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ASSESSING THE EFFECTIVENESS OF THE 'PROGRAM CANTAS GAGAL' ON REDUCING FAILURE RATES IN SOLID MECHANICS

Nor Hafida Hashim[1*], Muhamad Faizal Pakir Mohamed Latiff[2], Mohd Zaini Endut[3], Hasbullah Hashim[4], Nik Farhanim Imran[5], Daliah Hasan[6]

[1] Civil Engineering Studies, College of Engineering, Universiti Teknologi MARA Cawangan Pulau Pinang, Permatang Pauh Campus, 13500 Pulau Pinang, Malaysia
Email: norhafida995@uitm.edu.my
[2] Civil Engineering Studies, College of Engineering, Universiti Teknologi MARA Cawangan Pulau Pinang, Permatang Pauh Campus, 13500 Pulau Pinang, Malaysia
Email: faizal.pakir@uitm.edu.my
[3] Civil Engineering Studies, College of Engineering, Universiti Teknologi MARA Cawangan Pulau Pinang, Permatang Pauh Campus, 13500 Pulau Pinang, Malaysia
Email: zaini.endut@uitm.edu.my
[4] Sekolah Menengah Kebangsaan Permatang Pasir, Jalan Permatang Pasir, Permatang Pauh, 13500 Pulau Pinang, Malaysia
Email: sihasbihashim@gmail.com
[5] Civil Engineering Studies, College of Engineering, Universiti Teknologi MARA Cawangan Pulau Pinang, Permatang Pauh Campus, 13500 Pulau Pinang, Malaysia
Email: farhanim4611@uitm.edu.my
[6] Civil Engineering Studies, College of Engineering, Universiti Teknologi MARA Cawangan Pulau Pinang, Permatang Pauh Campus, 13500 Pulau Pinang, Malaysia
[*] Email: daliahasan@uitm.edu.my
Corresponding Author

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Abstract:

Improving student performance in challenging subjects like Solid Mechanics requires innovative intervention strategies. This study evaluates the effectiveness of the "Program Cantas Gagal," a targeted remedial program implemented at UiTM Pulau Pinang to reduce the failure rate in Solid Mechanics for Diploma Civil Engineering students. The program involves conducting multiple extra classes where past year exam questions are extensively discussed with students.The problem addressed is the high failure rate observed in previous semesters, particularly a 20% failure rate in semester 20232. In response, the "Program Cantas Gagal" was introduced in semester

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20234, aimed at providing students with additional support and focused revision sessions. The objective of this study is to assess the impact of this program on reducing the failure rate and improving overall student performance. Methodologically, this research involves a comparative analysis of failure rates and student grades from semester 20232 and semester 20234. Results show a significant reduction in the failure rate, from 20% in semester 20232 to 6% in semester 20234, indicating the program's effectiveness. The discussion highlights how the additional classes and focused discussions on past exam questions have contributed to a better understanding and application of the course material by the students. In conclusion, the "Program Cantas Gagal" has proven to be an effective strategy in improving student performance in Solid Mechanics. This study contributes valuable insights into educational intervention programs, demonstrating that targeted remedial actions can substantially enhance student outcomes in engineering education.

Keywords:

Solid Mechanics, Student Performance, Program Cantas

Introduction

The "Program Cantas Gagal" is an innovative educational intervention designed to address the high failure rates in Solid Mechanics (ECS226) among Diploma Civil Engineering students at Universiti Teknologi MARA (UiTM) Cawangan Pulau Pinang. Solid Mechanics is a critical course that lays the foundation for understanding the mechanical behavior of materials and structures, encompassing essential topics such as stress and strain analysis, torsion, shear forces, bending moments, and Euler's Buckling Theory. Mastery of these concepts is vital for civil engineering students, as they are directly applicable to real-world engineering challenges McGowan & Bell (2020).

The implementation of the "Program Cantas Gagal" was motivated by a significant failure rate of 20% observed in the previous semester, highlighting the urgent need for targeted academic support. This program focuses on providing additional classes that emphasize the discussion of past examination questions, thereby reinforcing students' understanding of key concepts and enhancing their problem-solving skills. The effectiveness of such remedial programs has been documented in various educational contexts, where active learning strategies have been shown to improve student engagement and performance (Theobald et al., 2020). For instance, Lin Khan & Law (2015) suggests that flipped learning approaches can enhance students' learning performance in engineering courses by promoting active participation and engagement.

