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STUDENT PERSPECTIVE IN ExCoS APPROACH IN ELECTRONIC COURSE IN UNIVERSITI TEKNIKAL MALAYSIA MELAKA (UTeM)

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Abstract:

For students studying electronic engineering, having a firm grasp of the foundations of electronic circuits is essential. This prowess includes both academic and practical components, preparing students for more challenging courses by helping them become resilient. Additionally, having a solid understanding of the fundamentals of electronic circuits equips students to apply their learning in courses that include design components, such as Integrated Design Projects (IDP) and Final Year Projects (PSM). Based on these issues, the Experiential with Cooperative and Service Learning (ExCoS) approach has been designed and implemented in Fundamental Electronic courses in semester 1 2023/2024 at Fakulti Kejuruteraan Elektronik & Kejuruteraan Komputer (FKEKK), UTeM. The ExCoS approach integrates experiential, cooperative, and service-learning theory in this course. As a result of this approach, the achievement percentage of Learning Outcome 1 (LO1) in Fundamental Electronics increased from 83% to 93%. Moreover, this method has nurtured students who are more confident, skilled, and critical thikers attributes that contribute to their future success in the professional realm. According to students's feedback the ExCoS approach enhances student understanding of basic electronic circuit and boost their communication confidence. Besides, participant from SMK Durian Tunggal have benefited from the service-learning program embedded in this approach. Through this program, students have improved their understanding of fundamental circuit concepts and have been successful in rekindling the students' enthusiasm in the science and technology sector, which has recently received less attention.

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Introduction

Engineering courses involves interdisciplinary knowledge, problem solving and critical thinking skill that must follows Engineering Accreditation Council (EAC) requirements and guidelines. The Engineering curriculum must adhere to the seven criteria listed in EAC standard 2020 (EAC, 2020). Criterion 2 is about Program Outcomes (PO) that engineering students expected to attain by the time of graduation. An academic curriculum has been designed to cover all POs with various delivery and assessment method. Diverse methods in teaching and learning also one of the contributions to develop intellectual and positive attributes in students that aligned with POs. Fundamental Electronic is one of a fundamental course in Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer (FKEKK) in UTeM that covers PO1: Engineering Knowledge and PO2: Problem Analysis. This course covers the essential principles that form the foundations for electronic engineering courses such as principles and application of diode, operation of Bipolar Junction Transistor (BJT) and Field Effect Transistor (FET). This proficiency of engineering concepts in this course is crucial for student's academic success and future professional endeavours. Developing a strong conceptual understanding of engineering principles is essential for students to achieve competence in their field.

There are some students struggle to grasp the course's fundamental concepts, causing them more of trouble in more challenging courses in third and fourth year. Integrated Design Projects (IDP) and Final Year Projects (FYP) are two examples of pinnacle courses that require students to think critically and creatively designing and solve problems. The proficiency in fundamental knowledge not only helps students excel in their coursework but also prepares them to solve complex engineering problems and contribute to innovative solutions in the industry. An approach that combines three theories: Experiential Learning, Cooperative learning, and Service learning named as ExCoS approach is proposed to enhance student learning and proficiency of basic concept in Fundamental Electronic course.

The ExCoS approach in this study is designed to encourage student participation, critical thinking and problem solving to develop a solid foundation of engineering knowledge. The main concept of ExCoS is developing a Service-learning program that involved all student in the class and a community target. According to (Maharam Mamat, 2019) service-learning is the subset of experiential learning that emphasize on the concept of "learning by doing" as in (Iris M. Yob, 2014). In service-learning, student will engage with community to solve problems. According to (Yusof, 2020), this approach helps to prepare students in the era of Industrial Revolution 4.0 (IR 4.0) and exposes them to various issues in society.

Students are encouraged to use creativity when using the knowledge and skills they have learned in the classroom to address problems and difficulties that arise in the community through service-learning. The students will be guided by lecturers in this learning technique. According to (Clua,2020), students can gain experimental skills not covered in earlier laboratory by using an interdisciplinary approach to service learning, which integrates analysis,

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implementation, design, and testing. This work investigates engineering students' experience in service-learning approach in capstone subject, Informatic Engineering course.

