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IMPROVEMENT OF NON-ELECTRICAL ENGINEERING STUDENT KNOWLEDGE CONTENT AND MOTIVATION TO LEARNT ELECTRONIC CIRCUIT AND SYSTEM THROUGH IMPLEMENTATION OF HANDS – ON LEARNING

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Abstract

Electronic circuit and system (ECS) course introduces students to understand the circuit and system operation as well as using tool and technique to solve engineering problem related to circuitry. This course is compulsory offered for both electrical and non – electrical engineering students. The non – electrical engineering student will find this course challenging and difficult to understand especially when it involves circuit design and analysis. Therefore, transforming the learning environment from traditional to innovative approach could help in the enhancement of student learning. Therefore, this paper is presented to assess student reflection after the implementation of hands – on learning towards improvement of content of knowledge and motivation in learning about active filter in ECS course. Students are required to design an active filter using the specification given, verified using simulation tool and doing the actual testing in laboratory. A qualitative study is conducted via survey questionnaire and the student reflections were analyzed using thematic analysis. Results shows an improvement in student content of knowledge and motivation to learnt after the implementation of the hands – on learning. The outcome shows in this study suggest the necessity of including the hands – on learning to maximize student engagement for students as well as achieving the course learning outcome.

Keywords: *electronic, circuit and system, hands – on learning*

Abstrak

Kursus litar elektronik dan sistem (ECS) memperkenalkan pelajar untuk memahami operasi litar dan sistem serta menggunakan alat dan teknik untuk menyelesaikan masalah kejuruteraan yang berkaitan dengan litar. Kursus ini wajib diwajibkan untuk pelajar dalam bidang kejuruteraan elektrik dan bukan elektrik. Pelajar kejuruteraan bukan elektrik akan mendapati kursus ini mencabar dan sukar difahami terutamanya apabila ia melibatkan reka bentuk dan analisis litar. Oleh itu, mengubah persekitaran pembelajaran dari pendekatan tradisional ke inovatif boleh membantu dalam peningkatan pembelajaran pelajar. Oleh itu, kertas kerja ini dibentangkan untuk menilai refleksi pelajar selepas pelaksanaan pembelajaran amali ke arah peningkatan kandungan pengetahuan dan motivasi dalam mempelajari topik penapis aktif dalam kursus ECS. Pelajar dikehendaki merekabentuk penapis aktif menggunakan spesifikasi yang diberikan, mengesahkan menggunakan alat simulasi dan melakukan ujian sebenar di makmal. Kajian kualitatif dijalankan melalui soal selidik dan refleksi pelajar dianalisis menggunakan analisis tematik. Keputusan menunjukkan peningkatan dalam kandungan pengetahuan pelajar dan motivasi untuk belajar selepas pelaksanaan kaedah pembelajaran amali. Hasil yang ditunjukkan dalam kajian ini menunjukkan perlunya memasukkan pembelajaran amali untuk memaksimumkan penglibatan pelajar serta mencapai hasil pembelajaran kursus.

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Kata kunci: *elektronik, litar dan sistem, pembelajaran amali*

1.0 INTRODUCTION

Hands – on learning in education is one of the component of an experiential learning where learner obtain knowledge by doing. Kolb's experiential learning theory (Kolb,1984) defines experiential learning as the process whereby knowledge is created through transformation of experience. Baxter (1995) have outline several advantage of using computer simulation to assess hands – on in science learning which and found considerable impact on the student performance. In the same view, Greenberg et al. (2012) mentioned that the hands – on learning were engaging and motivating and provide opportunities for the students to recognize weakness in their understanding. The main goal of using hands – on learning is to enhance student learning by making student actively doing and learnt. The hands – on learning has also proven to be able to inspire and engage the electrical engineering student (Bowman,2013). This approach has also been found effective not only to circuitry related course but also in programming (Miskon et al, 2016). Electrical related subject like electronics circuit and system is also offered to non – electrical engineering program such as mechanical, chemical, civil and biomedical engineering which is part of their curriculum. Teaching

electronics to these non – electrical engineering student could be very challenging as this is not their core subject Dahnoun (2017). Some of them will find it difficult to understand the topic well. As a result, students' motivation is normally low. Therefore, an alternative teaching and learning approach is necessary to satisfy the course-learning outcome at the same time allowing student to be active with strong motivation to learn. One way to achieve this is using the hands – on learning approach.

