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Performance of Regular Students vs Repeaters of the Solid Mechanics Course for Engineering Diploma Programme

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Abstract

This study examines Universiti Teknologi MARA Diploma in Civil Engineering students' Solid Mechanics performance. The course is aligned with two Programme Outcomes (PO1 and PO2) and its objective is to utilize fundamental engineering principles and evaluate clearly specified engineering challenges. This study examines the demographic distribution, assessment results, and programme outcomes of a total of 66 students, comprising 30 regular students (12 male, 18 female) and 36 repeaters (17 male, 19 female). The assessment findings indicate that regular students tend to attain higher ratings, notably in the top grades (A+ and A), although repeaters demonstrate notable progress, particularly in the middle-range grades (B+). The mean scores for examinations, assignments, and final assessments were 50.4%, 81.8%, and 51.9% respectively, resulting in an overall mean score of 57.6%. Repeaters outscored regular pupils by 58.3% to 56.7%. Analysis of the Programme Outcomes revealed that repeaters did better in PO2 (67.5% vs. 60.7%), although normal students did better in PO1 (52.7% vs. 49.1%). The study highlights the unique difficulties and advantages that regular students and repeaters face, highlighting the significance of customized academic assistance to improve learning results in demanding courses such as Solid Mechanics. The findings affirm the efficacy of OBE in offering a well-organized and results-oriented instructional structure, fostering a thorough and efficient learning encounter.

Keywords: Outcome-Based Education (OBE), Programme Outcomes (POs), Solid Mechanics, Diploma in Engineering, Academic Performance

Introduction

Outcome-Based Education (OBE) is being widely adopted in higher education institutions globally, including Malaysia, with the aim of improving the quality of education and ensuring

that graduates possess specified competencies. Since 2004, the Malaysian Higher Education Ministry and the Board of Engineers Malaysia (BEM) have introduced the Outcome-Based Education (OBE) system in collaboration with a chosen set of engineering education providers who are leading in the field. OBE primarily emphasises three specific learning activities for students: learning outcome statements, which clearly define the expected knowledge, understanding, or skills that students should possess; and learning activities that facilitate the attainment of these outcomes (Ahmad Zakwan, Ismail, & Endut, 2022) (Abu Bakar, Raja Hussain, & Idris, 2010) (Yasmin & Yasmeen, 2021).

The implementation of OBE represents a recent and significant change in the approach of teaching and learning in higher education. Its primary objective is to prepare graduates who are well-prepared for employment and capable of adapting to evolving economic circumstances (Kulkarni & Barot, 2019) (Naqvi, et al., 2019). The course mapping of programme outcomes (POs) and course outcomes (COs) for each course should be established in advance to ensure that the students' accomplishments may be evaluated in accordance with the OBE scheme (Le, 2018) (Osman, Jaafar, Wan Badaruzzaman, & Rahmat, 2012). There are 12 programme outcomes for the programme of diploma in Civil Engineering offered by Universiti Teknologi MARA (UiTM) as follows:

PO1 - Apply mathematical, natural science, engineering fundamentals, and engineering specialization knowledge to a wide range of practical procedures and practices.
PO2 - Identify and analyze well-defined engineering problems reaching substantiated conclusions using codified methods of analysis specific to their field of activity.
PO3 - Design solutions for well-defined technical problems and assist with the design of systems, components, or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO4 - Conduct investigations of well-defined problems; locate and search relevant codes and catalogues, conduct standard tests and measurements.
PO5 - Apply appropriate techniques, resources, modern engineering and IT tools to well-defined engineering problems, with an awareness of the limitations.
PO6 - Demonstrate knowledge of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering technician practice and solutions to well-defined engineering problems.
PO7 - Understand and evaluate the sustainability and impact of engineering technician's work in the solution of well-defined engineering problems in societal and environmental contexts.
PO8 - Understand and commit to professional ethics, responsibilities and norms of technical practice.
PO9 - Function effectively as an individual, and as a member in diverse technical teams.
PO10 - Communicate effectively with the engineering community and society at large on well-defined engineering activities by understanding the work of others, documenting their own work, and giving and receiving clear instructions.
PO11 - Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, as a member or leader in a technical team and to manage projects in multidisciplinary environments.