Experiential learning helps in improve student understanding in fundamental knowledge as reported in (Villarroe, 2020, Prashant, 2020 & O'Brien, 2021). Prashant compared the ability of first year medical students that joined the experiential session with student that follow traditional method. This work shows a statistical improvement, P=0.006 in examination performance for a group of students that join the experiential session. Additionally, research on engineering courses indicates that the use of experiential learning increases student participation in the classroom and improves technical skills at the same time (Espinosa, 2020 & Scherrer, 2020).

In the meantime, students worked together to design the program as part of the ExCoS approach, which incorporates a cooperative theory. During cooperative learning, students take part in planned and structured group tasks (Shuib Basri, 2017). Each group member is accountable for their assigned work and will undergo evaluation. This research suggests that cooperative learning can help students comprehend and visualize software system modeling and analysis. Meanhwhile in (Kanawit Klinbumrung, 2020) shows that the cooperative learning techniques employed in training programs can help students acquire the information and abilities needed for the twenty-first century and can be effectively applied to the engineering curriculum. Furthermore, it has been demonstrated that cooperative learning improves student performance in mathematical abilities and learning objectives (Ziziumiza, 2022 & Abd Algani, 2021).

According to previous studies, students learn effectively through active learning since it incorporates a variety of interactive activities. The effective of learning is explained in Dale's cone (Anderson, 2009), which suggest that people generally remember 90% of things that they have done and only 20% of what they heard. This demonstrates the significance of learning activities in helping students retain and comprehend what they have learnt. One of the active learning strategies that involves students in activities is the suggested ExCoS approach used in this study. In this paper an ExCoS approach to Fundamental Electronic course is presented. student feedback is used to measure the effectiveness of the learning technique, and the course structure and samples of student work are highlighted.

Methodology

The ExCoS approach comprises three learning theory which are experiential, cooperative, and service- learning. The study was designed in three phases as shown in Figure 1. In Phase 1, planning is the important part of the study as the researcher need to identify the target community to participate in the Service-Learning program to match with the syllabus of Fundamental Electronic course. Researcher guided the students to design activities that compatible with target community and achieved target learning outcomes, which is to enhance understanding in series and parallel circuit.

Phase 2: Students need to implement the planned activities in a limit time to achieve the learning outcomes. Program implementation which is service-learning program developed communication and critical thinking skills in students. Students need to communicate and execute the planned learning activities with the community. The program of service-learning includes the analysis and evaluation of appropriate activities, the design and development of

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Teaching Aids (TA), and the resolution of unexpected issues. All of the program's activities incorporate critical thinking skills.

Phase 3: The last phase, reflection is where the feedback is collected, analyze and recorded in a comprehensive report. Student and community feedback is gathered, and it will be statistically analyzed. The details of the feedback will be explained in *Instruments* part.

Figure 1: Phase in ExCoS Approach

Framework

This study employed of quantitative approach based on FKEKK students and SMK Durian Tunggal students' perspective. The FKEKK students who participated in this study is the student that fully involved in the Service-Learning activities in the Fundamental Electronic course. Meanwhile the SMK Durian Tunggal students is the target community of the service-learning activities that is organized by the FKEKK students. SMK Durian Tunggal is chosen as the target community because of its location in rural areas near UTeM. Besides, to instil interest in students in science and technology field.

Service-learning program is an approach in ExCoS where FKEKK students are divided into 6 groups and act as mentors to SMK Durian Tunggal students. Mentee or SMK Durian Tunggal students will join two main activities prepared by mentor for 5 hours program held in Lecture Room and Fundamental Electronic Laboratory, FKEKK. Each group will guide 5 to 6 mentees in both activities. Table 1 shows the details of participant in Service-Learning program.

Table 1: Participant of Service-Learning Program

Participant	Number of students	Description	Course or Subject
Mentor	17 FKEKK student (6 groups)	Year 2 Bachelor of Electronic Engineering (BENG)	Fundamental Electronic (BENE 2123)
Mentee	32 SMK Durian Tunggal students	Form 2 from 2 RK1 class	Science Form 2, Topic Electricity

Figure 2 shows the ExCoS framework that has been applied to all groups. In Phase 1, mentors have been collaborating within their respective groups to generate ideas for implementation in Service-Learning program. Mentors leverage the knowledge and skills acquire from classroom lectures to design and create activities to captivate mentees and ensure their active participation throughout the program.

