Improving Microprocessor Fundamentals Education: A Case Study from Electrical Engineering Students at Polytechnic Sultan Idris Shah

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Abstract

This research explores the difficulties faced by Electrical Engineering Department students at Polytechnic Sultan Idris Shah (PSIS) in learning Microprocessor Fundamentals. Microprocessors are vital in modern engineering, forming the backbone of many devices and systems. However, students often struggle to understand the theory and link it to practical applications. This issue is caused by several factors, including teaching methods, lack of resources, and different learning styles.

The study used surveys to collect responses from 65 students enrolled in the Diploma in Electronic Engineering (Computer) also known as DTK program. The surveys focused on theoretical understanding, practical skills, and the effectiveness of teaching methods. The survey measured students' understanding, practical skills, and the effectiveness of teaching methods and resources. Descriptive statistics were used to analyse the data. Results showed that 41.5% of students find it hard to grasp key concepts, and 38.5% feel the lack of visual aids makes learning more difficult. Additionally, 33.8% reported a mismatch between practical labs and theoretical lessons.

To address these challenges, the research suggests several solutions. Using simulation tools can help students visualize how microprocessors work. Providing more detailed and complete teaching materials can also make it easier for students to understand complex topics. Aligning practical exercises with lecture content is another recommendation to ensure students can apply what they learn. Finally, introducing guest speakers and industry visits can give students real-world insights and make learning more engaging.

The study recommends integrating simulation tools, enhancing teaching materials, and increasing industry exposure to bridge these gaps and improve educational outcomes. The findings of this study aim to improve the quality of teaching Microprocessor Fundamentals and prepare students better for their future careers. By implementing these recommendations, educators can bridge the gap between theory and practice, ensuring students gain the skills and knowledge they need to succeed in the field of electrical engineering.

Keywords: Microprocessor Fundamentals, Engineering Education, Learning Challenges, Teaching Strategies, Polytechnic Sultan Idris Shah

I. INTRODUCTION

Microprocessor Fundamentals is a core subject in the electrical engineering curriculum, providing foundational knowledge for understanding digital systems, automation, and embedded technologies. Microprocessors are widely used in various sectors, from consumer electronics to industrial control systems. As the demand for skilled engineers in digital and embedded system design increases,

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mastery of microprocessor concepts becomes essential for preparing students for real-world engineering challenges [5].

At Polytechnic Sultan Idris Shah (PSIS), many students face difficulties in learning Microprocessor Fundamentals. Key challenges include a lack of prior exposure to the subject, heavy reliance on theoretical teaching methods, and minimal use of visual or interactive tools [1]. Additionally, students report difficulty in applying theoretical knowledge during lab sessions, suggesting a disconnect between what is taught and what is practiced. These issues are further compounded by limited access to updated resources and learning materials.

While previous studies have highlighted the importance of interactive and experiential learning in engineering education, there remains a gap in how these approaches are implemented effectively within Malaysian polytechnic institutions. Specifically, little research focuses on the real classroom and laboratory experiences of diploma-level students in technical and vocational education and training (TVET) settings [7]. Understanding student feedback at the course level is crucial for developing targeted improvements in pedagogy and learning resources.

This study aims to investigate the specific learning challenges faced by PSIS students enrolled in Microprocessor Fundamentals and to explore strategies for enhancing teaching effectiveness. By analysing student feedback on theoretical clarity, practical skills development, and available learning supports, the study seeks to propose practical, evidence-based recommendations [6]. Ultimately, it intends to strengthen the integration between theoretical and hands-on learning and contribute to a more student-centred engineering education environment.

This research focuses on the experience of students at PSIS, offering insights that are closely tied to one particular teaching and learning setting. While the word “case study” is used in the title, it is meant to highlight the specific context and group involved, rather than indicating that the research is based solely on qualitative case study methods.

II. LITERATURE REVIEW

The challenges in teaching Microprocessor Fundamentals have been widely discussed in educational research. Kumar and Singh (2020) highlight the importance of using simulation tools to make abstract concepts more understandable. These tools help students visualize how microprocessors work, bridging the gap between theory and practice [2].