PO12 - Recognize the need for, and have the ability to engage in independent updating in the context of specialized technical knowledge.

The Solid Mechanics course (ECS226) is available to second-year students pursuing a Diploma in Civil Engineering at UiTM. This course is a prerequisite for the courses Basic Structural Analysis, Structural Concrete and Steel Design, and Civil Engineering Design Project. Out of the 12 specified POs, this course aligns with only two specific POs, namely PO1 and PO2. Regarding course outcomes, this course only includes two COs as follows:

CO1 - Apply basic understanding of stresses and strains in the solid body, beam, shafts and column.
CO2 - Develop solutions for problems related to statically determinate beams.

The main goal of OBE is to enhance student learning outcomes by prioritizing the specific achievements that students are expected to attain by the completion of their study (Thirumoorthy, 2021). Research has demonstrated that OBE can greatly improve student involvement and academic achievement. Universiti Teknologi MARA's OBE system has effectively synchronized the curriculum with industry requirements, resulting in enhanced graduate employability (Sun & Lee, 2020).

In a study that was conducted by Hassan and colleagues, the authors highlighted the development of a Learning Outcome-based Question Examination Tool (LoQET), which provides assistances to lecturers in the process of developing examination questions that are matched with particular learning objectives (Hassan, Admodisastro, Kamaruddin, Baharom, & Che Pa, 2016). This guarantees that the assessments are directly connected to the educational goals that are meant to be achieved.

One of the most important aspects of OBE is quality assurance, which ensures that the educational outcomes are up to the required standards (Qadir, et al., 2020). However, little empirical research has explored the comparison in learning outcomes between regular students who take the course for the first time and repeaters who retake the course due to unsatisfied previous grade. The continuous evaluation and feedback process in OBE enables the continued enhancement of the curriculum. The research conducted by Sun and Lee (2020) highlights the importance of using data from the OBE system to continuously improve the quality. Regular students and repeaters may face different challenges such as motivation aspect, foundational concept literacy, and self-efficacy concerns. These challenge may impact their performance in achieving learning outcomes.

Within the realm of Civil Engineering education, the implementation of OBE has resulted in the creation of curriculum that are better attuned to the demands of the industry. This connection guarantees that graduates possess the essential skills and knowledge required to thrive in the workforce. Research has shown that implementing OBE in Civil Engineering programmes leads to favorable results in terms of student achievement as well as fulfilment. (Khan, Salele, Hasan, & Abdou, 2023) (Rajaee, Junaidi, Taib, Salleh, & Munot, 2013). This study aims to explore the comparison of academic performance and engagement of learning outcomes between regular students and repeaters within an engineering course in Universiti Teknologi MARA.

Methodology

This study included students pursuing a Diploma in Civil Engineering at the Faculty of Civil Engineering, UiTM Johor Branch Campus Pasir Gudang, during the academic year of October 2023 to February 2024. The students were registered in the Solid Mechanics course (ECS226). The study examined the demographic composition of students enrolled in the Solid Mechanics course, classifying them based on their status as either regular students or repeaters, and further studying the data by gender. The total number of students was 66, consisting of 30 normal students and 36 repeaters. Out of the total number of pupils, there are 12 males and 18 females. Out of the individuals who are repeating, there are 17 males and 19 females.

Table 1
Demography of students taking Solid Mechanics Course

Students	**Gender**		**Total**
	Male	**Female**	
Regular Students	12	18	30
Repeaters	17	19	36

The purpose of this study is to investigate the academic performance of two distinct groups of students, namely regular students and repeaters on the same course. Regular students were defined as those who were enrolling in the course for the first time after successfully completing the previous semester, while repeaters were students who were retaking the course after failing it in the previous semester.