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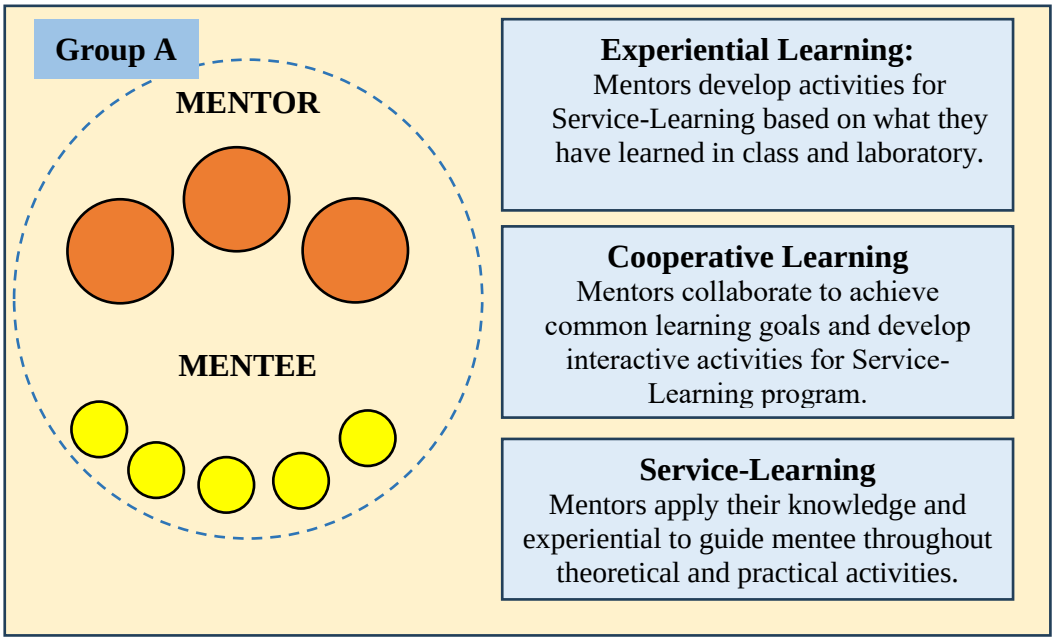

Figure 2: ExCoS Framework Apply In Each Group.

Instruments

The data is collected through feedback from the students at the end of the activities. Two questionnaires were used to collect feedback from mentor and mentee in the service-learning program. Each item in the questionnaire were design with a scale of 1 to 5 which is from strongly disagree to strongly agree. Numerical data collected in the study were analyzed quantitatively using analytic technique namely descriptive statistics. The measurements provide an understanding of collective properties on an element in the data sample.

Data Analysis and Findings

The weekly implementation of ExCoS approach in Fundamental Electronic course is shown in Figure 3. The framework shows the weekly planning for the whole semester which includes conventional learning technique which are lectures and tutorials and ExCoS approach.

The theoretical part of the program incorporates engaging and interactive activities led by mentor shown in Figure 4. Mentor has designed creative Teaching aids (TA) to make the activities fun and beneficial to mentees. Those TA are included presentation using Power Point slides, quizzes to assess comprehension, and crosswords to reinforce the key concepts as shown in Figure 5. Meanwhile, the practical section involves hands-on activities is shown in Figure 6. Mentee are guided to assemble both series and parallel circuits, which can help them grasp the fundamental of electrical and electronic circuits.