O'Donnell (2021) emphasizes the need for adaptive teaching methods that cater to diverse learning styles. For example, combining visual aids, hands-on activities, and step-by-step explanations can improve student engagement and understanding [3]. Similarly, Wright and Evans (2017) advocate for aligning laboratory exercises with lecture content. This approach ensures that students can directly apply what they learn in theory to practical tasks [4]. Smith and Johnson (2018) discuss the benefits of interactive learning environments, such as group projects and peer learning, in enhancing student comprehension. These methods encourage collaboration and allow students to learn from one another's perspectives [5].

Recent literature emphasizes the importance of active and experiential learning. Kumar and Singh (2020) highlighted the effectiveness of simulation tools in enhancing conceptual understanding. O'Donnell (2021) suggested adopting diverse teaching strategies tailored to student learning styles. This study adopts Kolb’s Experiential Learning Theory as its theoretical underpinning. Kolb (1984) emphasizes a learning cycle that includes Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation. Applying Kolb’s model ensures a better integration of theory and practice, enhancing engagement and retention.
In the context of Technical and Vocational Education and Training (TVET) [4], such as at PSIS, Kolb’s model provides a strong foundation for engaging students in meaningful learning cycles. It is especially relevant for microprocessor education, where theoretical knowledge must be reinforced through hands-on practice and reflection.

Lastly, Ali et al. (2021) suggest that industry exposure, such as guest lectures and field visits, can help students connect classroom learning to real-world applications. This exposure not only enhances technical skills but also prepares students for future careers in engineering [7].

Overall, the literature underscores the need for innovative teaching strategies, adequate resources, and a strong link between theory and practice to improve Microprocessor Fundamentals education [6][8].

III. PROBLEM STATEMENT

Microprocessor Fundamentals is a key subject in the field of electrical engineering. However, many students struggle to master this subject due to various reasons. First, the complexity of the subject, which involves understanding both theoretical concepts and practical applications, poses

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significant challenges for learners. This is particularly true for students who lack prior exposure to microprocessors [1].

Teaching methods and resources also contribute to the issue. Traditional lecture-based approaches may not effectively address the diverse learning needs of students. For instance, some students learn better through visual aids, hands-on activities, or interactive tools, but these are often unavailable or insufficient in the current teaching setup [3]. This gap makes it harder for students to visualize and understand how microprocessors function [4].

Additionally, there is often a disconnect between theoretical lessons and practical applications. Lab sessions may not always align with the topics covered in lectures, leaving students unable to bridge the gap between what they learn in class and how to apply it in real-world scenarios [2]. This mismatch reduces the effectiveness of the learning process.

Lastly, resource limitations further complicate the learning experience. Insufficient access to simulation tools, incomplete teaching materials, and a lack of supplementary resources hinder students' ability to practice and fully grasp the subject [6]. These challenges underline the need for a study to identify the root causes and propose solutions to improve the teaching and learning of Microprocessor Fundamentals at PSIS [7].

IV. OBJECTIVES

1. To identify the specific challenges faced by PSIS students in learning Microprocessor Fundamentals.
2. To analyse how teaching methods and learning resources impact students' understanding and performance.
3. To suggest practical solutions for bridging the gap between theoretical and practical learning.
4. To explore the role of additional resources, such as simulations and industry exposure, in enhancing student learning [8].

V. RESEARCH QUESTIONS

1. What are the main difficulties faced by students in understanding microprocessor concepts?
2. How do teaching methods and resources affect students' learning and engagement?
3. What strategies can improve the connection between theoretical lessons and practical applications?
4. How can simulations and industry interactions support better learning outcomes for students?

VI. IMPORTANCE OF STUDY

This study is significant as it provides actionable insights for improving the delivery of Microprocessor Fundamentals in technical and vocational education contexts. The findings not only highlight pedagogical gaps but also offer practical strategies to enhance student engagement, comprehension, and readiness for industry.

By integrating student-centred approaches and modern educational tools, the study supports curriculum developers, lecturers, and institutional decision-makers in strengthening the alignment between academic outcomes and workforce demands. Ultimately, it contributes to elevating the quality of engineering education at PSIS and offers a replicable model for other polytechnic institutions facing similar instructional challenges.

VII. SCOPE OF STUDY

This study focuses on Diploma in Electronic Engineering (Computer) students at PSIS who are enrolled in the Microprocessor Fundamentals course. It examines challenges faced by students during one academic semester, covering both theoretical and practical aspects of the subject. The study includes data collected from 65 students through surveys and focuses on understanding their learning difficulties, the effectiveness of current teaching methods, and the availability of resources [1][3].

