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THE NEED TO INVESTIGATE STUDENT PERFORMANCE THROUGH DIAGNOSTIC TESTS IN HIGHER EDUCATION

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Abstract:

Early identification of student performance in civil engineering plays a crucial role in improving academic outcomes. Diagnostic tests are practical tools in this process. This study examined the performance of 38 students in Course SM through a diagnostic test administered in the first week. Various statistical methods, such as minimum, mean, standard deviation, t-test, and Pearson Correlation, were utilised to analyse the scores of male and female students separately. The results indicated that male students initially outperform female students in the diagnostic test. However, by the end of the semester, female students demonstrate a remarkable average percentage improvement of 129%, compared to 59% increase for male students. These results suggest that female students show a more significant enhancement in their performance throughout the course. The findings underscore the importance of early diagnosis of student performance, offering valuable insights into individual strengths and areas needing development. By understanding these aspects, educators can adapt their teaching approaches to enhance overall academic success in civil engineering programs.

Keywords:

Civil Engineering, Diagnostic Assessment, Student Performance, Academic Growth

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Introduction

In the landscape of higher education in Malaysia, the increasing student enrollment in disciplines like mathematics, science, and engineering underscores the growing importance of foundational knowledge in these fields. Despite this increase in enrollment, the rise in student numbers presents significant challenges for lecturers due to the expansion of university access, resulting in heterogeneous academic cohorts with varied educational backgrounds and syllabi at the faculty level. This variation requires a strategic approach to evaluate students' abilities in mathematics, physics, and science early as to recognise and address the gaps in their understanding.

Student performance plays a significant role in shaping academic achievement and career prospects. High academic achievement reflects students' mastery of subject matter and their interest in the professional world. Zaccaro and Banks (2019) underscore the long-term benefits of exceptional academic achievement, leading to lucrative job opportunities, leadership positions, and career advancement. They emphasise the continued importance of academic excellence in shaping successful careers.

Engineering courses are renowned for their emphasis on calculation, problem-solving, design principles, and engineering fundamentals. A strong foundation in mathematics, science, and technical skills is crucial in the civil engineering program as it helps students understand complex concepts and problem-solving. Researchers like Zhang (2021) stated that consistent academic quality has a positive impact, such as higher graduation rates and sustainable career development. Excellent academic performance opens competitive job opportunities in STEM fields (Kazu, İ. Y., 2021). Rojewski and Kim (2019) and Mavridis and Koutouzis (2020) underscore the importance of high academic achievement in developing essential skills that employers value. