



Semarak International Journal of STEM Education

Journal homepage:
<https://semarakilmu.my/index.php/sijste/index>
ISSN: 3030-5152



Integration of Industrial Field Trip with Video Project Case Study Assessment

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ARTICLE INFO

Article history:

Received 17 June 2026

Received in revised form 22 September 2026

Accepted 30 September 2026

Available online 12 October 2026

Keywords:

Process optimization; active learning; experiential learning; industrial field trip; video-based assessment; chemical engineering education

ABSTRACT

Engineering education increasingly emphasizes the need for experiential learning approaches that bridge the gap between theoretical knowledge and real-world industrial practice. However, industrial field trips are often conducted as standalone activities with limited integration into formal assessment, reducing their potential impact on student learning. This study investigates the integration of an industrial field trip with a video-based case study assessment as an experiential learning strategy in undergraduate chemical engineering education. The approach was implemented in Process Optimization and Energy and Process Utility Engineering courses at Universiti Teknologi PETRONAS (UTP). The methodology comprised four stages: establishment of industry collaboration and approval, student preparation, implementation of the industrial field trip, and execution of a video-based case study as a summative assessment. Following the visit, students developed optimisation-based case studies derived from actual industrial observations and communicated their analyses through video presentations. The effectiveness of the approach was evaluated through a comparison of student presentations with and without industrial field trip integration, supported by assessment rubric outcomes and instructional observations. The findings indicate that students who participated in the industrial field trip demonstrated stronger problem formulation skills, greater industrial relevance in optimisation modelling, deeper analytical discussions, and higher creativity in their presentations. The field trip also enhanced student engagement by encouraging active observation, questioning, and exploration of real engineering challenges. Furthermore, the video-based assessment provided an authentic platform for evaluating both technical competence and communication skills. Overall, the integration of industrial field trips with video-based case study assessments offers an effective pedagogical framework for promoting experiential learning, strengthening industry-academia linkage, and enhancing students' ability to apply engineering concepts in practical contexts.

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1. Introduction

Recent developments in engineering education have highlighted the need for teaching approaches that actively engage students, support authentic learning experiences, and strengthen the connection between theory and real-world engineering practice [1].

As industry expectations continue to evolve, engineering graduates are expected not only to possess strong technical foundations but also to demonstrate critical thinking, problem-solving, communication, and professional skills [2,3]. However, traditional lecture-based teaching and assessment methods, while effective for content delivery, often limit students' ability to contextualize theoretical concepts within practical industrial settings and may result in passive learning experiences [4].

In chemical engineering education, particularly in technically intensive courses such as Process Optimization and Energy and Process Utility Engineering, students are frequently exposed to complex systems, operational constraints, and decision-making frameworks that closely mirror real industrial challenges. Despite this, conventional assessments such as written examinations or report-based assignments may not sufficiently capture students' ability to analyse real processes or translate theoretical understanding into practical insights [5]. Similarly highlighted in another study, conventional assessments often fail to connect technical material with real-world applications, limiting students' ability to analyze processes and translate theoretical knowledge into practical insights effectively [6]. This gap can lead to difficulties in bridging classroom learning with industry practice, ultimately affecting students' readiness for professional engineering roles.

Experiential learning has been widely recognized as an effective approach to address this challenge by enabling students to learn through direct experience, reflection, and application [7]. University College Dublin has applied this concept through their university-industry partnerships project, the findings show it increases students' ability to understand the implications of principles and theories learned in the classroom through lived experiences [8]. Industrial field trips, in particular, offer valuable opportunities for students to observe real engineering systems, operational strategies, and constraints that cannot be fully replicated in classroom environments [9]. Such exposure allows students to contextualize abstract concepts, enhance systems-level understanding, and develop a more holistic perspective of engineering practice. However, the educational impact of industrial visits is often underutilized when they are treated as standalone activities without structured integration into assessment and learning outcomes [10,11].

In parallel, advancements in educational technology and assessment design have encouraged the adoption of alternative assessment formats that emphasize creativity, communication and higher-order cognitive skills [12]. Video-based assessments have gained increasing attention as a pedagogical tool that enables students to demonstrate understanding through visual explanation, storytelling, and technical presentation [13,14]. When combined with real industry case study approaches, video-based assessments can promote deeper analysis, collaborative learning and reflective thinking, while also supporting diverse learning styles [15].

Despite the recognized benefits of both industrial field trips and video-based assessments, existing studies have largely examined these approaches independently. There remains a lack of empirical research on the structured integration of industrial field experiences with multimedia-based case study assessments, particularly within chemical engineering education. More specifically, limited attention has been given to how such integration influences students' ability to analyse industrial systems, communicate technical knowledge effectively, and demonstrate experiential learning outcomes.

This study addresses this gap by proposing and implementing an integrated teaching and assessment approach that combines an industrial field trip with a video-based case study as a summative assessment. The approach is designed to transform students' industrial exposure into an active learning experience, where observations from the plant visit are systematically analysed, synthesized, and communicated through a structured video presentation. By comparing student presentations with and without industrial field trip integration, the study evaluates the effectiveness of this pedagogical strategy in enhancing experiential learning and presentation quality.

The study is implemented in undergraduate chemical engineering courses at Universiti Teknologi PETRONAS (UTP) and adopts a comparative evaluation framework to assess learning outcomes. By embedding industrial exposure directly into assessment design, this work contributes practical insights into experiential learning implementation and offers a replicable model for integrating industry engagement with innovative assessment practices in engineering education.

1.2 Research Question

How can an industrial field trip be effectively integrated with a video-based case study as a summative assessment to support experiential learning in undergraduate engineering courses?

What is the impact of integrating industrial field trips on students' ability to analyse real industrial processes and communicate their findings through video-based presentations?

Is there a significant difference in presentation quality and demonstrated learning outcomes between students who participated in industrial field trips and those who did not?

1.3 Research Objectives

Our study objectives are as follows:

1. To design and implement an experiential learning approach that integrates an industrial field trip with a video-based case study as a summative assessment for undergraduate engineering students.
2. To evaluate the impact of industrial field trip integration on students' ability to analyse real industrial systems and communicate technical findings through video-based case study presentations.
3. To compare students' presentation quality and learning outcomes between cohorts with and without industrial field trip integration, in order to assess the effectiveness of the proposed teaching and assessment strategy.

2. Methodology

This study adopts an experiential learning-based instructional design to integrate an industrial field trip with a video-based case study assessment in undergraduate chemical engineering courses. The methodology was structured to ensure systematic implementation, alignment with course learning outcomes, and consistency in assessment. The approach comprises four main stages: establishment of industry collaboration and institutional approval, student preparation and information dissemination, implementation of the industrial field trip, and execution of a video-based case study as a summative assessment. Together, these stages were designed to transform industrial exposure into an active learning experience by requiring students to observe, analyse, and communicate real-world engineering processes. The effectiveness of the approach was subsequently evaluated through a comparison of student presentation outcomes with and without industrial field trip integration.

2.1 Establishment of Industry Collaboration and Approval Process

Industry collaboration was initiated through existing professional networks established from prior academic–industry engagements. Initial communication with the industry partner was conducted via follow-up email to formally propose the industrial field trip, outline the learning objectives, and confirm student numbers and course relevance. Approval from the industry partner was subsequently obtained through email correspondence confirming the visit date, time, and scope of activities as shown in Figure 1.