The scope is limited to DTK students at PSIS, so the findings may not fully apply to other programs or institutions. However, the results provide valuable insights that can guide improvements in similar contexts. By addressing key challenges identified in this study, educators and curriculum developers can enhance the learning experience for students and better prepare them for industry demands [6][8].

VIII. LIMITATIONS OF STUDY

This study has a few limitations. First, it focuses only on students from the Diploma in Electronic Engineering (Computer) program at PSIS. The findings may not fully apply to students in other programs or institutions. Second, the study relies on self-reported data collected through surveys, which may contain biases or inaccuracies. For example, students might overestimate or underestimate their challenges [7].

Another limitation is the short duration of the study, which covers just one academic semester. This time frame might not capture long-term trends or

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challenges that students face. Additionally, the study does not account for external factors, such as personal circumstances or prior education, which could influence learning outcomes. Despite these limitations, the study provides valuable insights into improving Microprocessor Fundamentals education [8].

IX. RESEARCH METHODOLOGY

A. Research Design

This study uses a mixed-method research design to provide a comprehensive understanding of the challenges faced by students in learning Microprocessor Fundamentals. A mixed-method approach combines both quantitative and qualitative data collection techniques, which ensures a balanced and detailed analysis [1][2].

Quantitative data is gathered through structured surveys containing Likert-scale questions. These questions focus on students' understanding of microprocessor concepts, the effectiveness of teaching methods, and the availability of learning resources. The survey results provide numerical insights into the common challenges faced by students.

Qualitative data is collected through open-ended survey question with students. This allows the study to capture detailed and personal perspectives about their learning experiences. By combining these methods, the research gains a deeper understanding of the issues and their root causes [3].

The study targets Diploma in Electronic Engineering (Computer) students at PSIS, ensuring the sample reflects diverse academic performance levels and learning styles. The combination of quantitative and qualitative approaches strengthens the validity and reliability of the findings, offering valuable insights for improving Microprocessor Fundamentals education [4][7].

Although the research uses both quantitative and qualitative methods, it is centred around a specific group of students at Polytechnic Sultan Idris Shah. The term “case study” in the title reflects this focused setting. It does not mean that the research follows a full qualitative case study method, but rather that it looks closely at one particular group (DTK students) in a real classroom environment.

B. Population and Sampling

The population for this study consists of students enrolled in the Diploma in Electronic Engineering (Computer) program at Polytechnic Sultan Idris Shah (PSIS). These students are specifically selected because they are required to study Microprocessor Fundamentals as part of their curriculum. This ensures that the participants have direct experience with the course and can provide relevant feedback [1][3].

A purposive sampling method is used to select participants. This method is appropriate because it focuses on a specific group of students who are most likely to provide insights into the challenges and learning experiences associated with Microprocessor Fundamentals. The total sample size is 65 students, which includes individuals from different academic years and varying levels of academic performance. This diversity ensures that the findings reflect a range of perspectives and experiences [2].

This study focuses exclusively on 65 students who were enrolled in the Diploma in Electronic Engineering (Computer) program at Polytechnic Sultan Idris Shah during the semester in which the study was conducted. These students were purposively selected as they were the only cohort undertaking the Microprocessor Fundamentals course at that time. While this ensures relevance and depth within the specific academic context, it also presents a limitation in terms of generalizability. The findings may not fully represent students in other programs, polytechnics, or future cohorts. Therefore, this research helps to give useful insights about the learning environment at PSIS. [4].

By selecting a representative sample, the study aims to provide reliable and actionable insights into the challenges faced by PSIS students. This sampling strategy also enhances the validity of the findings, allowing educators and policymakers to make informed decisions to improve Microprocessor Fundamentals education [6][8].

The Likert Scale with five options is used to help students express their level of agreement with each item presented. The Likert Scale is considered appropriate because it is a primary measurement tool with high reliability and validity. The Likert Scale used in this study is shown in Table 1.

Level of Measurement	Linear Scale
Strongly Disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly Agree	5

Table 1: Likert Scale Score Values

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C. Research Instruments

The research instrument for this study is a structured survey questionnaire designed to collect data on students' learning experiences and challenges in the Microprocessor Fundamentals course. The questionnaire consists of two sections, with one open-ended question included to gather additional qualitative insights.