Research indicates that curricula emphasizing active participation and practical application of knowledge yield better educational outcomes. For example, McGowan and Bell McGowan & Bell (2020) found that innovative approaches to engineering education, such as project-based learning, can significantly enhance students' critical sociotechnical literacy. Similarly, Ayar & Yalvaç (2022) emphasize the importance of hands-on, inquiry-oriented activities that mimic real-world engineering tasks, which are integral to the learning process in engineering education.

The assessment structure of ECS226 aligns with the Malaysian Qualifications Agency (MQA) and Engineering Technology Accreditation Council (ETAC) standards, ensuring that the course meets both national and international educational requirements (Davis & Caldwell,

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2022). The "Program Cantas Gagal" aims to complement this structure by providing targeted support that addresses the specific challenges faced by students, particularly those stemming from weak foundational knowledge in mathematics and physics.

Moreover, the evaluation of educational interventions is essential for understanding their impact on student learning outcomes. Theobald et al. (2020) conducted a comprehensive analysis showing that active learning environments can narrow achievement gaps for underrepresented students in STEM fields, underscoring the importance of inclusive teaching practices. Effective curriculum evaluation involves assessing not only student performance but also the teaching methodologies employed and the overall educational environment (Singh et al., 2021; Terrón-López et al., 2020). The "Program Cantas Gagal" were evaluated by comparing failure rates and student performance data from semesters 20232 and 20234, providing insights into the program's effectiveness and areas for improvement.

In conclusion, the "Program Cantas Gagal" represents a strategic response to the challenges faced by Diploma Civil Engineering students in mastering Solid Mechanics. By focusing on active learning and targeted support, this program aims to enhance student performance and reduce failure rates, contributing to the overall quality of engineering education at UiTM Pulau Pinang. The findings from this study were not only inform future iterations of the program but also contribute to the broader discourse on effective educational interventions in engineering disciplines.

Literature Review

The effectiveness of educational interventions in engineering disciplines, particularly in challenging subjects such as Solid Mechanics, has garnered significant attention in recent years. The "Program Cantas Gagal," implemented at UiTM Cawangan Pulau Pinang, aims to address high failure rates among Diploma Civil Engineering students by providing targeted remedial support. This literature review synthesizes relevant studies that explore the impact of similar educational programs and innovative teaching methodologies on student performance and learning outcomes.

One of the key components of effective educational interventions is the incorporation of technology and innovative teaching strategies. For instance, the use of digital tools and gamification has been shown to enhance student engagement and learning in various educational settings. Antonopoulou et al. (2022) highlight that digital learning games can equip students with essential skills for future academic and professional environments, suggesting that such tools can significantly improve learning outcomes in engineering education.

The integration of practical applications and real-world problem-solving into the curriculum is another effective strategy. Wang et al. (2019) discuss the implementation of multi-scale characterization and visualization techniques in Solid Mechanics education, which not only enhances students' understanding of complex concepts but also fosters their ability to apply theoretical knowledge in practical scenarios. This aligns with the objectives of the "Program Cantas Gagal," which focuses on reinforcing students' understanding through the discussion of past examination questions and practical problem-solving techniques.

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Furthermore, the assessment of educational programs is crucial for understanding their effectiveness. Canney and Bielefeldt Canney & Bielefeldt (2016) provide evidence of the validity and reliability of assessment tools designed to measure students' attitudes towards social responsibility in engineering, underscoring the importance of robust evaluation methods in educational interventions. Such assessments can help identify the strengths and weaknesses of programs like "Program Cantas Gagal," facilitating continuous improvement.

The challenges faced by students in mastering Solid Mechanics often stem from inadequate foundational knowledge in mathematics and physics. Zhen Zhen (2023) notes that innovative teaching approaches, such as those based on finite element techniques, can significantly enhance students' comprehension of material mechanics by providing visual and interactive learning experiences. This is particularly relevant for the "Program Cantas Gagal," which aims to address these foundational gaps through focused review sessions.

Recent studies have also emphasized the need for civil engineering education to adapt to contemporary challenges, including sustainability and industry demands. Ramadhan Kothari et al. (2011) argues for the integration of sustainability education into civil engineering curricula, aligning educational practices with Sustainable Development Goals (SDGs). This perspective is supported by Hunashyal (2024), who emphasizes the role of education in promoting sustainable practices among future civil engineers. Such integration is essential for preparing students to meet the evolving needs of the industry.

