among community college students, which is due to low admission requirements. Some students do not have good grades, especially in mathematics. Thus, the lecturer is responsible to impart knowledge creatively in the learning and teaching process to ensure that these students can understand what they learn. An educator should consistently attempt to understand the level of student achievement so that teaching approaches can be fitted to the students' cognitive abilities (Subari, Yahya & Yusof, 2019). Therefore, lecturers must vary their teaching approaches to stimulate students' interest and improve their understanding of the taught subjects. As a result, the purpose of this research is to identify lecturers' and students' learning approaches in the field of electrical as well as the level of mastery, and causes of students' difficulties in the topics covered by the Electrical Technology Certificate Programme.

1.1. Research Background

Single-phase electrical installation, three-phase electrical installation, electric motor installation and control, and industrial installation are some of the modules available in the SKE Programme. In each module, students must understand and apply measuring equipment, particularly during and after the implementation of a practical project. Students have to master the topic of measuring instruments because they will use them throughout the semester. Students must be exposed to the basic concepts and theories of measuring instruments, such as the types of measuring equipment, tests conducted, range counts, and testing techniques. The fundamentals of these measurement instruments' concepts must be taught and repeated at the beginning of the semester so that students can master them before moving on to other topics. According to Musa, Yaacob, & Wahid (2018), first-year electrical engineering students must grasp basic abilities and knowledge in the field of electricity to increase their comprehension throughout their studies. For students who are studying these concepts for the first time, mastery of this information and abilities is important so that they do not have difficulty doing measurements and tests during practical later on and less reliance on lecturers (Subari et al., 2020).

Therefore, understanding and mastering measuring instruments are important as measurement and instrumentation are subjects of knowledge that cover a wide range of real-world applications in industrial, commercial, and residential settings (Eliza, Myori, & Fadli, 2019). According to Salim, Puteh, & Daud (2012) in research done at Universiti Teknologi Malaysia, students' competence to operate electrical measurement equipment is still below competent level. Most practical sessions are conducted, hence, could contribute to students not achieving the competencies they should have. As a result, each student is not able to complete all practical assignments or fully use the measurement equipment. Demonstration sessions in big groups are also held. This finding is supported by Mohamad, Idris, & Idris (2020), who state that one of the reasons students have not reached the level of competence to operate measurement equipment is because practical sessions are conducted in groups and lecturers find it difficult to implement demonstration sessions on equipment. As a result, students' understanding and practical skills in handling basic electrical measuring equipment such as oscilloscopes, megger testers, power clamps, and multimeters must be improved. To ensure that measurements are accurate, zero short circuits occur, and the measuring instrument is not damaged, students should have enough skills and knowledge.

According to the Course Learning Outcome (CLO) SKE Programme evaluation report for 2019, there are still students who are less competent in utilising measurement instruments, especially multimeters. According to the report, lecturers have to explain the proper handling of measuring instruments to students as they progress through semesters

two and three. This is true, especially when they are doing practical that requires the use of such measuring instruments. As a result, the PdP process takes longer than expected. Hadiati et al. (2019) support this by stating that, although the electrical and electronic equipment curriculum focuses on training, students' learning sessions still do not have enough time to master all the necessary abilities. In addition, students' lack of mathematical knowledge is one of the factors that affect their level of competence. This involves the calculation of appropriate measuring ranges, and mathematical knowledge is particularly crucial in understanding the concept of measurement. To achieve accurate readings and measurement values, students must understand theories that require mathematical knowledge. When students have a moderate level of mathematical understanding, it influences their comprehension process and makes it harder for them to apply measurement theory, particularly in range calculation when measuring tests are used. As a result, students are unable to test circuits and equipment, operate electrical circuit controls, or maintain equipment (Melo, 2018).