This course was chosen since it is a mandatory course offered to students in the second semester of their studies. Additionally, this course is renowned for being one of the most challenging courses in the Diploma in Civil Engineering programme offered at UiTM. One-dimensional and two-dimensional linear stress and strain, stresses and deflection of statically determinate beams, torsion of circular shafts, and elastic buckling of column were the four topics that were addressed in this course. Each of these topics were addressed in this course.

The Solid Mechanics course assessment framework is specifically developed to measure students' proficiency and competence using a range of different evaluation techniques. The alignment of each assessment type with specified Course Outcomes (CO) and Programme Outcomes (PO) ensures a comprehensive evaluation of students' learning. This is achieved by incorporating multiple assessment types, as indicated in Table 2. The framework enhances the attainment of certain educational objectives and competencies by ensuring that assessments are in line with both course and programme outcomes.

Table 2
Course Assessments

Assessment	**CO-PO**	**Assessment Marks (%)**
Test	CO1-PO1 CO2-PO2	20
Assignment	CO1-PO1 CO2-PO2	20
Final Examination	CO1-PO1 CO2-PO2	60
TOTAL		100

Tests constitute 20% of the overall assessment score. A test was administered to assess the students' performance and comprehension of the course. This assessment concentrates on specific topics and course outcomes, offering valuable understanding into areas where students may want more enhancement. The test was aligned with the learning outcomes CO1-PO1 and CO2-PO2 in order to provide a balanced assessment approach.

Meanwhile, assignments account for 20% of the overall assessment score. The purpose of these assignments is to assess students' capacity to apply theoretical principles of Solid Mechanics to practical problems. Assignments necessitate the use of critical thinking and problem-solving abilities, in line with the learning outcomes CO1-PO1 and CO2-PO2. The implementation of this ongoing evaluation approach promotes a sustained commitment to academic progress and knowledge acquisition over the period of the course.

Finally, the Final Examination contributes to 60% of the overall assessment score. This examination evaluates students' thorough comprehension of Solid Mechanics and encompasses both CO1-PO1 and CO2-PO2. The significant weighting of the final examination underscores its significance in assessing the overall proficiency and retention of knowledge of students in the subject.

Result and Discussion

Figure 1 displays the mean percentage of scores achieved in all the assessments for the ECS226 course, including tests, assignments, and the final exam. Tests and assignments each account for 20% of the overall score, while the final exam accounts for 60% of the total score. The average score achieved by students in the test evaluation is 50.4%. These findings suggest that students perceive tests as somewhat difficult, and their performance is slightly better than average. For the assignment, pupils demonstrate a considerable improvement, attaining an average score of 81.8%. The high score indicates that pupils have a greater proficiency in completing assignments, likely because they have more time to work on them and potentially have access to resources and collaborative opportunities.

The final exam's average score decreases to 51.9%, suggesting that students perceive the final exams to be equally difficult as the tests. The scores exhibit a modest increase compared to the exam scores, indicating a somewhat better performance, potentially attributable to the accumulation of knowledge throughout the period of the course.

The overall score, calculated as the weighted mean of all evaluations, is 57.6%. The total score represents the comprehensive performance of students, demonstrating an overall positive result when combining tests, assignments, and final exams. The entire score surpasses the scores of the individual tests and final exam, however falls short of the assignment score, indicating that assignments have a substantial impact on the overall performance.

