Study On The Effectiveness Of Using The Power Supply Trainer Learning Kit Among Students Of Electrical Engineering Department, Tuanku Syed Sirajuddin Polytechnic During Hands-On Practical Work.

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ABSTRACT

The use of Teaching Aids (ABM) and Teaching Materials (BBM) will enhance the effectiveness of the interaction process between lecturers and students. A good Teaching Aid serves as a concise and easily understandable facilitator, capturing students' interest and improving their performance. To enhance the effectiveness of learning and teaching in the DEE30043 Electronics Circuits course, a teaching aid called the Power Supply Trainer Learning Kit has been developed. A study was conducted to assess the effectiveness of this kit. The overall purpose of this research is to gather feedback from users of the Power Supply Trainer Learning Kit. The research method employed includes surveys, pre-tests, and post-tests. A set of questionnaire and practical result forms were distributed to third-semester students taking the DEE30043 Electronics Circuits course to obtain data related to students' perceptions and the effectiveness of the Power Supply Trainer Learning Kit.

Keywords*: Teaching Aid, learning and teaching, Power supply Trainer, Electronic Circuit*

1.0 INTRODUCTION

The DEE30043 Electronics Circuits course is one of the core courses for Electrical Engineering Diploma students in Malaysia Polytechnics. This course imparts knowledge related to the concepts and principles of electronic devices. It exposes students to the configuration of power supply unit circuits, operation and applications of these units. However, students' proficiency in practical work is not very effective based on assessment results (Heng et al., 2005). In addition, constraints in laboratory equipment require students to share existing equipment (Abdullah et al., 2021). Furthermore, the purchase of a single piece of existing laboratory equipment involves high costs per unit (Rani A, 2020). Therefore, Power Supply Trainer has been developed by a group of lecturers from Department of Electrical Engineering, Politeknik Tuanku Syed Sirajuddin (PTSS) for the Electronic Circuits course. The construction of this teaching aid initiative is aimed at addressing the issues that have arisen. After the trainer kit is completed, this study is conducted to gather feedback on the effectiveness of the teaching aid.

The developed trainer kit consists of five parts: converter, rectifier, filter, voltage regulator, and voltage divider. The output of each section is equipped with testing points to allow students to obtain output waveforms.

2.0 LITERATURE REVIEW

The course DEE30043 Electronics Circuits involves both theory and practical components. By utilizing appropriate teaching aids, the concepts and applications of Linear DC Power Supply are expected to be more easily understood by students. The output results for each section of the power supply block can be tested and observed directly by students and applied using teaching aids, enabling students to relate it to real-life situations.

Based on Pramudita Budiastuti (2023), electronic engineering vocational education is a study program that has the goal of producing superior graduates who achieved electrical machine competence and are ready to work in the industry. Electronic engineering vocational education is a new study program that is still in the development stage to achieve this goal. This trainer kit is a user-friendly design that helps enhance students' motivation in conducting laboratory experiments, thereby facilitating the teaching and learning process. Research findings indicate that the testing period conducted using trainer kits is faster and easier compared to conventional connection methods.

Based on Azman, Ali, Mustapha, Balamuralithara, and Mohd Isa's study (2014), the use of teaching aids (ABM) further enhances the effectiveness of students' understanding of concepts and theories implemented in practical work compared to oral explanations. The use of learning kits is also recognized as one of the Teaching Aids (ABBM) in the Teaching and Learning (P&P) process to help students understand the subject matter more effectively (Noor Suhaiza, 2017).

Numerous figures in educational psychology, including Lewin, Piaget, and Vygotsky, indirectly endorse education programs that lean towards practicality, drawing from the learning process theories they have put forth. According to Lewin, the process of learning involves the formation of knowledge through the transformation of experiences. Learning takes place when students engage with their surroundings (Kolb, 1984).