Students' interests could be affected by a theoretical learning approach, which can lead to them becoming demotivated, hence, they do not understand the subject they are studying (Mei & Fauziah, 2018). This clearly shows that the learning approach has a positive influence in enhancing students' interest and excitement for learning. Therefore, quality teaching and learning approaches must be improved to foster and increase students' attention. Generally, lecturers' learning implementations in higher education that involve measurement themes and instruments still rely on printed teaching materials such as notes or modules as media. According to Subari et al. (2020), a traditional teaching method is one of the causes students find it difficult to understand electricity. This learning process becomes less effective as teaching and learning materials require media aid such as pictures, animations, videos, and simulations to illustrate measurement equipment so that they are better understood by students. The utilisation of media and appropriate teaching materials should be a significant part of the learning process. This is because a teaching approach that includes comprehensive and logically organised learning resources can assist students in improving their level of comprehension, mastery, and competency in their studies (Eliza et al., 2019).

1.2 Problem Statement

Based on the research background, it is apparent that there are issues in lecturers' teaching approaches and students' ability of mastery in the topic of measurement instruments. Students' lack of interest, difficulties in understanding the topic, and inability to properly use the measuring test must be overcome to produce knowledgeable and competent students. Previous research found that many factors contribute to this difficulty, including lecturers' teaching and learning approaches, teaching aids used, and students' inability to master theoretical knowledge. As a result, the researcher has decided to conduct a study to examine the following objectives:

a) To identify the extent of mastery in the topic of measurement instruments among students.
b) To explore teaching approaches and their effects on student comprehension and knowledge in the topic of measurement instruments.
c) Analyse suggestions for improvement to increase student's comprehension and mastery of measuring instruments skills.

2. Research Methodology

This study employed a qualitative approach with an explanatory study design (semi-structured interviews) that involved focus groups to support the study data. Explanatory study can be useful for example to study a phenomenon in general (Noor, 2008). Purposive sampling was used in this study, which included eight lecturers with prior experience in the electrical field. The participants were three Heads of the Programme, three academic senior lecturers, and two lecturers who are members of the SKE Programme curriculum drafting committee. All participants have experience between 10 and 20 years in teaching the electrical field. Qualitative research instruments were created to identify the teaching approaches used by community college lecturers and also the level of mastery of students in the topic of measuring equipment through the lecturers' perspectives. To ensure its validity, the interview protocol went through a validity and reliability phase. Three research experts were assigned to (i) assess the interview protocol and check its suitability, and (ii) examine the interview protocol's language to ensure its suitability and clarity. The conversations in focus groups were recorded with the participants' permission via a letter of consent. Participants were interviewed using interview guidelines that included semi-structured questions. In a semi-structured interview, the questions were determined first, but the answers to those questions were open-ended and can be developed at the interviewer's and participants' discretion. Interviews were designed to collect qualitative data to answer the research questions. Thematic deductive analysis was used to analyse the data from these interviews.

3. Findings and Discussion

The results of the semi-structured interviews were assessed by asking designed formal questions and allowing the interviewers to inquire further about the participants' responses. There were five male respondents (62.5%) and three female respondents (37.5%) among the interviewed lecturers. The electrical lecturers were asked the following questions.

3.1. Students' mastery of the measurement instruments topic

a) Do you agree that students have still not mastered the topic of measurement instruments?
b) What factors cause students to lack understanding of the topic?

According to the findings, seven lecturers (87%) agreed that students still haven't mastered and are having difficulty mastering topics related to measurement instruments. The following text depicts several lecturers' perspectives on the proposed research questions:

> "Students are less skilled because they don't understand how to take measurements, and some students forget how to use measurement instruments, especially multimeter, to take voltage and current readings. It is important to know these measuring instruments to determine circuit problems. It's also crucial to detect any defects or damages right away, as well as to recognize what maintenance work is needed." - Lecturer 7

> "Students are less competent at utilising measurement instruments, particularly multimeter. One of the causes is that they are confused with measurement principles. They are less interested in theoretical topics and prefer to focus on practical learning". - Lecturer 3

