Industrial Visits as Experiential Pedagogy in Engineering Education

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Abstract
Industrial visits are a vital element of engineering education, directly contributing to the attainment of graduate outcomes as outlined in Outcome-Based Education (OBE) frameworks. However, without structured pedagogical planning, such visits often risk being more recreational than educational. This study applied the SEAR (Summarise, Elaborate, Apply, Reflect) method, originally developed in prior research, and adapted it to align with Kolb's Experiential Learning Cycle to evaluate the impact of a short-term industrial visit in an Electrical Engineering course. Pre-visit and post-visit questionnaires were distributed to measure student's perceptions, understanding, and engagement. The data were analysed using descriptive statistics, with mean score comparison to identify improvement in learning outcomes. The results showed significant learning gains where 87% of students reported improved theoretical understanding, 81% enhanced practical understanding, 76% better ability to link theory with real-world applications, and 72% increased confidence in problem-solving. Assessment scores rose from 64% to 84%, indicating a 20% improvement in overall understanding. Qualitative feedback revealed that students valued seeing real operations, which strengthened their motivation and improved connections between classroom theory and practical application. These findings demonstrate that industrial visits, when guided by structured pedagogical models such as SEAR, can effectively enhance Programme Learning Outcomes (PLOs) related to engineering knowledge, practical application, and lifelong learning, transforming site visits into impactful experiential learning opportunities.

Keywords: Industrial Visits; Engineering Education; Experiential Pedagogy.

1.0 Introduction
Engineering education faces the challenge of preparing graduates to adapt theoretical knowledge to practical, real-world problems. While classroom learning builds foundational understanding, many students struggle to visualise how principles work in practice. Industrial visits bridge this gap, immersing learners in environments where engineering systems, processes, and safety protocols are actively applied. Beyond technical exposure, industrial visits promote teamwork, communication, professional confidence, and other industry-readiness skills (Naseer et al., 2025; Shore & Dinning, 2023). The impact of an industrial visit depends greatly on how it is planned. If the visit only involves observing, students may become passive participants, and the learning gained will be limited. In contrast, a well-planned visit includes preparation before the trip, guided activities during the visit, and

reflection afterwards (Markom et al., 2011). This approach helps students engage actively, think critically, and apply what they have learned in a meaningful way.

Industrial visits have long been acknowledged as valuable tools for connecting theory with practice, enhancing engagement, and deepening understanding (Anderson & Lucas, 2001; Carbone et al., 2020). Their pedagogical benefit is particularly evident when scaffolded with structured preparatory and reflective activities, which help learners meaningfully integrate experiences (Putri & Dewi, 2025). Central to experiential learning is Kolb's Experiential Learning Cycle, consisting the stages of concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 2013). In engineering, this model guides the design of activities that move learners beyond passive reception, encouraging them to experience, reflect upon, and apply concepts in real-world practice. Within this theoretical framework, (Kulkarni & Dandge, 2024) proposed the Stimulate, Experience, Assimilate/Accommodate, Reinforce (SEAR) model as a structured method to enhance the educational outcomes of industrial visits SEAR adapts Kolb's cycle into a focused, engineering-specific sequence: "Stimulate" primes students with pre-visit materials, "Experience" provides the hands-on visit, "Assimilate/Accommodate" encourages reflection and integration, and "Reinforce" ensures consolidation via post-visit assignments and presentations. Their case study demonstrated a significant improvement in outcome attainment from 52.95% to 77.78% when visits followed this structured approach. This development builds on earlier models of experiential pedagogy, such as pre- and post-activity scaffolding in field experiences (Anderson & Lucas, 2001), and outcomes-based industrial visits that link directly to PLO (Beldar & Kushare, 2025). Despite the demonstrated benefit, these structured approaches remain under-explored in certain contexts, particularly short-term visits within engineering curricula.