The objective of this study is to assess student reflection after the implementation of hands – on learning in active filter topic in ECS course among third year non - electrical engineering student in one of the school under faculty of engineering, Universiti Teknologi Malaysia (UTM). The research question for this study is (i) would the hands – on learning enhance student content of knowledge about active filter and (ii) would the hands – on learning applied in the teaching and learning environment lead to greater motivation. The framework of ECS course learning environment adapted from New Academia Learning Innovation (NALI) framework (Zaini,2013) is shown in Figure 1. These hands – on activity provide opportunity to the student to familiarize themselves with electrical measurement and component needed to design an active filter. Moreover, student would be able to apply the analytical skills acquired during in class lecture. Besides, this activity also exposed student to do proper electrical circuit connections and troubleshooting which is not directly taught during lecture.

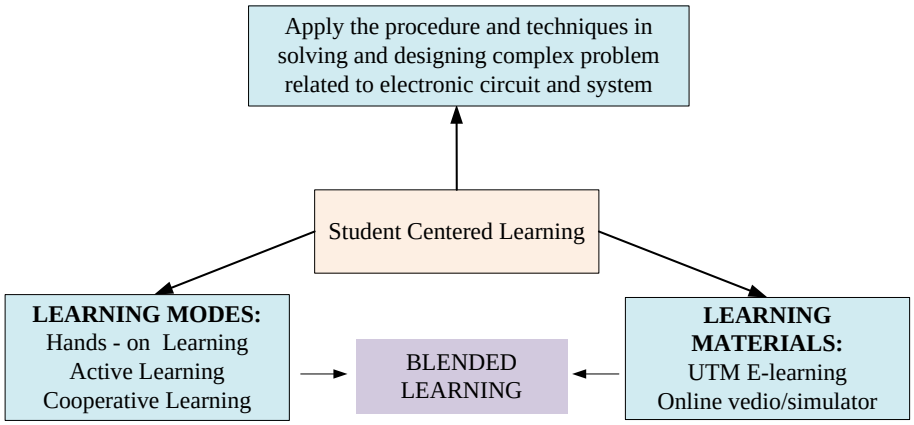

Figure 1: Framework of Teaching and Learning Environment in ECS course

2.0 METHODOLOGY

The research methodology consist of two phases; (i) in class lecturer and tutorial and (ii) teaching innovation-using hands – on learning approach that consist of three stages. The two phase and the hand – on learning stages about learning active filter in ECS course is as shown in Figure 2. In phase II, the student will go through three stages involving doing the manual

calculation to determine the value of the capacitors and resistors following the specification given. During stage 2, the student will verify their design using simulation tool. Once the verification is done, in stage 3 student will implement the circuit on breadboard and doing the testing in laboratory. An example of the active filter design question using 2nd order low pass filter, 1dB Chebychev response with cut – off frequency of 200 Hz and pass band gain of 25dB for the hands – on learning indicating the three stages are as follows:

- **Stage 1:** Design the circuit and manually determine the value for the capacitors and calculate the values for the resistors by minimizing the offset current error.
- **Stage 2:** Design verification using simulation tool showing the pass band gain and cut – off frequency that full fill the specification given.
- **Stage 3:** Implement the circuit on breadboard and test the active filter circuit functionality.