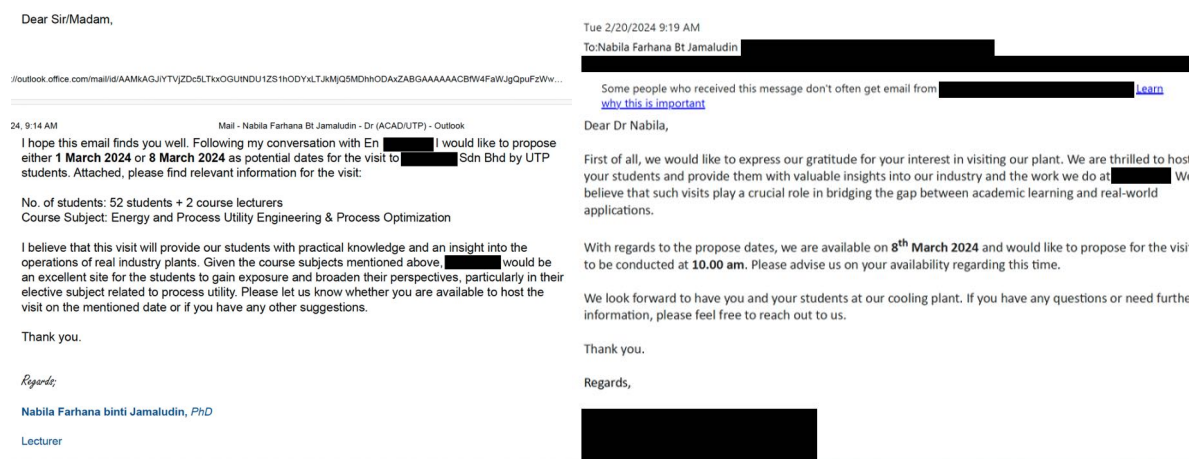


Fig. 1. Email communication with the industry partner

Following industry confirmation, formal approval was sought at the departmental level through the preparation and submission of an official memorandum. This process included justification of the educational objectives, proposed itinerary, and logistical requirements. Departmental approval was accompanied by the allocation of funding to support field trip expenses, including transportation, meals, and other related costs. Documentation of the email correspondence with the industry partner and the approved departmental memorandum is included as in Figure 2 to demonstrate the approval and coordination process.

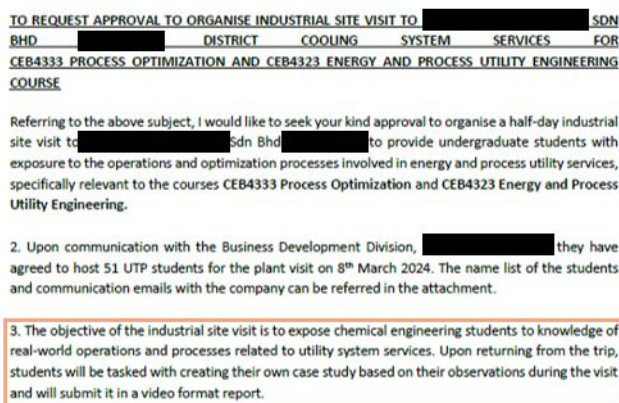


Fig. 2. Field trip approval request

2.2 Dissemination of Site Visit Information and Student Preparation

Prior to the industrial field trip, students were organised into small groups consisting of four to five members. Essential information related to the site visit, including the itinerary, logistics, safety requirements, and expected professional conduct, was disseminated to ensure adequate preparation as shown in Figure 3. Students were also briefly informed that they would be required to develop a video-based case study following the visit.

However, detailed assessment requirements and evaluation criteria were intentionally not disclosed at this stage. This deliberate instructional decision was made to encourage students to remain open-minded during the visit, engage actively with the industrial environment, and focus on observation, inquiry, and exploration rather than being constrained by assessment expectations. By minimising assessment-driven behaviour during the visit, students were encouraged to ask questions freely, consider multiple perspectives, and identify diverse potential case study angles based on their own interests and observations. This approach aimed to enhance the authenticity of the experiential learning process and promote deeper cognitive engagement during the industrial exposure.

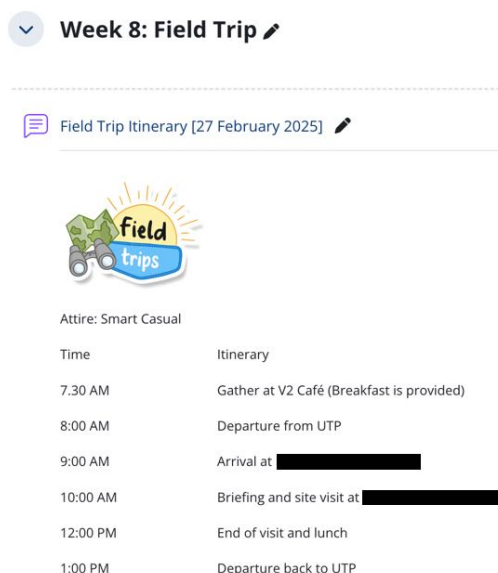


Fig. 3. Field trip itinerary provided for student's preparation

2.3 Implementation of the Industrial Field Trip

The industrial field trip was conducted in accordance with the approved itinerary and safety requirements. Upon arrival at the industrial site, students participated in a structured briefing session delivered by industry personnel, where an overview of the plant operations, safety briefing, system configuration, and utility management strategies was presented as shown in Figure 4. This session provided students with essential contextual understanding prior to the site walkthrough.