A broader context of experiential pedagogy supports SEAR's relevance. Active learning methodologies, which engage students in hands-on or interactive learning, have been shown to significantly improve performance and retention in Science, Technology, Engineering, and Mathematics, (STEM) disciplines (Kyere, 2017). Similarly, project-based learning promotes deeper understanding and skill acquisition through real-world problem solving (Lavado-Anguera et al., 2024). Industrial trips across engineering disciplines also consistently lead to enhanced motivation, improved comprehension, and stronger cognitive and social development (Jusoh & Hadibarata, 2024; Labib & Abdelsattar, 2025). Notably, a Malaysian study within the Technical and Vocational Education and Training (TVET) context reported that industrial visits significantly boosted practical understanding, critical thinking, and willingness to apply learned concepts (Labib & Abdelsattar, 2025). This aligns well with the goals of SEAR, yet there remains a clear gap regarding its structured application in Electrical Engineering education under the OBE standard in Malaysia. Previous research has established the benefits of industrial visits for student engagement and knowledge application (Burns &

Chopra, 2016), (Bethel, 2017).

As higher education shifts toward interactive, skills-based learning, such visits prepare graduates to be technically skilled and workplace-ready. In Malaysia, engineering programmes follow Outcome-Based Education (OBE) under the Malaysian Qualifications Agency (MQA) and Engineering Accreditation Council (EAC) (Qadir et al., 2020). with revised 2024 standards (Malaysia, 2024) emphasising Programme Learning Outcomes (PLOs) in technical knowledge, problem-solving, and practical application. Industrial visits can address PLO2 (Problem Analysis) through identifying and analysing on-site engineering challenges; PLO4 (Investigation) via operational data collection and interpretation; PLO6 (The Engineer and the World) by recognising societal, safety, and environmental impacts; and PLO11 (Life-long Learning) by linking industrial practices to emerging technologies and industry trends.

Despite meeting accreditation requirements, many industrial visits fail to reach their full educational potential due to a lack of intentional design, structured preparation, and purposeful follow-up. Without these elements, students may view visits as leisure activities, making it harder to connect observed practices with classroom theory. To maximise impact, visits should include clear learning objectives, pre-visit preparation, guided on-site activities, and post-visit reflection. Prior research shows that structured planning and reflection can transform passive tours into valuable experiential learning. However, most studies lack systematic assessment of knowledge gains for specific engineering subjects. In Malaysia, few integrate pre- and post-assessments with experiential pedagogy, and even fewer apply SEAR or similar models in short-term technical visits. This gap limits measurable evidence of contributions to PLO attainment. This study proposes applying SEAR in Electrical Engineering visits to enhance motivation, conceptual clarity, and achievement of PLOs in engineering knowledge, problem analysis, and communication skills.

2.0 Methodology

This study used a mixed-methods design combining quantitative surveys and qualitative feedback to assess the educational impact of an industrial visit. It integrated pre- and post-assessments, reflections, and observations to evaluate knowledge gain and engagement. Analysis followed the SEAR framework to systematically link pre-visit preparation, onsite learning, and post-visit outcomes. The SEAR flowchart is shown in Figure 1.

2.1 Participants

The subjects were undergraduate Electrical Engineering students enrolled in the Electrical Machine course at Universiti Teknologi PETRONAS (UTP). The industrial visit took place at the Langkawi SkyCab cable car located in Langkawi, Kedah, Malaysia.

2.2 Data Collection

A structured questionnaire was developed to capture both quantitative and qualitative data. The survey method consisted of two sections:

2.2.1 Quantitative Method

This section included 10 Likert-scale items designed to measure student's perceptions across key domains: relevance of the visit, understanding of electrical machines, connection to theoretical knowledge, motivation, and satisfaction with the visit's delivery. The output of the survey is calculated using the equation provided in next sub-headings.