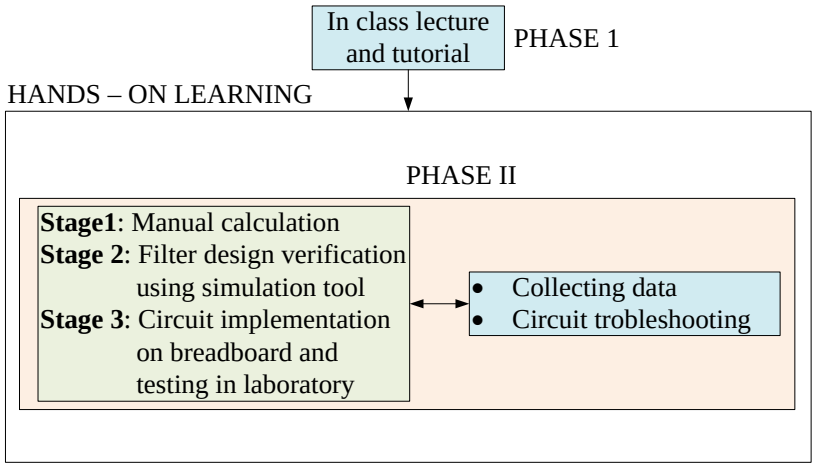

Figure 2: Two phases of Teaching and Learning about active filter in ECS course

In quantitative study, description analysis was carried out using average ranking score based on student agreement on the factor they like most ranking from F1 to F4. The factors are:

F1: learnt to assemble component on breadboard and do the wiring connection
F2: solving the problem/circuit troubleshooting with group member
F3: collecting data and obtain the characteristic
F4: discuss with the lectures on the problem faced and identify possible solution

Meanwhile, in qualitative study, the data are obtained through reflection collected from the student after the hands – on session. Thematic analysis (Braun and Clark,2006) is used to analyze the data to identify the improvement in content of knowledge and learning motivation.

3.0 Results and Discussion

Figure 3 illustrates the result of the survey and shows that the majority of the students very much liked learnt to assemble the component on breadboard and do the wiring connection with an average ranking score of 2.81. It can also be seen that these students ranked factor F3 lowest with an average score of 2.03. The possible reason for this may be due to the new experience they learnt during the learning which they have not experience in their core subject