3.0 PROBLEM STATEMENT

The previous practical exercises involved the use of a protoboard along with other electronic components such as a transformer, LM7805 IC, diode, capacitor, and resistor. The practical exercise for the regulated DC power supply required students to make circuit connections on the protoboard for each section of the power supply. If the connections made did not produce the correct output waveform, students would have to redo the connections. This repetition could lead to errors in the connections and, in some cases, potential damage to the components and equipment used. Repeated installations also resulted in a considerable waste of time completing the exercises. Obtaining accurate and correct output waveforms is crucial to help students connect the theory learned in class more clearly.

The repetitive nature of the process, coupled with incorrect output waveforms, could cause students to lose focus, become bored quickly, and lose enthusiasm.

Geiwitz (1966) explained that monotony can trigger boredom and describes it as a “subjective feeling of repetitiveness” that reduces cognitive arousal. Hill (1985) endorsed this idea, noting that “subjectively monotonous” stimulation leads to boredom. This connection between subjective repetitiveness and boredom is confirmed by Shackleton (1981), who analyzed the link between repetitive industrial work and boredom. Mikulas (1993) defined boredom as a “state of relatively low arousal and dissatisfaction,” attributing it to the lack of stimuli and activation. According to Scherer et al. (2001), the absence of cognitive activation is a key factor in the emotional experience of boredom.

This would hinder the achievement of CLO2, which involves constructing various electronic circuit applications based on the theory and principles outlined in the DEE30043 Electronics Circuits course.

The interaction of various components is crucial, especially for students who are still learning and gaining practical experience. To address these challenges, course instructors need to provide clear and detailed instructions during practical sessions. Additionally, offering guidance and support during hands-on work can help students avoid unnecessary errors and prevent equipment damage. Creating a supportive learning environment where students feel comfortable asking questions and seeking assistance can also contribute to overcoming these challenges. Likewice, Davood Khodadad (2023) noted that the challenges of engineering education go beyond academic rigor and technical skills. Students face various obstacles in their learning, including fear of failure, lack of confidence, and feelings of isolation and infinite number of possible engineering problems in practice. These factors can contribute to a negative learning environment that undermines students’ ability to reach their full potential. By creating a trusting environment, educators can help students overcome these challenges and develop the confidence and skills needed to success in engineering

Encouraging teamwork and peer collaboration can enhance the learning experience as students exchange ideas and collectively solve problems. Hanni Muukkonen and Anu Kajamaa (2024) stated the goal is to established a genuine environment that includes people, material resources, tools, and epistemic objects. Within this environment, teams are expected to collaboratively interpret and utilize the resources and setting, with a particular focus on leveraging the varied knowledge and expertise of each team member.

Designing learning experiences for an interdisciplinary context introduces extra complexity because of the diverse disciplinary backgrounds, which can lead to confusion and inadequate communication across boundaries. (Muukkonen et al.(2010). Therefore, the design must incorporate tasks and supports that specifically promote effective interdisciplinary communication and integration.

Education is not only aimed at improving good attitudes but also involves the process of changing the attitudes and behaviours of individuals or groups in the effort to seek knowledge not only through teaching but also through practice.

Based on TCS Potter (2017), learning itself is complex, and many factors influence it. Learning is demanded by the learning model that encourages students to learn the variations in learning. The development of this kit aims to fulfil the student's needs in terms of motivation and knowledge. Indirectly, the learning process becomes more effective and enjoyable for the students. The study focuses on assessing the effectiveness of the kit in terms of student’s motivation, behavioural changes, and understanding.

3.1 Research objectives

The Power Supply Trainer Learning Kit is a teaching aid tool developed for practical use in the DEE30043 Electronics Circuits course. The conducted study aims to:

1. Evaluate Time Efficiency : Measure the time taken by students to accurately complete practical exercises using the Power Supply Trainer Learning Kit, aiming for significant time saving.

2. Assess Accuracy in Connections : Determine the students' ability to make precise circuit connections, ensuring a significant reduction in errors.

3. Analyze Component Damage : Evaluate the reduction in component damage resulting from improvements in connection accuracy and time management during practical exercises.