> "The students' main flaw is that they are don't know how to accurately determine the range on the multimeter. This is because some of them have difficulty learning mathematics and do not understand how to accurately estimate the range". - Lecturer 5

Overall, the quotes above show that students have not fully mastered the topic of measuring instruments, in terms of acquiring accurate range readings and appropriate utilization of testing instruments, especially multimeter tools. One of the causes for this issue is that certain students lack computational skills. This is not impossible due to the low entry requirements for community college students. This is supported by Jalani (2015), who states that community college students are primarily skilled students who are classified as having low cognitive levels. According to the results of the interviews, students are still confused and easily forget how to operate the equipment while taking measurements.

As a result, students are unable to detect and resolve circuit problems. This is supported by Espinel & Vega (2019), who discover that uncertainty is related to randomly measured signal variation, instrument malfunction, instrument inaccuracy, and resolution all influence the measurement process. The lecturers also highlight that the topic of measurement instruments is very important and that it will be applied in the next semester. This shows that there is a crucial need for students to master this topic.

3.2. The teaching and learning approach practiced

a) What teaching approach is used in learning about measurement instruments?
b) Do you agree that the teaching and learning approaches have an impact on students' comprehension and master? Why?

The second qualitative finding shows that the majority of lecturers still use traditional teaching approaches such as whiteboards or PowerPoint slides with notes that are referenced according to the SKE Programme's syllabus. The lecturers feel that this teaching approach is particularly well suited to theoretical learning. Apart from that, the lecturer uses the demonstration approach before the students do the practical session. The excerpts from some lecturers to show how the effect of teaching and learning approaches were implemented are as follows:

> "I agree that the teaching approach has an impact on students' learning because I notice students are less interested and also don't give attention to the content of topics describe in form of theory. This leads to misunderstandings, especially when it comes to calculations theory". - Lecturer 2,

> "When comparing the approaches, students prefer demonstration because it is more focused, easier to remember, and allows them to try out the measurements themselves."- Lecturer 1,

> "Students are more interested in practical learning because they can see the difficulty and the parts that they don't understand." - Lecturer 5.

According to the interview findings, a total of seven lecturers (87.5%) agree that the traditional approach, educator-centered approach, of using only notes or PowerPoint slides affects students' knowledge of measurement instruments. They said that this approach causes students to be uninterested and not focused on what they are learning, especially on theoretical content. Students prefer practical teaching approaches because it is easier to learn when they have the opportunity to practice the tasks hands-on. As a result, students are better able to spot difficulties and do well in measuring tests. Mei & Fauziah (2018) found that laboratory research (practical learning) can improve more beneficial student behaviour in terms of attitude, motivation, and learning interest in related subjects. This is supported by Shi (2014), who found that students who apply practical learning in their studies can improve their academic achievement. As a result, an interesting and effective teaching and learning approach may assist students in gaining a better understanding of the topic.

In addition, Dianne & Zenon (2007) state that one of the factors that contributes to students' increased interest in engineering learning is the attraction to the topic, delivery methods, and fundamental understanding of teachers. This is consistent with the findings of the interviews, which reveal that the majority of lecturers feel that it is important to select suitable teaching methods and approaches to guarantee that students can effectively follow what they learn.

> "I agree that lecturers have to choose the effective teaching approach thoughtfully to ensure that students are interested and understand what is being learned." - Lecturer 6.

Therefore, lecturers must play an important role in developing a teaching and learning approach that is appropriate for students' abilities and requirements. This is because students' learning styles can affect their understanding of the topics studied.