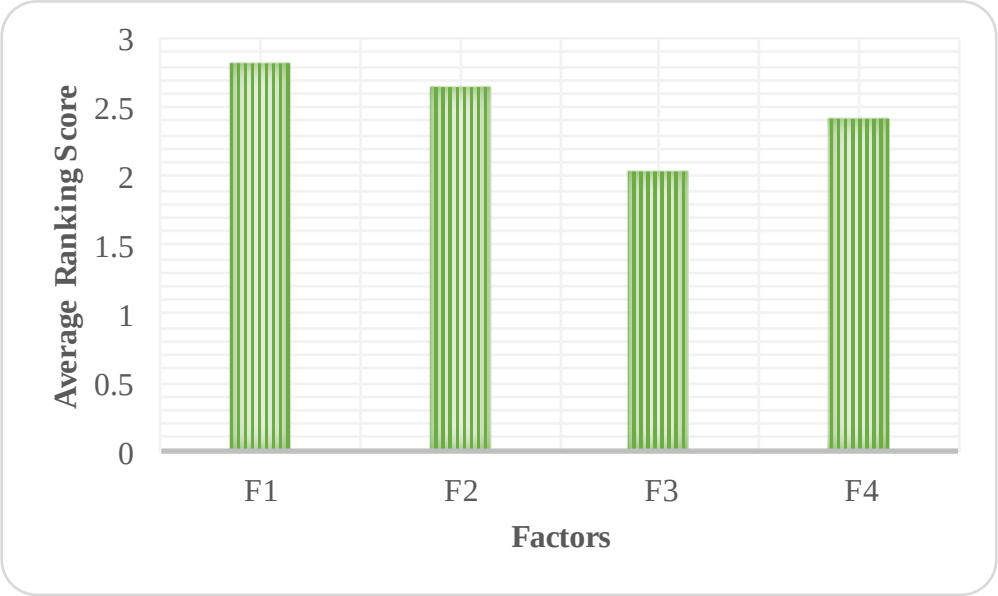

Figure 3: Survey results on the factor student like during the hands –on session

The improvement in content of knowledge among student learning about active filter in ECS course are evident from the reflection written by the students. It can also be seen from the perceptions that the majority of the student able to increase their knowledge especially on the functionality of the active filter system as well as doing the circuit troubleshooting and using equipment. Thus, they obtain new knowledge, which is not directly taught during lecture in Phase 1. A sample to statement from students is listed in Table 1 showing student agreement of content of knowledge enhancement after the activity. From Table 1, there was a positive response from students especially having the active filter circuit tested in laboratory. Students seemed to appreciate the hands – on session where they learnt more not only on the theoretical concept but the actual active filter circuit design. The result demonstrated here is provide another evident on the effectiveness of hands – on learning as been shown in previous study by John et al.,2018 for course content related to circuitry.

Table 1: Sample of student reflection indicating knowledge improvement.

Respondent	Statement
P19	"help me a lot in understand the active filter topic and circuit building as well"
P27	"enhance our ability to use oscilloscope and function generator"
P34	"I able to implement what I have learnt in class and what lead me to the perfect stage of understanding is when we got error"
P38	"I learnt few new thing such as using the function generator and the IC 741 op – amp"
P39	"I have learnt on how to troubleshoot the active filter circuit that have a problem on op – amp circuit connection"

Analysis from students' reflections shows that there are two types of motivation the students' have gained, which are intrinsic and extrinsic motivation. Extrinsic motivation is related to individual's motivational that are coming from outside. For example, the struggle they faced to design and obtained the characteristic of the circuit. Meanwhile, intrinsic motivation is the individual's motivation coming from within such as the enjoyment in completing the task. A sample to statement from students are listed in Table 2 and Table 3 showing the intrinsic and extrinsic motivation among student in doing the hands – on learning about active filter in ECS course. Previous work related to electronics course applying the hands – on learning have also shown to have positive impact on student motivation (Camilo, 2017).

Table 2: Sample of student reflection indicating intrinsic motivation improvement

Respondent	Statement
R6	"After building the circuit successfully, it was really interesting to see the result"
R14	"I fell quiet interesting when we successfully get few constant output voltage within the range of low and high cut – off frequency"
P15	" I also learned on how to handle oscilloscope, function generator and power supply which I am afraid to touch it before"
P38	" I am truly glad to be able to have this experience and strongly believe that my understanding in this topic has increase compared to what learnt in class previously"

Student agreement showed in Table 2 shows that student enjoy doing the activity as

they can observe the output of the filter practically. They also able to relate what they have learnt in class and they fully engaged with team members to achieve the objective of the experiment.

Table 3: Sample of student reflection indicating extrinsic motivation improvement

Respondent	Statement
R7	"Although we did not manage to get the results at the first time, we still hold our back and try again to get the result"
R14	"seem easy to design theoretically than practical. After a few trial and the determination of the team we manage to get it"
P15	"we got a lot of error and we are not able to get the desired output so what we did is keep trying"

Student statement on extrinsic motivation shows that they have put a lot of effort to achieve the output. This also proven that the hands – on experiment to learnt active filter increase their determination. Despite the successful implementation of the activity, further improvement is needed in terms of the time management and assessment such as quiz can be done. Apart from this, for a large number of students in the laboratory, a teaching assistance is needed. The results can be used to find the relation between students' performance with the teaching strategy applied.

4.0 CONCLUSION

The study shows the implementation of hands – on learning as an approach that could enhance student understanding about active filter in ECS course. Results obtained shows that:

1. Knowledge and understanding of non – electrical engineering student have enhanced after the implementation of hands – on learning
2. Hands- on strongly increase motivation among the students intrinsically and extrinsically.

The hands – on learning approach applied to non – electrical engineering student demonstrated here have created a more positive atmosphere in which the students' in group built off each other learning. It is expected that as more element is introduced during the hands

– on session, it will become even more useful to support the teaching and learning environment.

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