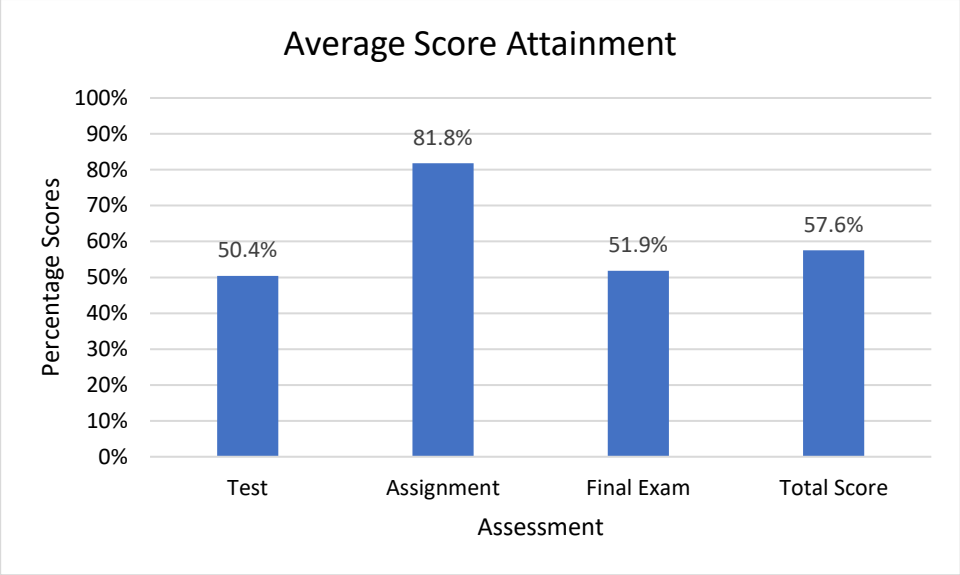

Figure 1: Average Score Attainment

On the other hand, Figure 2 shows the mean achievement of two Programme Outcomes (PO1 and PO2) in the ECS226 course. The data is displayed as percentage scores for various assessment components, namely Test, Assignment, and Final Exam. For PO1 students had an average attainment of 32.0% on the Test assessment, whereas for PO2 students have an average attainment of 68.9%. The Assignment assessment has an average accomplishment of 81.6% for PO1 and 82.0% for PO2. Finally, in terms of the Final Exam assessment, the average score for PO1 is 46.5%, while the average score for PO2 is 57.2%. Based on these three assessments, the Total Score can be calculated, which indicates that the average attainment for PO1 is 50.6% and for PO2 is 64.5%.

The scores for the Test assessment in Programme Outcome PO2 are much higher than those for PO1, with a 68.9% compared to 32.0%. Both PO1 and PO2 in the Assignments assessment demonstrate a high level of achievement, with scores of 81.6% and 82.0% respectively, which are practically equal. PO2 achieved a better accomplishment of 57.2% for the Final Exam assessment, while PO1 achieved 46.5%. The overall result for the Total result is 64.5% for PO2, which is greater than the score of 50.6% that PO1 obtains.

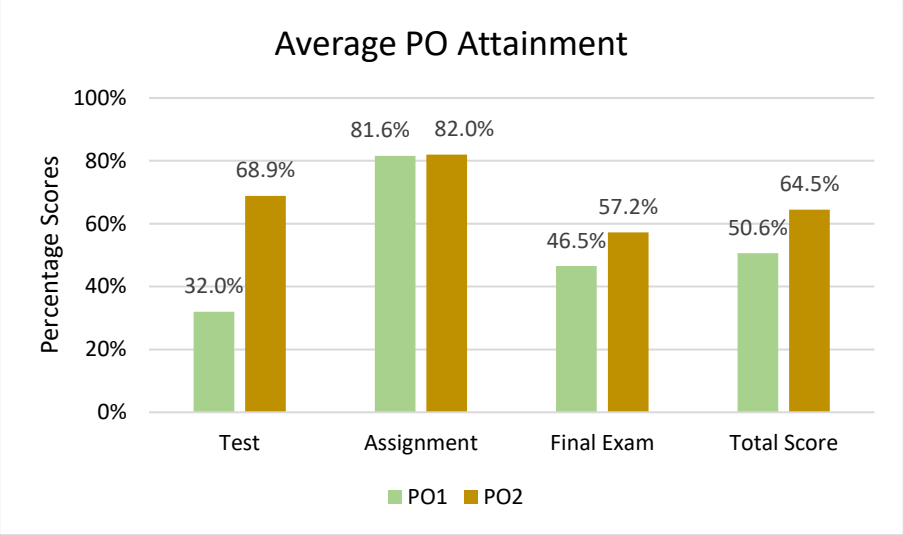

Figure 2: Average Score Attainment according to Programme Outcomes

A comparison of the average ratings between regular students and repeaters is also provided in Figure 3. Regular students are individuals who are enrolling in the course for the first time after performing satisfactorily in the previous semester. On the other hand, repeaters are students who are retaking the course after having failed the grade in the previous semester.