Moreover, the application of intelligent teaching systems has been proposed to enhance civil engineering education. Hao Gu et al. (2019) discusses the potential of intelligent teaching assistant systems to bridge the gap between theoretical knowledge and practical application, emphasizing the importance of aligning educational content with industry requirements. This approach can further support the objectives of the "Program Cantas Gagal" by providing students with relevant skills and knowledge.

In conclusion, the literature indicates that targeted educational interventions, such as the "Program Cantas Gagal," can effectively enhance student performance in Solid Mechanics. By incorporating innovative teaching methods, practical applications, and robust assessment strategies, such programs can address the challenges faced by students and improve overall learning outcomes. Future research should continue to explore the long-term impacts of such interventions and their applicability across various engineering disciplines.

Methodology

Solid Mechanics is for Diploma Civil Engineering students, usually in second semester in Diploma Programme. Students have four hours of class each week, including three hours of lectures and one hour of tutorials. Lectures are for the whole group, and tutorials are in smaller groups. Typically, there are about 30 students in each class. They attend lectures together and then split into groups of 15 for tutorials. The total number of students taking this course varies depending on the intake.

The subject of Solid Mechanics consists of four main topics which are 1D and 2D Linear Stress & Strain Systems, Stresses and Deflection of Statically Determinate Beams, Torsion of Circular Shafts, and Elastic Buckling of Columns. The assessment for this course is divided into formative and summative assessments. The formative assessment consists of a test (20%)

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and an assignment (20%), while the summative assessment, which makes up 60% of the final grade, covers all four topics comprehensively. This structure poses a significant challenge for students, as they must be well-prepared to answer questions on all topics in the final exam.

In this case study, the performance of students from two semesters were compared. The "Current Semester" refers to students from semester 20234, while the "Previous Semester" refers to students from semester 20232. This study aims to assess the effectiveness of the 'Program Cantas Gagal' in reducing the failure rates of Solid Mechanics for Diploma Civil Engineering students at UiTM Cawangan Pulau Pinang. The analysis was conducted on two different semesters: semester 20232 (Mac23-Aug 2023 for previous semester) and semester 20234 (Oct 23 - Feb 2024 for current semester). Table 1 shows details of these groups.

Table 1: Total Number Of Students

Groups	Semester	No. of students	**Activity**
Current Semester	20234 (Oct 23 -Feb 2024)	35 (PEC1103F and PEC1103G)	Program Cantas Gagal
Previous Semester	20232 (Mac23-Aug 2023)	69 (PEC1102A, PEC1102B, PEC1102C, PEC1102D, and PEC1102E)	-

In the current semester (20234), a total of 35 students were enrolled in the Solid Mechanics course. These students were divided into two classes, labelled PEC1103F and PEC1103G. Each class had a balanced number of students to ensure effective teaching and learning processes.
For the previous semester (20232), there were 69 students enrolled in the Solid Mechanics course. These students were distributed across five different classes, labeled PEC1102A, PEC1102B, PEC1102C, PEC1102D, and PEC1102E. The larger number of classes in the previous semester provided a broader data set for comparison with the current semester.

To assist students in mastering these topics and improving their final grades, the "Program Cantas Gagal" was implemented. This program aimed to reinforce understanding of students and readiness for the final exam. This focused preparation aimed to help students better understand the material and improve their performance in the final examination.

The 'Program Cantas Gagal' was implemented in the current semester as an intervention to support students who were struggling with the course content. The program included additional tutorial sessions, focused on solving past year exam questions and reinforcing key concepts. The effectiveness of this program was evaluated by comparing the failure rates between the previous and current semesters. The "Program Cantas Gagal" was planned and implemented across four structured sessions, each focusing on different critical topics within the Solid Mechanics course. Session 1 covered the topic of 1D and 2D Linear Stress & Strain Systems and lasted for 3 hours, providing students with foundational knowledge and hands-on examples from past exams to reinforce understanding. Session 2 focused on Stresses and Deflection of Statically Determinate Beams, also for 3 hours, where students solved example problems to clarify and solidify their understanding of beam stress and deflection.

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Session 3 involved Torsion of Circular Shafts, spanning 4 hours. During this session, students engaged in problem-solving activities that emphasized understanding torsional stress, using extensive discussion of past year questions to build their confidence. Session 4 addressed Elastic Buckling of Columns and was conducted over 4 hours. This session concentrated on Euler's Buckling Theory, where students revisited common problems and solved previous exam questions related to column buckling.