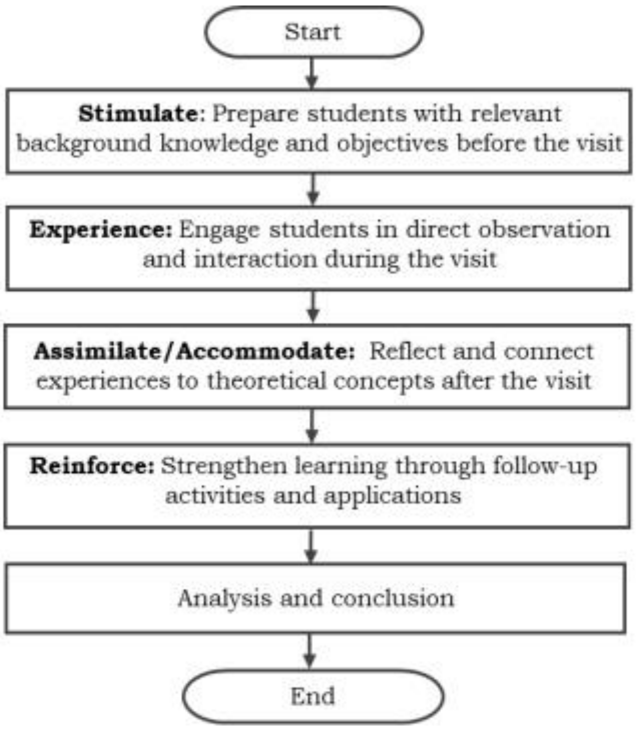


Figure 1: A flow chart for the SEAR process

2.2.1.1 Mean Score Calculation

The average score for each question is calculated using:

$$Mean, \bar{x} = \frac{\sum_{i}^{n} x_i}{n} \tag{1}$$

where $\bar{x}$ is the mean score is the score given by respondent, i on scale (1-5) and n is the total number of respondents in this study where, $n = 45$.

2.2.1.2 Percentage Agreement

The percentage of students who agree or strongly agree with a statement is determined by:

$$\% \, Agree = \frac{n_{strongly\ agree} + n_{agree}}{n} x \, 100\% \tag{2}$$

where $n_{strongly\ agree}$ and n_{agree} are the number of respondents who answered strongly agree and agree, respectively.

2.2.1.3 Knowledge Gain

The improvement in understanding, Δg before and after the visit is computed as:

$$\Delta g = \bar{x}_{post} - \bar{x}_{pre} \quad (3)$$

where $\bar{x}_{post}$ and $\bar{x}_{pre}$ are the mean post-visit and pre-visit understanding score, respectively. The positive gain will show that the visit effectively enhanced student's knowledge.

3.3.2 Qualitative Method

This section used open-ended questions analyzed through thematic analysis to identify recurring patterns. The responses were categorized into two themes: QL1, focusing on students' ability to connect theoretical knowledge with practical operations, and QL2, addressing their understanding of system integration, safety measures, redundancy, and real-time monitoring. This dual approach allowed for triangulation of findings, where statistical trends could be supported and explained by student's own narratives.

2.3 Data Collection

2.3.1 Data Collection Procedure

The data was collected immediately after the industrial visit to maximize recall and reflection accuracy. Students completed the survey as anonymized to ensure confidentiality and encourage honest feedback. Participation was voluntary, and informed consent was obtained beforehand. The questionnaire was pre-tested to ensure clarity, relevance, and appropriateness to the study topic.

2.3.2 Data Analysis

Quantitative responses were collected using a Likert-scale format. The mean score for each item was calculated using Equation (1) to determine the overall level of agreement among respondents. The analysis is expected to provide insight into the perceived effectiveness and impact of the visit on various learning outcomes.

2.3.3 Interpretation Metrics

To further support the analysis, the percentage of agreement combining "Agree" and "Strongly Agree" responses was calculated using Equation (2). This allows for a more intuitive understanding of how many students viewed the visit positively. Additionally, knowledge gain between pre-visit and post-visit understanding was evaluated using Equation (3), which calculated the change in mean scores to assess conceptual improvement.

3.0 Results and Discussion

This section presents the results and analysis from the post-visit survey designed to evaluate the educational impact of the industrial visit. A total of 45 participants voluntarily responded to a structured questionnaire comprising 10 items, each rated on a 5-point Likert scale: Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), and Strongly Disagree (SD). The survey items covered various dimensions, including relevance, conceptual understanding, motivation, and interest in future participation. For quantitative analysis, responses were scored as follows: SA = 5, A = 4, N = 3, D = 2, SD = 1. The frequency distribution was calculated, and the overall summary is presented in Table 1.