4.0 METHODOLOGY

Survey Form

This survey form is targeted at 65 third-semester students enrolled in the Electronic Circuits course. The survey consists of two main sections: the effectiveness of student's involvement and motivation in the course after using the Power Supply Trainer Learning Kit. The first part comprises five questions, while the second part is divided into ten questions. Respondents will indicate their level of agreement for items in Part A based on the Likert Scale provided in Table 1. All findings will refer to the tendency score in Landell table as shown in Table 2.

Table 1 Likert Scale

Scale	Interpretation
1	Strongly Not Agree
2	Not Agree
3	Not Applicable
4	Agree
5	Strongly Agree

Table 2 Mean Statistics level interpretation (Landell 1997)

Mean Score	Tendency level
1.00 - 2.33	Low
2.34 - 3.67	Moderate
3.68 - 5.00	High

Document Review.

The document review of the Course Outcome Review Report (CORR), also known as the Course Outcome Review Report, is conducted to assess the average performance according to the Course Learning Outcomes (CLO) set by the Curriculum Committee.

For this course, there are three CLOs:

CLO01: Applying the Principles of Electronic Circuits

Students will be able to use block diagrams or circuit diagrams to apply the principles of electronic circuit devices. This CLO focuses on the students' ability to understand and implement electronic concepts in a visual format to analyze and design circuits.

CLO02: Building Electronic Circuit Applications

Students will build various electronic circuit applications based on the theory and principles of circuit operation. This outcome requires students to translate theoretical knowledge into practical applications and circuit designs.

CLO03: Written Communication Skills

This CLO involves good written communication skills through essay writing in groups within a specified time frame. It emphasizes the importance of clarity and effectiveness in the written presentation of ideas, as well as collaboration within the group.

The trainer kit developed for this course is designed to meet CLO01 and CLO02.

The achievement of students for CLO2 can be assessed from the performance in Practical 1 after using the developed trainer, which involved circuit connections and circuit testing. The average achievement of students increased from 56% to 78.7%. This improvement indicates a positive impact on the use of the teaching aid. It can be considered a significant enhancement in students' understanding and proficiency in circuit connections and testing, following the utilization of the trainer kit. This demonstrates the effectiveness of the teaching aid in improving student's performance in the context of the learning objective CLO2.

Meanwhile, for the achievement of CLO1, the improvement in student's understanding and mastery related to power supply is assessed from questions distributed to students before and after using this trainer kit. A very noticeable changed can be seen in the achievement results after and before students use the trainer, where the average score changed from 68% to 84.2% for the achievement of 14 students.

Data Analysis Method

A survey was conducted to seek the minimum score values for the effectiveness of student's involvement and motivation in the Department of Electrical Engineering, PTSS when conducting practical work using the Power Supply Trainer for DEE30043 - Electronic Circuit course.

ANALYSIS AND RESULTS

Based on the survey conducted among PTSS electrical engineering diploma students taking the mandatory DEE30043 Electronics Circuits course, the effectiveness level of using the Power Supply Trainer learning kit was found to be very high. Table 3 presents the percentage of the effectiveness level of using the Power Supply Trainer learning kit.

Findings from the analysis indicated that time saving has been achieved, as students were able to correctly connect circuit connections for the practical exercises, as shown in Table 3 below. In addition to time saving, reducing component damage was also a primary objective of this innovation.

Table 3: Percentage of the complete practical work on time and component damage

Item	% Before	% After
Can complete our practical on time	40	91
Broken of component in circuit connection	20	0

Refer to Table 3 , results from the study shows that 91% of students agreed that using this trainer kit resulted in time saving. Prior to using the trainer kit, only 40% of students were able to complete the practical work within the allotted time. Additionally, damage to components was reduced by 20%.

It is evident that students are more comfortable using the developed trainer kit, with 86% of respondents agreed that they found it enjoyable. Additionally, 92% of respondents agreed that the trainer kit facilitates practical implementation. Respondents also acknowledged that the trainer kit helped them with better understanding of Topic 1 and easier to master the topic. Moreover, the trainer kit enables them to improve their ability to draw output waveforms for each power supply block.