Fig. 4. Briefing session by the plant safety officer

Following the briefing, students were guided through selected operational areas of the plant, where key equipment, process flows, and control systems were explained in detail as shown in Figure 5. Throughout the visit, students were encouraged to observe operational practices, identify process integration elements, and relate the observed systems to theoretical concepts covered in the course. Interactive discussions between students and industry engineers were facilitated, allowing students to ask questions and gain insights into real-world operational constraints, optimisation considerations, and decision-making processes.



Fig. 5. Plant walkthrough

The field trip was successfully conducted under appropriate safety supervision, with students adhering to required personal protective equipment (PPE) and site regulations. Figure 6 shows one of the group photos taken at the end of the field trip session. The combination of briefing, on-site observation, and interactive engagement enabled students to gain firsthand exposure to industrial-scale engineering applications, forming the experiential foundation for the subsequent video-based case study assessment.



Fig. 6. Photo group at the end of field trip

2.4 Instructions of Video-Based Case Study Assessment

Following the industrial field trip, students were required to develop a case study based on their observations of the industrial plant and formulate a relevant optimisation problem. Working in small groups, students identified appropriate objective functions, decision variables, parameters, and constraints that reflected real operational challenges observed during the visit. The optimisation problems were solved using either Microsoft Excel or the General Algebraic Modeling System (GAMS), depending on the complexity of the selected case study.

Students were instructed to prepare a 10–15 minute video presentation to communicate their case study and optimisation analysis. The video submission was required to include a clear problem statement, optimisation formulation, solution and discussion, sensitivity analysis, and binary programming considerations where applicable. This format was designed to encourage students to demonstrate both technical understanding and the ability to articulate engineering reasoning in a structured and engaging manner. Example of the instruction can be referred to Figure 7.

ASSIGNMENT

Mini Project Submission

⋮

Mark as done

Based on [REDACTED] field trip, create a relevant case study and formulate the possible optimization problem statement:

- Identify the relevant objective function, decision variable, parameter and constraints
- Solver: Microsoft Excel or GAMS

Prepare a 10-15 mins presentation describing your problem statement with the inclusion of these aspects:

- Problem statement
- Optimisation formulation
- Solution + Discussion
- Sensitivity Analysis + Discussion
- Binary programming + Discussion
- Submit your report in video format
- Video submission will be in Week 11

Upload your video (maximum submission size is 1GB) together with PowerPoint slides for this submission.

Please be reminded submission of the mini project will be on 19 Mar 2025 by 11.59pm.

*ONLY THE REPRESENTATIVE OF THE GROUP IS REQUIRED TO SUBMIT THE VIDEO

Fig. 7. Shared information for video-based case study assessment requirements

The video-based case study served as a summative assessment and was evaluated using a structured rubric as outlined in Table 1. Assessment criteria included the quality of the problem formulation, depth of analysis and discussion, interpretation of sensitivity and binary programming results, and overall creativity in presentation. Each criterion was graded on a five-point scale, resulting in a total score of 25 marks. The use of a detailed rubric ensured consistency, transparency, and alignment with the intended learning outcomes of the course.

Table 1
Video-based case study assessment rubrics

Aspect	Marks
Problem statement and optimization formulation	1 (fair) – 5 (excellent)
Solution with discussion	1 (fair) – 5 (excellent)
Sensitivity analysis with discussion	1 (fair) – 5 (excellent)
Binary programming with discussion	1 (fair) – 5 (excellent)
Creativity	1 (fair) – 5 (excellent)
Total marks	25

3. Findings and Discussion

This section presents the findings from the implementation of an industrial field trip integrated with a video-based case study assessment and discusses their implications for engineering education. The results are drawn from an analysis of student video presentations, assessment rubric outcomes, and instructional observations during the site visit and assessment activities. The discussion focuses on comparisons between student cohorts with and without industrial field trip integration, the

quality and industrial relevance of problem formulations, observed student engagement and learning behaviours, and the effectiveness of the video-based case study as a summative assessment tool. Together, these findings provide insights into how experiential learning approaches can enhance students' ability to contextualise theoretical knowledge and communicate engineering solutions effectively.