Table 1: Quantitative summary of the survey

No	Question Summary	SA	A	N	D	SD	Mean	Interpretation
1	Pre-existing understanding	22	10	11	2	0	4.16	Moderate
2	Improved understanding post-visit	36	9	0	0	0	4.80	Very High
3	Improved understanding of electrical machines	39	6	0	0	0	4.87	Very High
4	Relevance to coursework	38	7	0	0	0	4.84	Very High
5	Visualizing real-world application	37	8	0	0	0	4.82	Very High
6	Satisfaction with technical explanations	35	9	1	0	0	4.76	Very High
7	Practical understanding improved	34	10	1	0	0	4.73	Very High
8	Met educational expectations	35	9	1	0	0	4.76	Very High
9	Increased motivation to study	36	8	1	0	0	4.78	Very High
10	Likely to join future visits	37	7	1	0	0	4.80	Very High

The summary of participant's responses to ten key survey questions related to the educational value of the industrial visit are presented. Each item reflects different aspects of learning outcomes, including conceptual understanding, motivation, satisfaction, and proven relevance to the course. The frequency of responses for each option is presented alongside the calculated mean score, which reflects the overall level of agreement for each item. To assist with interpretation, qualitative labels such as "Very High" and "Moderate" are included to represent the general point of view based on the computed mean values. This table depicts an overview of participants perceptions toward the visit experience and its impact on their learning.

3.1 Subject-Specific Learning Outcomes

This section discusses the change in student conceptual understanding before and after the industrial visit, and to analyse the impact on subject-specific knowledge through hands-on exposure. In addition to the overall indicators presented earlier, a more focused comparison was conducted to assess student's understanding of the course content prior to and following the visit. The results are illustrated in Figure 2, which presents a side-by-side comparison of student's responses to a key question measuring their self-reported understanding.

From the figure, "Strongly Agree" responses rose sharply from 48.9% pre-visit to 80.0% post-visit, while "Neutral" dropped from 24.4% to 0%. Combined "Agree" and "Strongly Agree" responses reached 100%, indicating all students saw clear benefits. This shift reflects greater confidence and conceptual clarity, showing the visit strengthened understanding of course theory. The elimination of “Neutral” and “Disagree” suggests reduced doubts and improved knowledge integration.

The industrial setting acted as an extended classroom, enabling students to relate real machines and systems to lecture concepts. As (Anderson & Lucas, 2001), note, post-visit activities are crucial for improving learning, linking experiences to curriculum content.

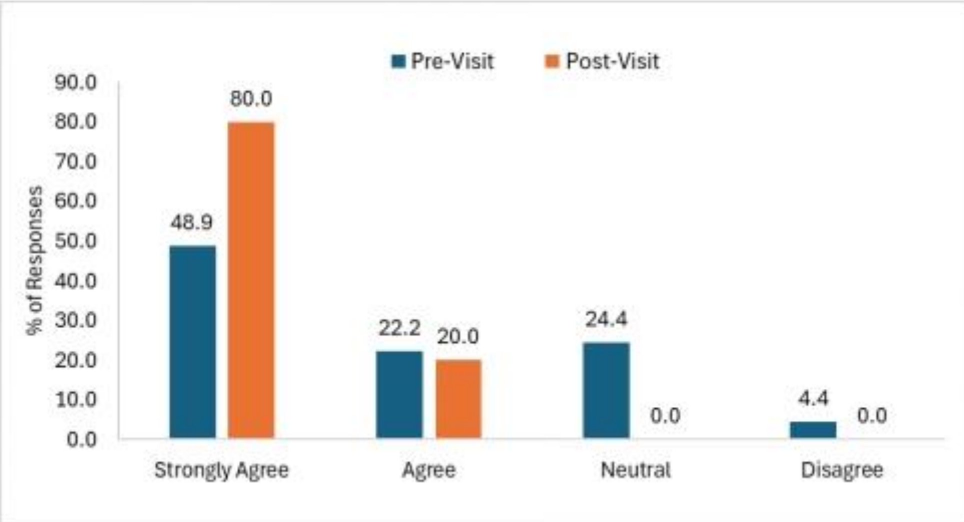


Figure 2: Results of Pre- and Post-visit understanding on the course subject

Hands-on exposure proved effective in technical subjects, aiding retention and concept internalization. These results align with (Putri & Dewi, 2025) who found that active, industry-based learning boosts satisfaction, deepens understanding, and enhances engagement leading to better academic performance and confidence.