Based on this analysis, improvements are observed in all survey items, including increased understanding and enthusiasm for practical implementation. Students can easily see the theory they have learned demonstrated through the use of the Power Supply Trainer.

The proper and safe use of equipment can be applied through the Power Supply Trainer. Time savings are also evident as practical work can be completed within the allocated time. A more comfortable, clean, and organized working environment is achieved because practical work steps are easier and in order.

The use of the Power Supply Trainer should be expanded to all other polytechnics in line with the requirements of the Polytechnic Studies Department to produce graduates who master in Outcome-Based Education (OBE).

Table 4: Percentage of the effectiveness level of using the Power Supply Trainer learning kit

No	Item	% Before	% After
	Motivations		
1	Enjoyable to use the Power Supply Trainer Learning Kit	62	86
2	Make me focus in class	46	95
3	Makes me feel excited to learn	54	94
4	I prefer to ask if I do not understand	54	91
5	The experience encouraged me to explore various issues and potential opportunities that arose.	62	89
	Comprehension		
1	Easier for me to conduct practical work	54	92
2	Improve my ability to draw waveform	55	82

3	Kindly allocate enough time for me to retain and comprehend each learning thoroughly	62	89
4	Creative and helps me master Topic 1	62	91
5	Link the theory with an actual situation	57	91
6	Stimulates the development of ideas in connecting theory and practice	58	86
7	Can help me enhance my understanding in recognizing the knowledge taught by the lecturer	57	91
8	Enhancing learning to be more comprehensive and diverse.	57	88
9	I acquired an experience that is not commonly attainable through conventional teaching methods.	58	89
10	The topics that are being taught are easier to understand	58	91

Referring to Table 4, the findings highlight the effectiveness of utilizing the Power Supply Trainer tool, as assessed by 65 respondents who strongly agreed that using this trainer has enhanced their understanding and motivation towards learning Topic 1, DC Regulated Power Supply.

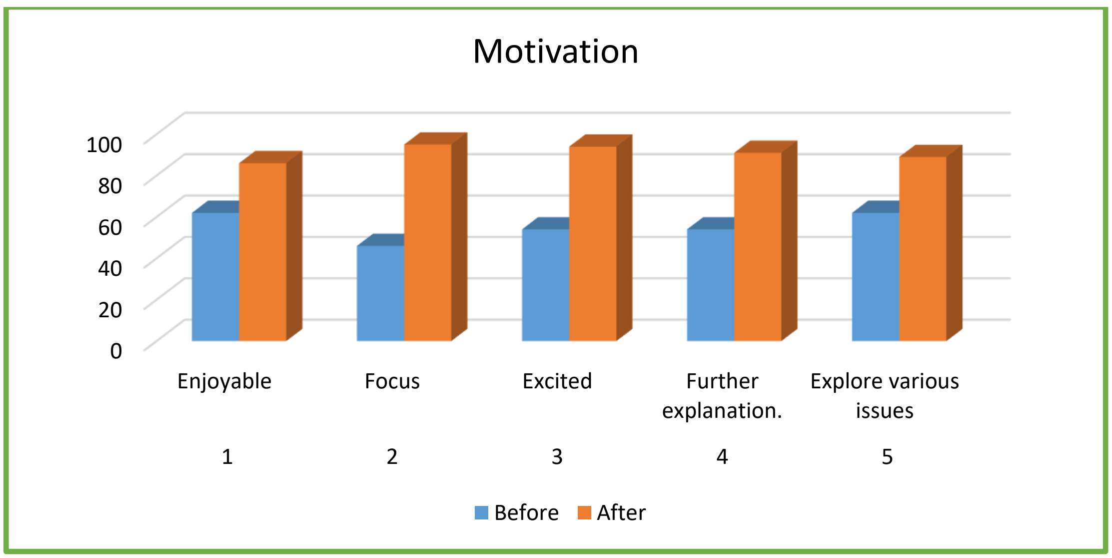

Figure 1: Comparison before and after the use of the trainer.