3.3. Suggestions for improving student learning

a) What suggestions do you have to enhance the teaching and learning process to address the issue of students' mastery and skills as measured by this instrument?
   - Teaching and learning approaches
   - Self-Learning Module Learning Aid
   - Through expert energy's skills
   - Other suggestions

The final qualitative result is that advances in teaching and learning can help pupils grasp things better. According to the findings, six lecturers (75%) suggest learning modules for the topic of measurement instruments as one of the improvements to be implemented. Furthermore, there has been no comprehensive module on this topic. The lecturers also believe that accessible and interactive modules can attract students to follow the learning, even if it is theoretical. In addition, Sidek & Rahman (2010) state that the usage of self-learning modules for each activity has been created and developed in compliance with students' abilities and can attract attention, provide motivation, and given challenges in the learning environment. The following are some of the lecturer's views on the improvement suggestion:

> "As a reference for students, I propose developing a self-learning module on the topic of measurement instruments. SKE still doesn't have a fully developed module. Lecturers use reference resources and their notes to lecture, with the programme syllabus as a guide." Lecturer 3

> "Make interactive testing kits or modules that accessible for students to review whenever and wherever they want." - Lecturer 5

> "Students' skills will be improved by having training sessions related to use of measurement equipment or complete modules to make troubleshooting and equipment handling easier." - Lecturer 4

In another perspective, two lecturers (25%) make different suggestions, which include improving lecturers' approach when teaching. The lecturers assert that students' knowledge and skills can be improved through repeated training with the use of appealing teaching aids. Excerpts from relevant lecturers are provided below:

> "To attract students' attention and help them understand what they're learning, teaching approach and teaching aids must be improved. Appropriate approaches, such as instructing students to take tests in pairs rather than in large groups, can help students improve their understanding and skills." - Lecturer 7

The lecturer's suggestions for improvement are shown in the passage above, which suggests that the measurement and testing activities be done in pairs rather than in large groups. This activity is seen as one of how students can share their knowledge. This is especially beneficial for students with a higher level of understanding. Students can develop mutual trust through this partnership. This type of discussion can also foster two-way communication, which can make the learning experience more engaging. Esteves et al. (2018) support this by stating that students who want to master the core of knowledge are willing to communicate, interact, and contribute to the exchange of ideas rather than passively receiving and absorbing information, as is the traditional pedagogical approach in lectures. Pairing or group activities are one of the more interesting learning methods that can benefit the students. As a result, lecturers must understand and choose appropriate pedagogy to ensure that students benefit from their education.

4. Research Implication

Several implications have been identified based on the findings of this study, including implications for lecturers and students. The main implication for lecturers is to change their teaching approach from traditional to a more active, systematic, and appropriate teaching approach to students' needs, in line with recent technological advancements. The

traditional approach affects students and they become less interested and less focused on what they are learning. As a result, students are unable to comprehend and master the topic of measuring instruments. Therefore, if students are unable to master and comprehend this topic, they will be unable to utilise measurement tools to ensure that the measurements taken are accurate and follow the safety rules. However, if this situation is not addressed, students will be unable to perform accurate measurements, resulting in a short circuit and damage to the measuring instrument. This has implications for students in terms of preparing knowledge, skills, and confidence to participate in industrial training and enter the workforce. As a result, this study has proposed a more engaging teaching and learning approach based on the use of teaching modules that include interactive elements, reference materials, and resources, as well as curriculum-based learning activities. This self-assessment module should also assist lecturers in ensuring that students achieve the best possible results.

5. Conclusion

Overall, the study found that SKE students in community colleges have a moderate level of mastery and understanding in the topic of measuring equipment. Researchers discover that traditional teaching methods, particularly theoretical learning, are still used by lecturers in lecture rooms and workshops. As a result, students are less engaged in the classroom and are unable to stimulate active learning. However, in light of the suggested improvements, it can be concluded that there are many critical elements to consider in ensuring that students' mastery of measuring equipment can be improved. Among them are the use of effective teaching methods, the use of high-quality modules, and learning methods that are tailored to the students' needs. The study discovers that today's lecturers' teaching practices include a greater emphasis on student-centered teaching and learning approaches, for example, the use of modules that are characterised by self-learning. It is hoped that this approach will aid in improving students' understanding as well as producing students who are positive, creative, and cooperative.

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Conflict of Interest

The authors declare no conflicts of interest.

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