3.2 Academic Relevance and Learning Outcomes

Figure 3 illustrates the comparison of percentage score for four key aspects evaluated in the post-visit survey: relevance to coursework, improved theoretical understanding, improved practical understanding, and fulfilment of educational expectations.

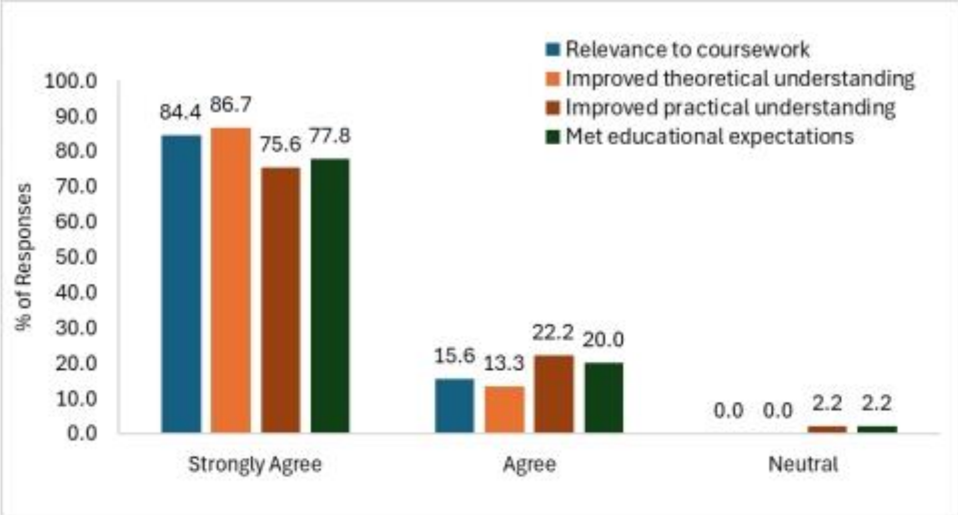
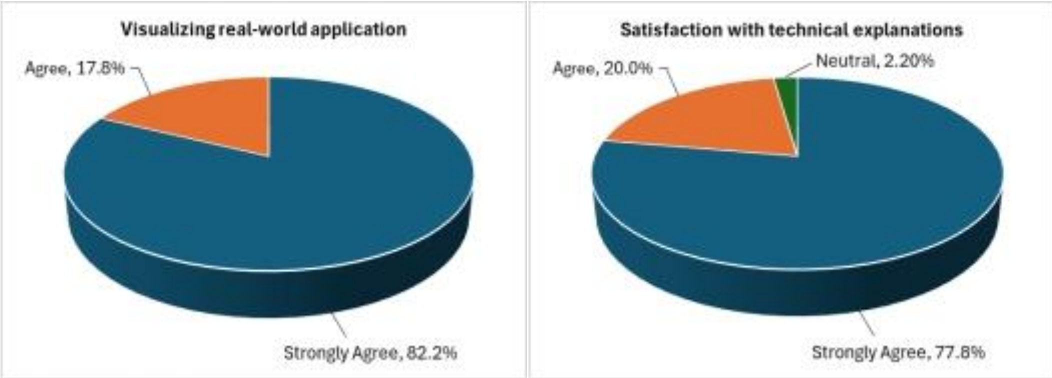