Figure 1 above, illustrates students' achievement after using the Power Supply Trainer Kit in terms of student's motivation. The level of student's motivation increased for all the survey items conducted. The survey findings indicated that students are more focused on the learning process after using this trainer. There was an improvement from 46% to 95% in the second item. The rate of improvement in the effectiveness of this trainer kit in terms of student's motivation increased between 24% to 49%.

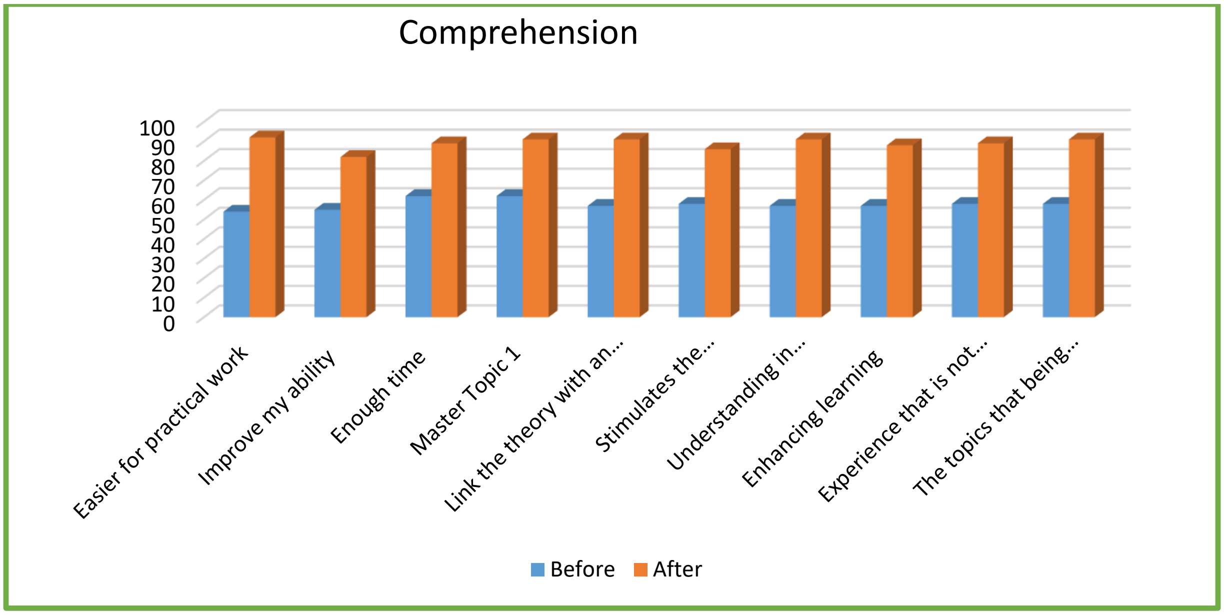

Figure 2: The level of student understanding before and after

According to Figure 2 above, the graph depicts students' performance following the use of the Power Supply Trainer Kit concerning student's comprehension. There was an improvement in student understanding of all survey items conducted. The survey results indicated that students found it more manageable to accomplish practical course exercises and could complete experiments within the designated time frame. The effectiveness increased from 54% to 92% in the first item. The study found that all assessed items in the category of student comprehension increased between 27% to 38%.

The Effectiveness of Student Involvement

Findings from items 1 to 10 represent the level of effectiveness of student's involvement in DEE30043 - Electronic Circuit subject after the use of the Power Supply Trainer.

Table 5 : The level of student understanding before and after.

No	Item	Mean Score	Mean Score Interpretation
	Comprehension		
1	Easier for me to conduct practical work	4.32	High
2	Improve my ability to draw waveform	4.02	High
3	Kindly allocate enough time for me to retain and comprehend each learning thoroughly	4.26	High
4	Creative and helps me master Topic 1	4.31	High
5	Link the theory with an actual situation	4.42	High
6	Stimulates the development of ideas in connecting theory and practice	4.31	High

7	Can help me enhance my understanding in recognizing the knowledge taught by the lecturer	4.43	High
8	Enhancing learning to be more comprehensive and diverse.	4.28	High
9	I acquired an experience that is not commonly attainable through conventional teaching methods.	4.38	High
	Total mean score average	**4.32**	**High**

Table 5, illustrates the analysis on the effectiveness of the trainer kit in terms of understanding. Based on this analysis, improvements are observed in all survey items, including increased understanding and enthusiasm for practical implementation. Moreover, the trainer enables them to improve their ability to draw output waveforms for each power supply block. The proper and safe use of equipment can be applied through the Power Supply Trainer.