These sessions total of 14 hours and provided focused support that allowed for better understanding of challenging topics, ensuring students could handle final assessments effectively. The sessions were specifically designed to enhance the students' abilities to apply concepts, emphasizing the importance of revisiting key areas where students typically struggled. The program aimed to reinforce students' understanding through a structured approach, targeting both theoretical knowledge and practical problem-solving.

The effectiveness of this program was evaluated by comparing the failure rates between the previous and current semesters. Data collection involved gathering the final exam results of students from both semesters. The primary metric for evaluation was the failure rate, defined as the percentage of students who did not achieve the minimum passing grade. By analyzing and comparing these results, the impact of the 'Program Cantas Gagal' on performance of students in Solid Mechanics were determined. Figure 1 below shows some activities conducted during the 'Program Cantas Gagal' sessions, highlighting the interactive and collaborative aspects of the program.

Session 1

Session 2

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Session 3

Session 4

Figure 1: Program Cantas Gagal

Results and Discussion

The grade distribution data for the "Solid Mechanics" course before and after the implementation of the 'Program Cantas Gagal' shows a noticeable shift in student performance. The program aims to reduce failure rates and improve overall academic achievement. Table 2 illustrates the grade achievements for the previous semester (semester 20232) and current semesters (semester 20234).

Table 2: Grade Achievements

Semester	DO : GRADE ACHIEVEMENTS							
	A+,A,A-	B+,B,B-	C+, C	C-,D+,D	E	F	Total	% Fail
Current	3	15	15	2			35	6%
Previous	12	18	25	6	7	1	69	20%
Difference	-9	-3	-10	-4				-15%

The implementation of the 'Program Cantas Gagal' in the Solid Mechanics course has significantly improved student performance, as evidenced by a notable reduction in failure rates and an enhancement in overall grade distributions. Prior to the program's introduction in semester 20232, the failure rate was 20%, indicating that many students struggled with the course material. However, following the program's implementation in semester 20234, this rate decreased to 6%, reflecting a remarkable 14% reduction in failures, as shown in Figure 2. This improvement underscores the effectiveness of targeted interventions in education, supporting studies that demonstrate how structured support can greatly enhance student success and retention rates (Zahid et al., 2023; Mutanda, 2023).

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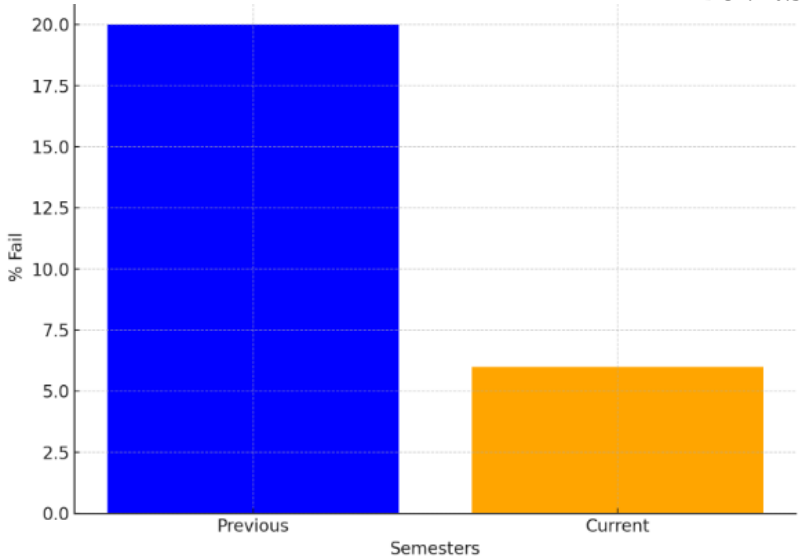