3.1 Comparison of Student Presentation Performance

A comparison of student video presentations revealed noticeable differences in both technical depth and contextual relevance between cohorts with and without industrial field trip integration. Students who participated in the industrial field trip consistently demonstrated stronger performance across assessment criteria, particularly in the formulation of optimisation problems, clarity of assumptions, and depth of discussion.

In the field trip–integrated cohort, problem statements were predominantly grounded in realistic industrial contexts observed during the visit, such as power generation scheduling, utility resource constraints, and operational decision-making under demand and water limitations. In contrast, presentations from students without industrial exposure tended to rely on abstract or generic scenarios, often adapted from textbook-style examples, with limited reference to real operational constraints. While these problems were mathematically valid, they lacked industrial specificity and practical relevance.

3.2 Quality of Problem Formulation and Industrial Relevance

The quality of problem formulation emerged as a key differentiating factor between the two cohorts. Students who attended the industrial field trip demonstrated a clearer understanding of system boundaries, decision variables, constraints, and performance objectives. Their case studies frequently incorporated realistic operational limits, such as start-up times, utility availability, resource consumption, and demand requirements, closely mirroring actual plant conditions as in Figure 8.

In contrast, problem statements developed without industrial exposure often exhibited simplified assumptions and limited constraints, focusing primarily on numerical optimisation rather than decision-making realism as shown in Figure 9. The absence of contextual grounding resulted in formulations that, while technically correct, did not fully reflect the complexity of real engineering systems.

These findings suggest that industrial field trips play a critical role in enhancing students' ability to construct meaningful and industry-relevant optimisation problems, an essential competency in chemical engineering education.

PROBLEM STATEMENT

Malakoff Power Berhad is an independent water and power producer that comprises six power plants responsible for supplying most of the electrical energy around West Malaysia. The power produced from these power plants is mainly from the combined cycle gas turbine, where steam turbines produce steam that powers gas turbines. The system relies on demineralized water for steam generation.

Mr. Anwar, an executive of Malakoff, has been tasked to reevaluate the profit of operating three power plants from the company, which are Prai PP, Lumut PP, and Tanjung Bin PP. As electricity is an essential need for all downstream users in the industrial and residential areas, the start-up time is limited to 15 minutes to cater to the needs of power users around West Malaysia.

The company aims to maximize the total profit from power generation while ensuring that the daily energy demand of 3,000,000 kWh is met. However, the company also needs to operate within a daily demineralized water supply limit of 950 million liters.

The following table provides the details of each power plant respectively:

Power Plant	Max. Power Generated/day (kWh)	Start-up time (min)	Water Consumption (L/kWh)	Profit (RM/kWh)
Lumut PP	1,300,000	15	2.5	0.15
Prai PP	350,000	10	3.0	0.13
Tanjung Bin PP	2,100,000	15	2.2	0.17

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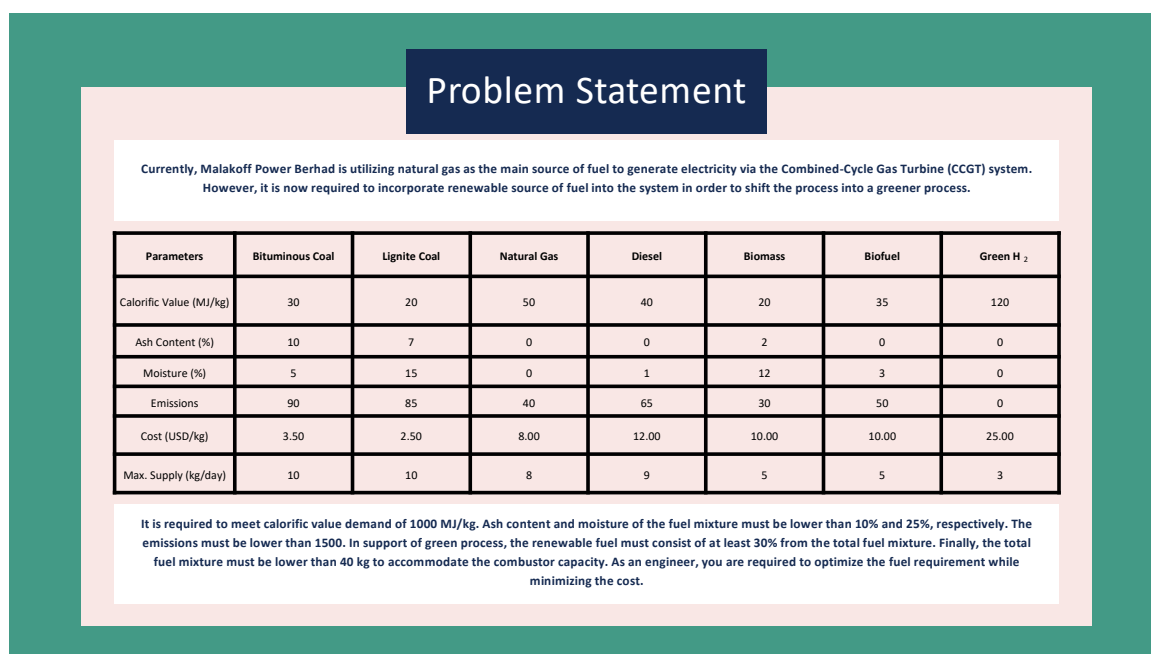
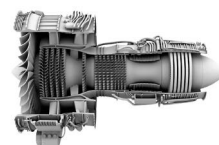