According to the results of this study, the highest score of 4.42 was obtained for item number 7, which pertains to "Linking theory with an actual situation." This indicates widespread agreement among respondents that, after utilizing this kit, they can established connections between theoretical concepts and real-world scenarios. Meanwhile, statement number 2, in this section, has recorded the lowest score, with a minimum of 4.02. This statement indicates the ability of students to sketch the output waveforms for the power supply block. The overall average minimum score for the assessment of the understanding of the application aspect recorded is 4.32.

The duration of the practical exercises conducted takes precedence in the development of this trainer kit, ensuring that students' errors in circuit connections can be avoided. The time-saving aspect of the practical sessions has been successfully reduced. Time saving is also the evident as practical work can be completed within the allocated time. A more comfortable, clean, and organized working environment is achieved because practical work steps are easier and in order. Respondents also recognized that the trainer kit aids in enhancing their comprehension of Topic 1 and facilitates mastery. Students find it convenient to witness practical demonstrations of the theories they have learned through the application of the Power Supply Trainer.

Student Motivation

The results from items 1, 2, 3, 4, and 5 reflect the degree of student motivation in the DEE30043 - Electronic Circuit subject following the utilization of the Power Supply Trainer. The motivation of students play a pivotal role in the teaching and learning process. The students' proficiency in learning is intricately connected to their enthusiasm for engaging with the material in the classroom. Hence, evaluating the level of student motivation is a crucial aspect of studying the effectiveness of utilizing this kit.

Table 6: Analysis of minimum scores for the level of student motivation after using the Power

Supply Trainer.

Table 6: Analysis of minimum scores for the level of student motivation after using the Power Supply Trainer.

No	Item	Mean Score	Mean Score Interpretation
	Motivations		
1	Enjoyable to use the Power Supply Trainer Learning Kit	4.06	High
2	Make me focus in class	4.18	High
3	Makes me feel excited to learn	4.34	High
4	I prefer to ask if I do not understand	4.26	High
5	The experience encouraged me to explore various issues and potential opportunities that arose.	4.22	High
	Total mean score average	**4.21**	**High**

Referring to Table 6, the highest minimum score is associated with statement 3, registering a value of 4.34. Conversely, the lowest-scoring statement in this section is statement 1, which recorded a minimum score of 4.06.

According to the survey findings, the level of student motivation significantly rises after incorporating the Power Supply Trainer. Students exhibit heightened focus in class, find increased enjoyment in learning, and display greater eagerness to interact with the lecturer. The use of the Power Supply Trainer has inspired students to explore a variety of issues and potential opportunities.

5.0 CONCLUSION

The results obtained from the study on the effectiveness of using the Power Supply Trainer learning kit indicated a very high level of effectiveness. According to Jambari (2018), these results proved that ETK, which is embedded with current technology, is an effective method to strengthen and enhance the acquisition of knowledge and technical skills of engineering students. Therefore, it is imperative that polytechnics rigorously plan and develop more ETKs for effective classroom teaching and learning activities. This suggests the utilization of the Power Supply Trainer learning kit has a positive impact on students' understanding of concepts and indirectly enhances their interest in DEE30043 Electronics Circuits course. Additionally, through the conducted pre and post tests, it was found that students' comprehension improved after using the Power Supply Trainer learning kit. This indicates that the kit is highly suitable as a teaching aid for explaining concepts and theories more effectively. As a recommendation, the researchers suggest that schools should provide adequate facilities for practical learning using the trainer kit (Anam etl 2024).

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