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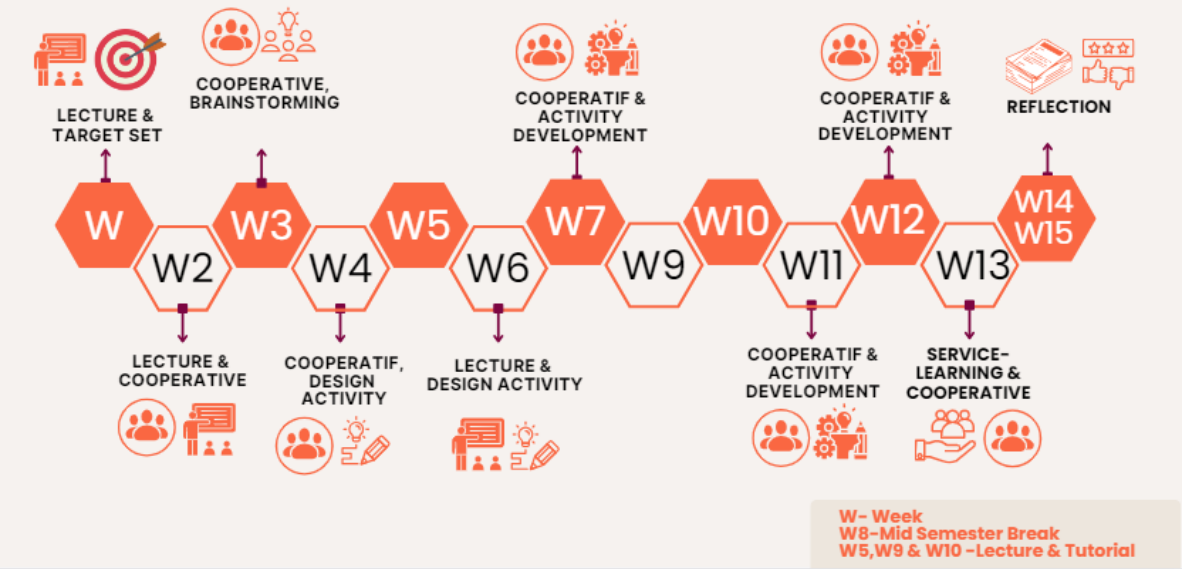

Figure 3: Weekly Implementation of ExCoS Approach in Semester 1 2022/2023

In order to facilitate the program, mentor need to study and prepare suitable material for the mentees. For example, to ensure the functionality of the designed circuit in the practical part, mentor conducted circuit simulations using Multisim software and selected the suitable components such as LED, resistor, and buzzer. Based on this hands-on involvement, mentor is learning through their experience and can help improve their understanding of the concepts and theories. This approach allows mentors to not only gain cognitive knowledge but also actively engage with the entire learning experience, encompassing thinking, feeling, perceiving, and behaving. This was demonstrated in (Villarroe, 2020), which concurred that because of all the actions, experiential learning is a helpful technique for teaching complex learning that involves procedural, cognitive, and attitude components. Students can approach the professional role and put their disciplinary knowledge in context thanks to it.

Figure 4: Theoretical Activities in Service-Learning Program

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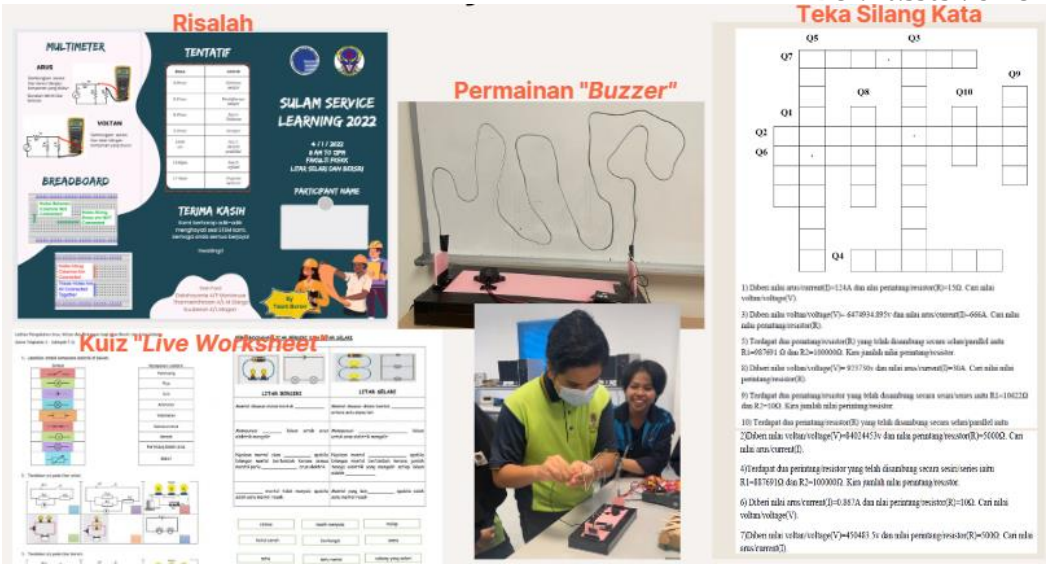