Fig. 8. Problem statement developed by the student with field trip integration

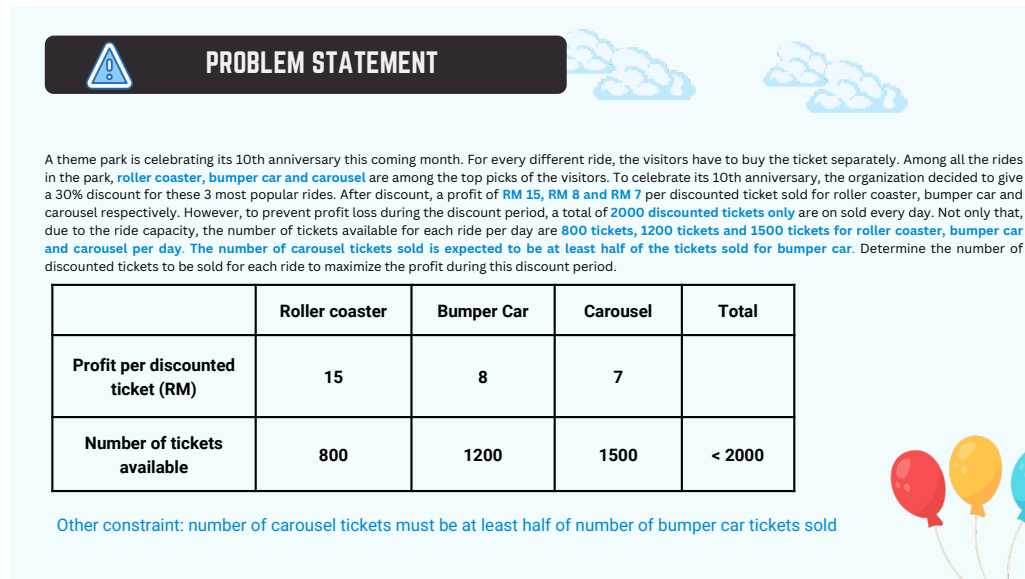


Fig. 9. Problem statement developed by the student without field trip integration

3.3 Student Engagement and Learning Behaviours Observed

Student engagement during the industrial field trip and subsequent video preparation was observed to be notably high. During the site visit, students actively asked questions related to plant operations, utility management strategies, and operational constraints, indicating curiosity and critical engagement with the industrial environment. This engagement translated into the diversity of case study themes selected, as shown in Figure 10 and the depth of analysis presented in the videos as shown in Figure 11.