Figure 2: % Failure Rate Comparison: Previous Vs Current Semester

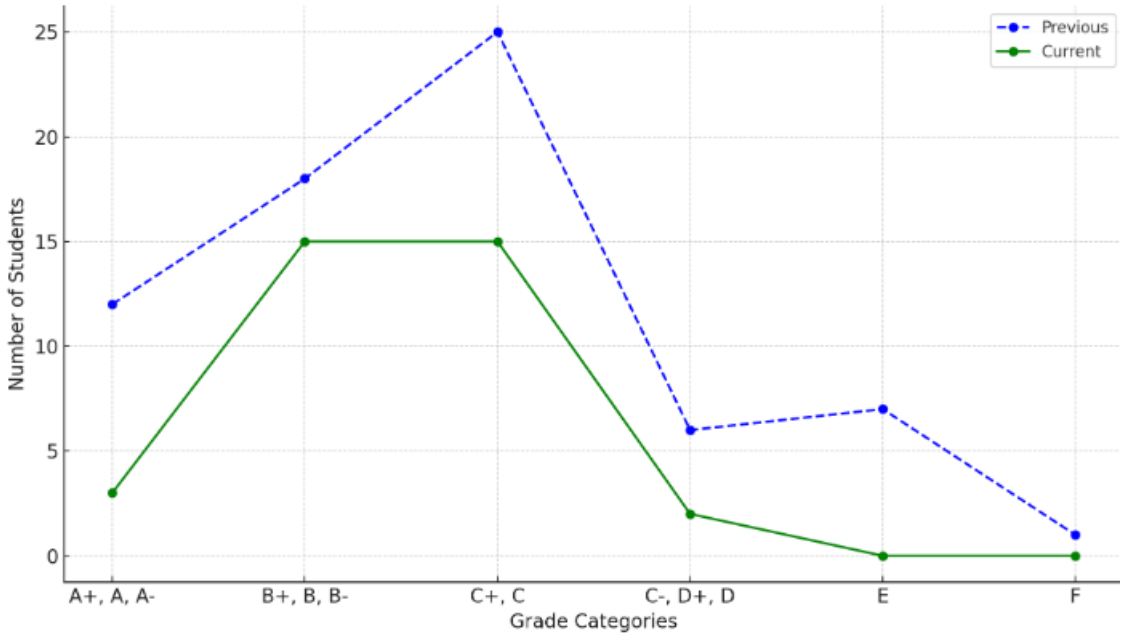

Figure 3: Overview of Grade Achievements

Based on the overview of grade achievement as shown in Figure 3, the most pronounced changes were observed in the mid-range grades, where the number of students achieving B+, B, and B- decreased from 18 to 15, while those attaining C+ and C grades also saw a reduction from 25 to 15. This shift indicates a more balanced performance among students, suggesting that the program has not only facilitated passing grades but has also encouraged higher academic achievement. The improved understanding and retention of the course material, likely due to the program's focus on active participation and problem-solving, have contributed to this positive result. Research shows that educational programs, especially those using active learning methods, can lead to better academic performance (Mutanda, 2023).

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The reduction in low grades, particularly the elimination of E and F grades, further emphasizes the program's success. Previously, 7 students received an E grade and 1 student an F, but the current semester recorded no students in these failing categories. This outcome highlights the effectiveness of the program in addressing the critical issue of course failures, thereby promoting higher retention and progression rates among students. Similar interventions have been shown to yield comparable results in various educational contexts, reinforcing the potential of such programs to transform student experiences and outcomes (Zahid et al., 2023).

One contributing factor to the high failure rates in semester 20232 may have been the reliance on traditional teaching methods, which often do not provide adequate opportunities for students to practice problem-solving or seek clarification on complex topics. The 'Program Cantas Gagal' appears to have addressed these shortcomings by fostering a more interactive learning environment. By emphasizing the resolution of past exam questions, the program likely bolstered student confidence and preparedness for assessments, a critical component of academic success (Zahid et al., 2023). This aligns with findings from educational research that suggest active learning and continuous assessment can significantly enhance student performance across various disciplines (Law et al., 2020).

In conclusion, the 'Program Cantas Gagal' has proven to be an effective strategy for reducing failure rates and enhancing overall student performance in the Solid Mechanics course. The elimination of failing grades and the reduction in low grades are particularly noteworthy outcomes. Future research should focus on conducting studies to assess the sustainability of these improvements and explore additional innovative methods, such as peer tutoring and technology-enhanced learning tools, to further support student success in challenging subjects (Mutanda, 2023). Understanding the specific elements of the program that contributed to these positive outcomes could provide valuable insights for refining and replicating such interventions in other courses (Zahid et al., 2023).

Conclusions

In conclusion, the 'Program Cantas Gagal' has proven to be an effective strategy for reducing failure rates and improving academic performance in the Solid Mechanics course. The program success provides a valuable model for similar initiatives aimed at enhancing student outcomes in higher education. By continuously refining and adapting such programs, educational institutions can better support their students, leading to higher retention rates and overall academic excellence. Future research should focus on the long-term sustainability of these improvements and explore innovative methods to further enhance student success in challenging subjects. The insights gained from this study can inform the development of more comprehensive and effective educational strategies across various disciplines.

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