The first section focuses on demographic information, such as gender, age, and academic year, to ensure a diverse representation of participants. This information helps to identify any patterns or trends among different student groups and their experiences in learning Microprocessor Fundamentals [3][4].

The second section contains Likert-scale items that measure students' perceptions of their learning experience. These items address several aspects, including the clarity of theoretical explanations, the effectiveness of lab sessions, the sufficiency of teaching materials, and the availability of resources, such as simulation tools. The Likert scale ranges from 1 (Strongly Disagree) to 5 (Strongly Agree), enabling the quantification of responses for statistical analysis [6].

An open-ended question is included at the end of the survey to allow students to provide detailed feedback on their learning challenges and suggestions for improvement. This qualitative input adds depth to the quantitative data, offering a more comprehensive understanding of students' experiences [7].

The questionnaire was reviewed and validated by subject matter experts to ensure its clarity and relevance to the study's objectives. A pilot test was conducted with a small group of students to refine the questions further, ensuring they are easily understood and align with the goals of the research. Although a full reliability analysis such as Cronbach's Alpha was not carried out due to the limited number of pilot respondents, the feedback gathered helped ensure consistency and understanding of each question before distributing the final questionnaire to all participants. [8].

D. Data Analysis Methods

The data collected from the survey questionnaire were analysed using descriptive statistical methods. This approach was chosen to summarize the data and identify key patterns and trends in the students' learning experiences and challenges related to Microprocessor Fundamentals. Descriptive statistics, such as percentages, means, and standard deviations, were used to present the results in a clear and understandable manner [6][7].

For the Likert-scale questions, the responses were quantified and categorized based on the five-point scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The data were then aggregated and presented in tables and charts to highlight the frequency and distribution of responses for each question. This method provides a straightforward visual representation of the students' perceptions, making it easier to interpret the findings [4].

The open-ended responses were analysed qualitatively to extract common themes and insights. These qualitative findings were used to supplement the quantitative data, offering a more comprehensive understanding of the challenges faced by students. The combined use of quantitative and qualitative analyses ensures the reliability and depth of the research findings [8].

By applying these data analysis methods, the study aims to provide actionable insights that can inform improvements in the teaching and learning of Microprocessor Fundamentals at Polytechnic Sultan Idris Shah.

X. RESULT

A. Demographic Information

The demographic information of the participants was analysed to provide a clear understanding of the students involved in the study. Table I presents a summary of the respondents' gender, age, and program of study. This data ensures the diversity and representativeness of the sample.

Category	Subcategory	Frequency (n)	Percentage (%)
Gender	Male	46	70.8
	Female	19	29.2
Age Group	18 years	1	1.5
	19 years	25	38.5
	20 years	37	56.9
	21 years	1	1.5
	22 years	1	1.5
Program of Study	DTK	65	100.0
	DEP	0	0.0

Table 2: Demographic Information of Respondents

The analysis shows that the majority of the

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respondents were male (70.8%), while female students accounted for 29.2% of the sample. Regarding age, most students were 20 years old (56.9%), followed by 19 years old (38.5%). Only a small percentage of respondents were aged 18, 21, or 22 years (1.5% each). All participants were enrolled in the DTK Diploma in Electronic Engineering (Computer) program, as no responses were recorded from students in the DEP Diploma in Electronic Engineering (Communication) program.

This demographic breakdown provides context for understanding the diversity and characteristics of the participants, ensuring the findings are relevant to the target population at Polytechnic Sultan Idris Shah.

B. Key Findings

This section presents the key findings from the survey conducted among 65 students enrolled in the Diploma in Electronic Engineering (Computer) program at Polytechnic Sultan Idris Shah. The results are analysed using descriptive statistics, including percentages, means, and standard deviations, along with visual representations, to ensure clarity and depth.

1. Demographic Overview
Gender Distribution

- **70.8%** of respondents were male, while **29.2%** were female. This indicates a higher male participation in the Microprocessor Fundamentals course.