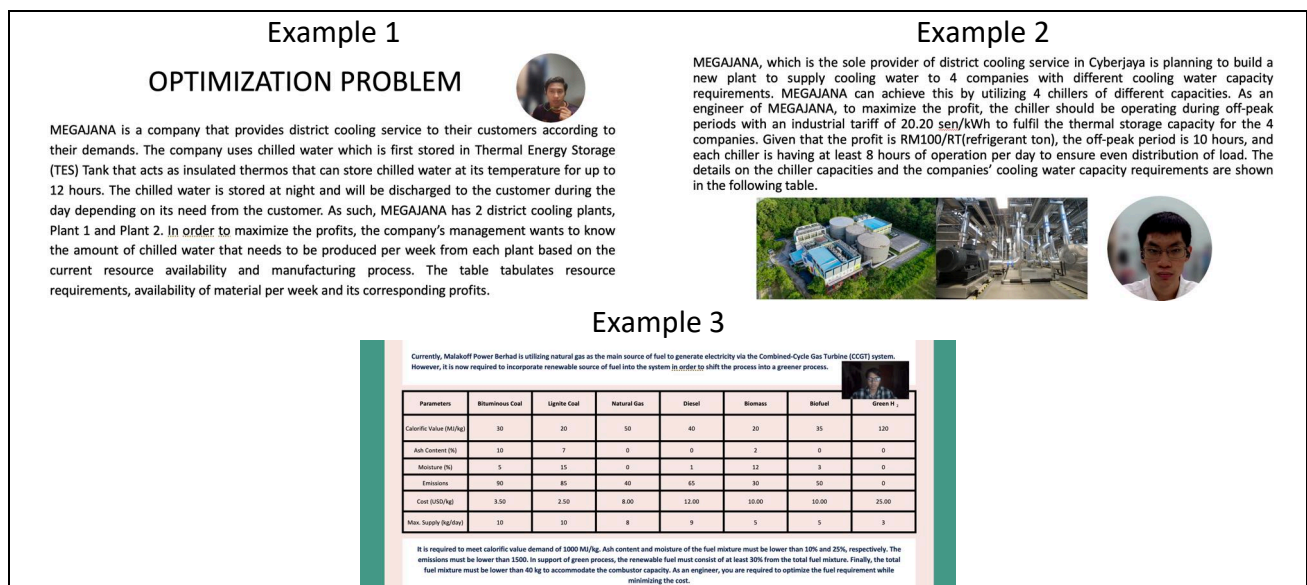


Fig. 10. Diversity of the case studies related to industry application

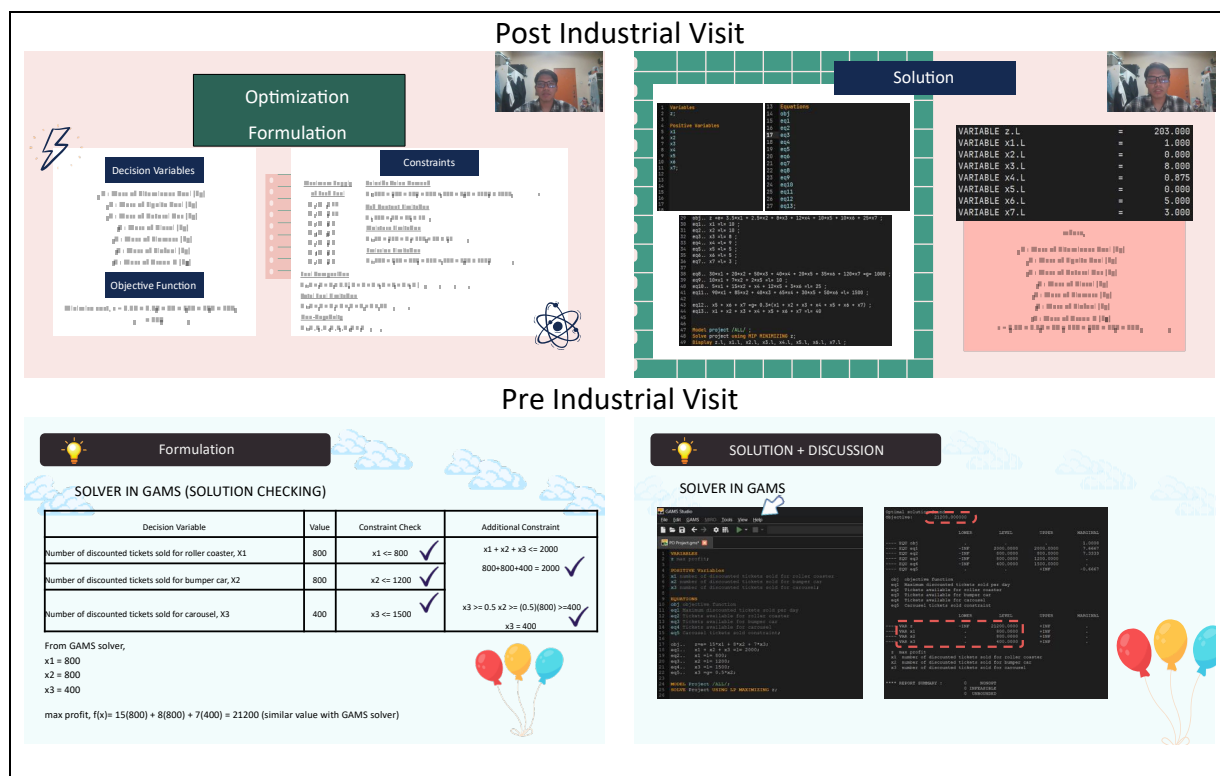


Fig. 11. Example of more complex optimization formulation and analysis post industrial visit

The open-ended nature of the task encouraged students to explore multiple perspectives rather than converge on a single prescribed solution. This was reflected in the range of optimisation problems formulated, as well as the creative approaches used to explain technical concepts in the video presentations. Such behaviours are indicative of active learning and align with the objectives of experiential education.

3.4 Impact of Industrial Field Trip Integration on Experiential Learning

The integration of the industrial field trip significantly enhanced the experiential learning process by providing students with concrete experiences that informed subsequent reflection and abstraction. Observations made during the plant visit served as a foundation for students to conceptualise optimisation problems, test assumptions, and evaluate alternative scenarios.

By linking real-world observations to mathematical modelling and analysis, students progressed through multiple stages of experiential learning, moving beyond passive knowledge acquisition toward applied problem-solving. The deliberate decision to withhold detailed assessment instructions prior to the visit further supported this process by allowing students to remain open-minded and exploratory during the industrial exposure.

3.5 Effectiveness of Video-Based Case Study as a Summative Assessment

The video-based case study proved to be an effective summative assessment tool for evaluating both technical competence and communication skills. The video format enabled students to articulate their reasoning, visualise optimisation frameworks, and present complex analyses in an accessible manner. Compared to traditional written reports, video presentations provided richer insights into students' conceptual understanding and problem-solving approaches.

The inclusion of creativity as an assessment criterion further encouraged students to engage meaningfully with the task, resulting in more coherent narratives and innovative presentation styles. Overall, the combination of industrial field trip integration and video-based assessment supported a more authentic evaluation of student learning outcomes, aligning assessment with real-world engineering practice.

4. Conclusion