The data illustrates that regular students have an average score of 56.7%, whilst repeaters have a slightly higher average score of 58.3%. On average, repeater students perform better than regular students when they retake a course, despite the fact that they initially failed the course. The enhanced performance of repeaters can be associated to various variables. Repeaters benefit from their prior exposure to the course material, which can lead to a more profound comprehension and improved performance when retaking the course (Tafreschi & Thiemann, 2016). Moreover, those who have previously failed the course may exhibit a higher level of motivation to exert additional effort in order to enhance their scores (Dibbs, 2019). In addition, repeaters may obtain supplementary academic assistance or resources, which can assist them in addressing their deficiencies and achieving improved performance.

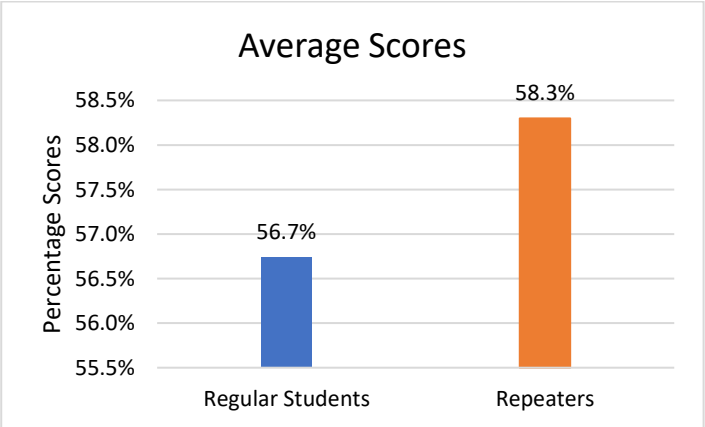

Figure 3: Average Scores Regular Students vs Repeaters

Figure 4 shows the average scores for two programme outcomes (PO1 and PO2) are compared between repeaters and regular students. The average score for regular students in

PO1 is 52.7%, while repeaters have a slightly lower average score of 49.1%. These findings reveal that regular students outperform repeaters in relation to PO1, indicating a higher level of knowledge or skill proficiency.

In contrast, repeaters demonstrate much better performance than regular students for PO2. Repeaters attain a mean score of 67.5%, in contrast to regular students who achieve 60.7% on average. The significant disparity indicates that repeaters, despite their prior failure in the course, exhibit notable progress and a more profound understanding of the concepts or skills evaluated by PO2 when they retake the course.