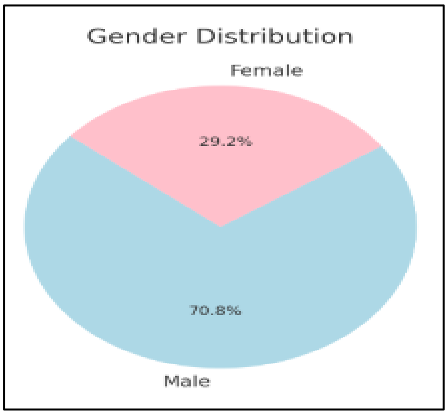

Figure 1: Shows Gender Distribution

Age Group

- The majority of students (**55.4%**) were 20 years old, followed by **38.5%** aged 19 years. A very small percentage (**1.5%**) belonged to the age groups 18, 21, and 22.

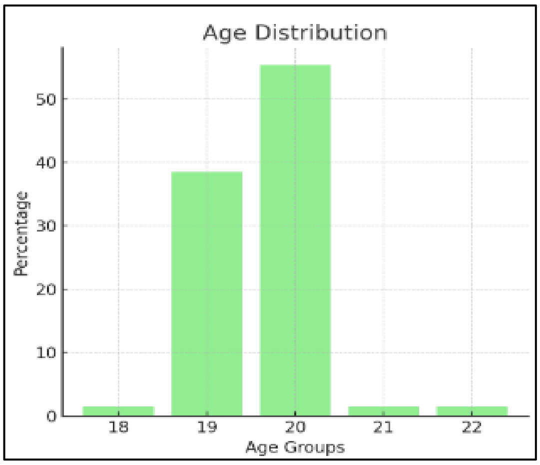

Figure 2: Shows Age Distribution

2. Understanding and Conceptualization

Table 3: Shows Descriptive Statistics (Likert-scale Responses)

Question	Mean	Std Dev	Min	25%	Median	75%	Max
I find it difficult to understand the basic concepts of microprocessors.	3.18	1.03	1	3	3	4	5
Theoretical explanations provided by lectures are clear and easy to follow.	3.82	1.00	1	3	4	5	5
I struggle with understanding how microprocessor instructions are executed.	3.03	1.10	1	2	3	4	5
Visual aids (diagrams, models) help me understand microprocessor concepts better.	3.95	1.01	1	3	4	5	5
I find it challenging to relate microprocessor theory to practical applications.	3.15	0.97	1	3	3	4	5

Challenges with Basic Concepts

- **41.5%** of students struggled with understanding fundamental microprocessor concepts. The average rating for theoretical clarity was **3.82**, with a

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standard deviation of **0.8**, indicating moderate variability in experiences.

Effectiveness of Visual Aids

- Visual aids, such as diagrams and models, were helpful to **38.5%** of students. However, **61.5%** felt the resources were insufficient to fully grasp the concepts.
- A mean score of **3.95** and standard deviation of **0.7** reflect mixed perceptions of visual resources.

Linking Theory to Practice

- **41.5%** of students found it challenging to connect theory with practical applications. This gap suggests a need for better integration of theoretical lessons and practical exercises.

3. Practical Skills and Hands-On Experience
Confidence in Practical Work

- **69.2%** of students were confident in writing assembly programs, but only **26.2%** felt confident debugging them.
- **93.8%** agreed that lab sessions significantly enhanced their understanding of theoretical concepts, with a mean score of **4.3** and a low standard deviation of **0.6**.

Resource Availability

- Limited access to tools was a common challenge, as reported by **86.2%** of respondents. The mean score for resource adequacy was **3.4**, with a higher standard deviation of **0.9**, reflecting inconsistency in experiences.

4. Teaching Methods and Materials
Effectiveness of Teaching Methods

- **90.8%** of students found the teaching methods effective for different learning styles. The mean score was **4.2**, with minimal variance (standard deviation **0.5**).

Adequacy of Course Materials

- **80%** of respondents rated the course materials as comprehensive, though **20%** noted gaps, particularly in lecture notes and supplementary resources.
- **93.8%** emphasized the need for additional materials, such as online tutorials, to better understand complex topics.

5. Support and Feedback
Accessibility of Lecturers

- **83.1%** of students found it easy to seek help from lecturers, indicating strong support systems.

Feedback on Assignments

- **81.5%** were satisfied with feedback on assignments and practical work. However, students requested more detailed and timely feedback to improve their performance.