This study investigated the integration of an industrial field trip with a video-based case study assessment as an experiential learning approach in undergraduate chemical engineering education. The findings demonstrate that combining direct industrial exposure with an authentic assessment task enhanced students' ability to contextualise theoretical concepts, formulate industry-relevant optimisation problems, and communicate technical analyses effectively.

Students who participated in the industrial field trip exhibited stronger performance in problem formulation, analytical reasoning, and presentation quality compared to students who did not receive industrial exposure. Their case studies incorporated realistic operational constraints, decision variables, and performance objectives derived from actual industrial observations, resulting in more meaningful and practically relevant optimisation problems. Furthermore, the industrial field trip stimulated greater student engagement, curiosity, and exploration, encouraging students to actively connect classroom knowledge with real-world engineering practice.

The video-based case study assessment proved to be an effective summative assessment tool for evaluating both technical competency and communication skills. By requiring students to analyse, synthesise, and present their findings in a structured video format, the assessment promoted higher-order thinking, creativity, and reflective learning while providing a more authentic representation of student understanding than conventional assessment approaches.

Overall, the integration of industrial field trips with video-based case study assessments offers a practical and replicable pedagogical framework for enhancing experiential learning in engineering education. The approach strengthens the connection between academic theory and industrial practice while fostering essential graduate attributes such as critical thinking, problem-solving, communication, and professional awareness. Future studies are recommended to incorporate larger student cohorts, multiple engineering disciplines, and student perception surveys to further evaluate the long-term impact of this approach on learning outcomes and industry readiness.

Acknowledgement

The authors would like to express their sincere appreciation and heartfelt gratitude to the esteemed institution of Universiti Teknologi PETRONAS and Chemical Engineering Department for its support and commitment to provide a highly conducive work environment, invaluable resources and state-of-the-art research facilities. This research was not funded by any grant.

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