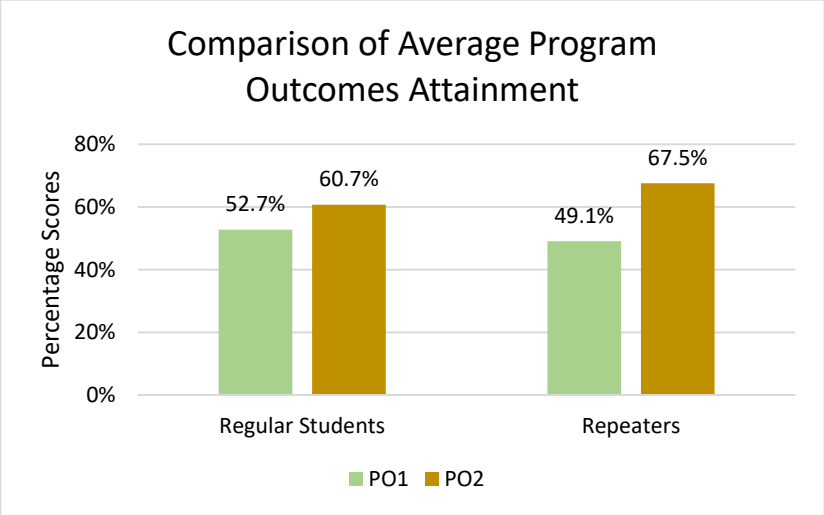

Figure 4: Average PO score for Regular Students vs Repeaters

Figure 5 displays the correlation between the grade performance of two student groups, namely regular students and repeaters. Noteworthy is the fact that a grade of C is required to pass the course. Typically, regular students have a higher likelihood of achieving higher marks compared to those who repeat courses. Their exceptional performance is indicated by a somewhat larger number of students receiving outstanding grades, such as A+ and A. Nevertheless, repeaters demonstrate notable enhancement in some advanced grades, such as A-, where they surpass regular students.

Repeating students tend to excel in the average grade range, achieving higher percentages in the B+ grade category. This indicates that those who have previously taken the course, known as repeaters, tend to obtain significantly higher results than the average when they retake the course. Regular students also excel academically, but their grades are more uniformly spread out among various levels (Waheed, et al., 2020).

Regarding the minimum passing grade of C, both groups exhibit comparable percentages, indicating a fundamental level of comprehension necessary to successfully complete the course. Remarkably, a substantial proportion of students who repeat the course achieve a C+ rating, surpassing other grades by a large margin. This peak indicates that a significant number of repeaters, though making progress, tend to gather around this level of satisfactory performance, which means that they meet the minimum requirements with an elementary understanding of fundamental concepts. Conversely, regular students exhibit a greater

proportion of C grades, suggesting a satisfactory level of proficiency but little understanding of the subject matter.

When it comes to low performance grades, it is more common to find regular students in the D+ and D grades, which are below a passing grade of C. This suggests that there are major gaps in their understanding. The D grade is predominantly comprised of regular students, with a substantial disparity in percentage. When it comes to grades E and F, both groups of students have percentages that are generally comparable to one another. However, regular students have slightly higher percentages, which indicates a lack of comprehension as well as insufficient effort or competence. Curiously, regular students exhibit a little larger proportion of low grades (F) compared to those who have repeated the course. This implies that although regular students have the capacity to attain superior grades, there exists a tiny subgroup that fails to satisfactorily finish the course. When compared to repeaters, regular students have a higher percentage of students who have grades that are lower than the passing grade, which is a C.