Figure 3: Comparison of four key aspects evaluated in the post-visit survey

These indicators highlight how effectively the visit aligned with the the syllabus and learning objectives. Results showed improved theoretical understanding with the highest mean score of 4.87, where 86.7% of students selected Strongly Agree and 13.3% Agree. This supports findings by (Jose et al., 2017) hat experiential learning strengthens cognitive links between theory and practice. Relevance to coursework followed closely with a mean of 4.84 (84.4% Strongly Agree, 15.6% Agree), reflecting strong syllabus alignment and supporting (Miller et al., 2021) on the value of authentic, context-based learning. eeting educational expectations scored 4.76 (77.8% Strongly Agree, 20.0% Agree, 2.2% Neutral), aligning with the SEAR model's preparation stage. Improved practical understanding, while high at 4.73 (75.6% Strongly Agree, 22.2% Agree, 2.2% Neutral), indicated fewer direct hands-on opportunities. Results confirm the visit's effectiveness within the SEAR framework, showing it bridged theory and practice. High scores for relevance, theoretical, and practical understanding highlight its academic value and suggest increasing hands-on interaction in future activities. These outcomes align with PLO2 and PLO4 by enhancing the ability to connect theory with real applications, and with PLO5 through exposure to modern engineering tools.

3.3 Real-World Relevance

This section discusses how the visit helped them visualize real-world implementation of the course subject. The results are shown in Figure 4.



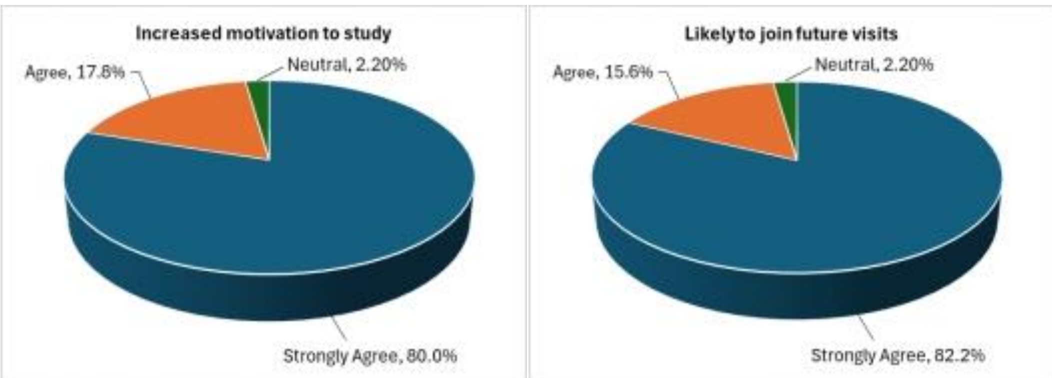
(a) (b)

Figure 4: Student’s perceptions of (a) the ability to visualize real-world applications, and (b) satisfaction with technical explanations during the visit.

This result reveals a total of 82.2% of students strongly agreed that the visit helped them visualize real-world applications of the concepts learned in class, while the remaining 17.8% agreed. Not a single student chose a neutral or negative response, reflecting a 100% positive perception of the visit’s relevance to engineering practice. In terms of satisfaction with the technical explanations provided during the visit, 77.8% of students strongly agreed, while 20% agreed, and only 2.2% remained neutral. No students expressed dissatisfaction. These results confirm that the information delivery during the visit was clear, engaging, and supportive of their academic understanding. These findings align with studies by (Попова, 2024) and (Wang & Huang, 2025), which emphasize that students benefit significantly when theoretical knowledge is complemented by real-world exposure and expert explanations. The immersive experience supports deeper learning, increases retention, and strengthens student’s ability to apply concepts in practical life.

3.4 Engagement and Motivation

This section explores how the visit influence on the student’s motivation, satisfaction with technical content delivery, and their interest in participating in similar future learning opportunities. The results are shown in Figure 5.



(a) (b)

Figure 5: Student’s feedback on (a) increased motivation to study the subject, and (b) willingness to participate in future industrial visits.

The findings indicated that 80.0% of the students strongly agreed that the industrial visit increased their motivation to study, while 17.8% agreed and only 2.2% remained neutral. Similarly, regarding future participation, 82.2% of students strongly agreed they were likely to join future visits, 15.6% agreed, and 2.2% were neutral. Importantly, no student expressed disagreement in either item, indicating overwhelmingly positive engagement. These findings align with the work of (Jusoh & Hadibarata, 2024), who emphasized that authentic learning experiences such as site visits can significantly boost student motivation and interest, particularly when the activity is relevant, participatory, and tied to course outcomes. Industrial visits provide a real-world context that helps students see the value and applicability of their coursework, thereby increasing intrinsic motivation and the likelihood of future involvement. An overwhelmingly positive responses show students are more inclined to continue engaging with real-world learning opportunities beyond the classroom. This aligns with PLO11 focus on recognizing the need for and having the ability to engage in independent and life-long learning.