Figure 5: Teaching Aids developed by mentor

Figure 6: Practical Activities in Service-Learning Program

Figure 7 displays a bar chart of student perspective (mentee) toward understanding series and parallel concept in theoretical and practical after the service-learning program. The finding shows that 20 students strongly agree that the program helps them enhance their understanding in the topic. The questionnaire item will be analyzed for mean score and standard deviation, as indicated in Table 2, in order to evaluate the theoretical and practical activity.

The analysis obtained from the sample data as depicted in Table 2 reveals the student perspectives (mentee) in service-learning program. The result clearly shows that each item for both activities have a relatively good mean score (more than 3.0) with standard deviation between 0.66 – 0.79. The range of standard deviation indicates that the responses were relatively consistent and not widely dispersed. The mean score for question Q1 is 4.41, indicating that the participant agreed that the theoretical activities carried out during the course aid in their understanding of the subject.

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These bar charts and tables support the conclusion that the 2 BENG students who serve as mentors have done a good job of teaching the mentee and assisting them in understanding and developing their practical skills in series and parallel circuits.

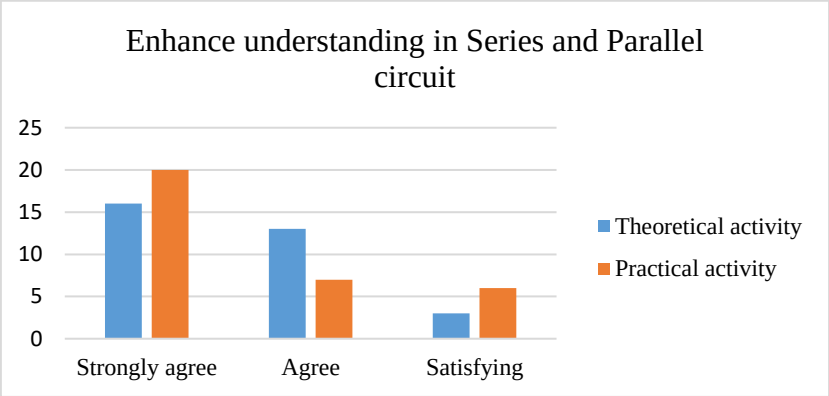

Figure 7: Mentee Perspectives in Understanding Circuit

Table 2:

Question	Activity	Item statements	Means	Standard Deviation
Q1	Theoretical	I can understand the topic of series and parallel circuits very well.	4.41	0.66
Q2	Practical	The circuit assembling activity can be easily completed with the help of a mentor.	4.42	0.79
Q3		I get to know electronic components more closely.	4.30	0.73

Discussion and Conclusion

The ExCoS approach has helped enhance 2 BENG students' competency of the learning outcomes (LO1) of the course, which is to "Explain the principal knowledge of semiconductor materials, the characteristics and applications of electronic." Students are able to articulate the basic concepts of electronic circuits effectively to their mentees and also develop simple electronic circuits during service-learning programs.

This teaching approach enhances students' potential in various aspects. Students have used the knowledge they have learned in class to design teaching aids (TAs), demonstrating their creativity, and helping mentees understand the material. Some of the TAs developed by students include electronic circuit handouts, quizzes, crossword puzzles, and a buzzer game. This also enhances students' critical thinking, the creation of the TAs stems from critical ideas proposed by students, contributing to the lively atmosphere of community service programs. The transfer of knowledge from mentor to mentee is more positive in this cheerful environment.

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The collaborative circuit assembly with mentees frequently presents a variety of problems in terms of problem-solving abilities because mentees may lack prior expertise in similar activities. Nonetheless, the involved mentors deal with the problems that come up and find solutions. Throughout the program's planning, execution, and reflection phases, students participate in cooperative activities that expose them to leadership and teamwork. Students that go through this procedure develop leadership skills and a collaborative attitude.

Additionally, the positive impact on student learning is further evidenced by a 10% increase in the achievement of LO1 in the first semester of 2022/2023 compared to the previous semester, rising from 83% to 93%.

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