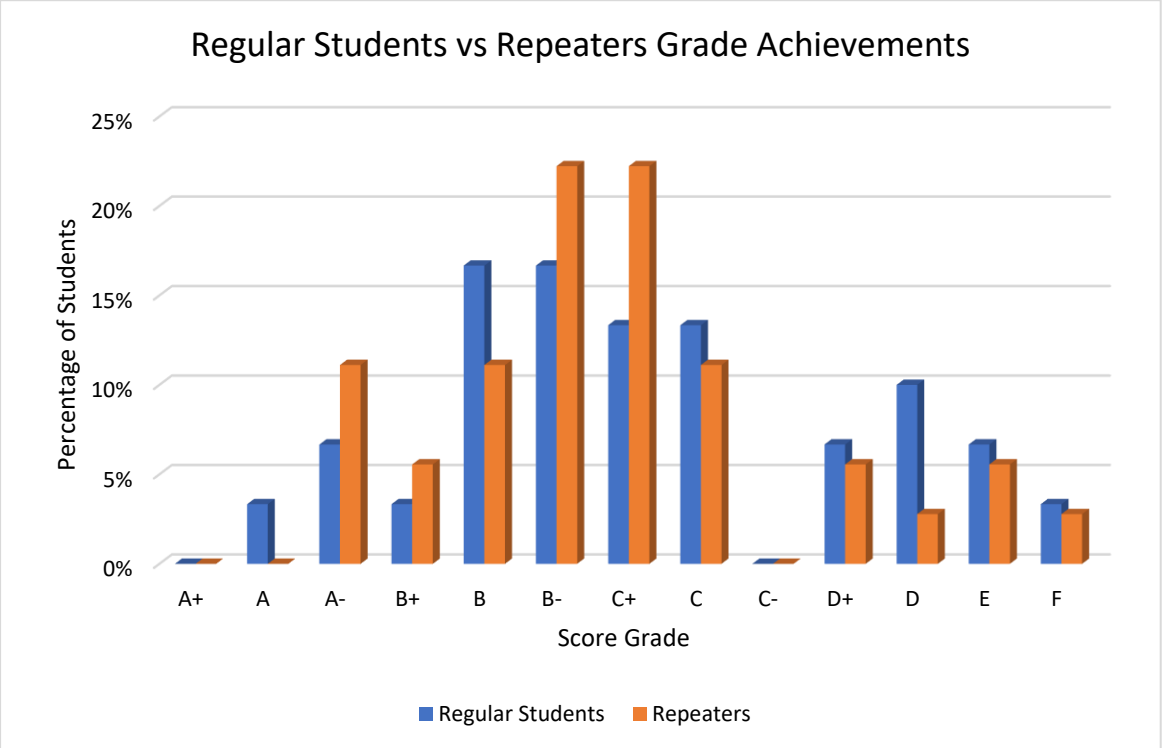

Figure 5: Regular Students vs Repeaters Score Grade

Conclusion

This study focuses on the Solid Mechanics course (ECS226) and provides a comprehensive analysis of the grade accomplishment and programme outcomes for students enrolled in the Diploma of Civil Engineering programme offered by UiTM Johor Branch Campus Pasir Gudang. A total of 66 students engaged in the study, with thirty of them being regular students and thirty-six of them being repeaters. The research identified important variations in performance between the two groups of students. This study provides insights into the factors affecting student success in technical courses like Solid Mechanics. The findings can help improve teaching strategies and student support programs by highlighting the benefits of prior exposure to course content.

According to the statistics, regular students, in comparison to repeaters, generally to get higher grades, particularly in the highest grades, such as A+ and A. Students who are taking the class for their first time have demonstrated a strong performance, as indicated by this. On the other hand, repeaters demonstrate a considerable improvement in some higher grades, such as A-, which suggests that past exposure to the course material and added motivation play essential roles in their improved performance when retaking the course. The study suggests that initial exposure to the course plays a key role in performance. Repeaters benefit from additional motivation and review, which can inform strategies for improving learning outcomes.

In terms of grades that fall within the middle range, repeaters perform better than regular students, particularly in grades such as B+, which is evidenced by their consistently above-average results. It is possible that their familiarity with the material covered in the course, as well as the possibility that they received additional academic support, contributed to their success. Despite the fact that they are performing well, regular students exhibit a more even range of marks across different levels. This is consistent with the idea that their performance varies greatly depending on the individual's level of comprehension and involvement with the subject matter of the course.

The course has a passing grade of C, and both groups' percentages at this level are comparable, suggesting that both have the baseline knowledge needed to pass. It is interesting to note that repeaters predominate in the C+ grade, showing that many of them do well enough to complete the course, while regular students have greater percentages in the C grade, indicating elementary competency.

Regular students are more likely to receive failing grades (D+, D, E, and F), which highlights severe gaps in understanding and insufficient performance below the passing mark of C. These grades are more widespread than failing grades overall. It is important to note that a tiny percentage of regular students receive a grade of F at the end of the course, which highlights the crucial need for customized assistance to overcome these inadequacies and enhance the academic achievements of these students. The higher failure rates in regular students show the need for early academic support. Identifying struggling students early can help reduce failure rates.

In general, the study highlights the various difficulties and strengths that regular students and repeaters face in their educational experiences. Repeaters exhibit significant improvement and consistency after retaking the course, frequently outperforming regular students in grades that fall somewhere in the middle range grades. These conclusions underline the significance of offering targeted academic help and resources to both groups. This will ensure that students in challenging courses like Solid Mechanics have an experience that is both complete and helps them succeed along with their educational journey. This study highlights the potential for tailored academic support to improve performance in challenging courses by focusing on interventions that could enhance outcomes for all students.

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