3.5 Qualitative Survey Analysis

The findings of the qualitative analysis complemented the quantitative results providing a deeper understanding of how students perceived and internalised the learning from the industrial visit. Open-ended responses were analysed using thematic analysis and categorised into two key areas; QL1; identifying the connection between theory and practice, and QL2; understanding system integration, safety, redundancy systems, and real-time monitoring. The findings are summarised in Table 2.

From the QL1 findings, most frequently key point mentioned was the opportunity to observe how classroom theories, particularly those related to motor control, electrical machines, and drive systems were directly applied in

Table 2: Qualitative summary of the survey

Theme	Frequent	Description	Example Quotes
Theory-Practice Connection	18	Students relate classroom theories such as motors, torque, tension to real-world application.	*"The visit helped me see how classroom concepts like cable tension and motor control work in real life."*
Motor Control and Operation	20	Insights into DC motor functioning, speed/torque control, AC to DC conversion, and drives.	*"I learned how DC motors provide smooth and precise control of speed and torque essential for safety."*
System Integration and Safety	15	Understanding of integration of electrical, mechanical, and structural systems with safety features.	*"Braking systems and feedback sensors ensure smooth and safe operation of the cable car."*
Real-World Complexity	10	Awareness of external factors like load, environment, and maintenance challenges in practice.	*"Engineers must consider load weight and wind conditions beyond what we learn in theory."*
Hands-on Observation	12	Value of seeing components and receiving explanations	*"Seeing the motor and control panel in action made the*

and Learning		on-site to reinforce learning.	*theory more tangible."*

the operation of the cable car. Students noted that this real-world exposure made abstract principles more tangible, clarifying challenging topics such as torque-speed relationships and braking systems. Observing engineers troubleshoot in real time also demonstrated how precision, safety protocols, and preventive maintenance sustain operational reliability, strengthening the link between classroom learning and professional practice. For QL2, many responses highlighted a deeper understanding of system integration, especially the interaction between mechanical, electrical, and control systems. Students valued learning about redundancy and backup features as safeguards against downtime and gained insights into real-time monitoring, where continuous data acquisition aids decision-making, optimises performance, and ensures safety. Overall, QL1 emerged as dominant, showing the visit's strongest impact in bridging theory and practice. QL2, though less frequent, enriched understanding of integrated system design and safety's role in operations. These experiences enhanced conceptual understanding, systems-level thinking, and professional readiness.

4.0 Conclusion

This study shows that integrating the SEAR method with Kolb's Experiential Learning Cycle can transform short-term industrial visits into impactful learning experiences that directly support Outcome-Based Education (OBE) goals. Significant score improvements and high percentages of students reporting enhanced theoretical and practical understanding confirm that well-planned visits effectively bridge classroom theory with real-world engineering practice. Addressing a gap in Malaysian engineering education, this research systematically assessed knowledge gains in specific technical subjects using pre- and post-assessments. Embedding SEAR into visit design improved motivation, conceptual clarity, and the ability to link theory with operations, contributing to PLO achievement. To maximise impact, future visits should retain structured frameworks with pre-visit briefings, targeted observation, and post-visit reflection. It is recommended to diverse industrial contexts and interdisciplinary exposure to broaden professional perspectives and adaptability in line with evolving industry demands.

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Author Contributions
Author H.F.J.: Conceptualisation, Methodology, Software, Writing-original Data Curation, Draft Preparation; **Author N.D.R.:** Methodology, Writing-Reviewing; **Author K.N.M.H.:** Validation, and Writing-Reviewing; **Author M.M.R., N.F.I.G.:** Validation, and Writing-Reviewing.

Conflicts Of Interest
The manuscript has not been published elsewhere and is not under

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