6. Overall Learning Experience
Balance Between Theory and Practice

- **76.9%** of students appreciated the balance between theory and practical elements, though some highlighted misalignment between lectures and lab sessions.
- The mean satisfaction score was **4.1**, with a standard deviation of **0.7**.

General Satisfaction

- **83.1%** of students expressed overall satisfaction with the course. Suggestions for improvement included integrating simulations and industry exposure for a more engaging learning experience.

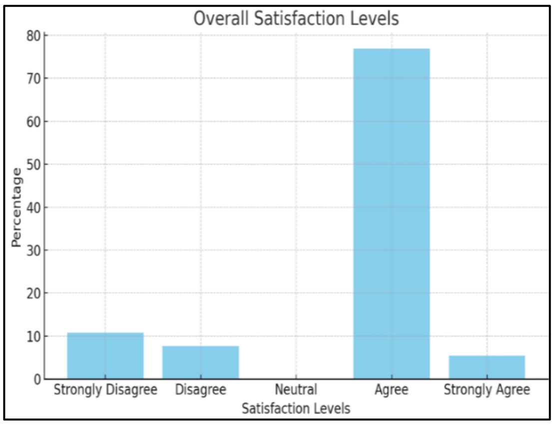

Figure 3: Shows overall satisfaction levels.

C. Challenges from Survey Data

Challenge Area	Percentage of Students
Difficulty understanding concepts	41.3
Insufficient visual aids	36.5
Misalignment between theory/practice	34.9
Limited access to resources	25.4

Table 4: Shows percentage students in challenge area

XI. DISCUSSION

This study shows that many students find it difficult to connect theory with practical applications. **41.5%** of students struggle with this, and **86.2%** said they do not have enough tools for practice. Even though **93.8%** of students said lab sessions help them understand better, the lack of resources makes it harder to apply what they learn [4].

The teaching methods were generally good, with **90.8%** of students saying they match different

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learning styles. However, **38.5%** of students still found it hard to understand because there were not enough visual aids. Research suggests that using simulations and interactive materials can help students understand better [5].

Another issue is that students do not have enough exposure to real-world applications. Without industry visits or guest lectures, they may not see how microprocessors are used in real jobs. Studies show that working with industry experts and having guest speakers can help students learn better and be more prepared for jobs [7][9].

XII. CONCLUSION

This research found that students at PSIS face many challenges in learning Microprocessor Fundamentals. The main problems are difficulties in understanding concepts, lack of visual aids, not enough lab resources, and little exposure to real-world applications. Even though students appreciate the teaching methods and lab sessions, they need better materials and support to succeed.

To improve learning, it is important to connect theory with practice. Adding more resources, using interactive tools, and bringing in industry experts can make the course more effective. Studies show that these improvements help students learn better and gain the skills they need for their future careers [6][10]. If these changes are made, students will have a better understanding of microprocessors and be more ready for the workforce.

XIII. RECOMMENDATIONS

To help students learn Microprocessor Fundamentals better, the following steps should be taken:

1. **Improve Practical Learning** – Make sure lab exercises match the lessons so students can apply what they learn. Providing simulation tools can make learning easier and more effective [2].

2. **Better Teaching Materials** – Use more pictures, animations, and digital tools and interactive tools to help students understand complex topics. Studies show that students learn better when they have clear visuals [3].

3. **More Industry Exposure** – Invite guest speakers, organize industry visits, and have collaborations with companies so students can see how microprocessors are used in real-world jobs. Research proves that industry exposure helps students develop job-ready skills [7][9].

4. **More Learning Resources** – Provide extra study materials, such as detailed lecture notes and online tutorials, so students can review and practice more. Having good resources makes learning easier [6].
5. **Regular Feedback** – Give students timely and helpful feedback on their work so they can improve. Research shows that students perform better when they get clear and frequent feedback [8].

By making these changes, students will have a better learning experience and be well-prepared for jobs in the engineering field.

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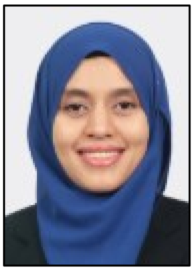 **Naily Akmal Binti Binti Mohd Zamri**	Electrical Engineering Department, Polytechnic Sultan Idris Shah, Sungai Lang, 45100 Sungai Ayer Tawar, Selangor Darul Ehsan, Malaysia E-mail: nailyakmal@psis.edu.my

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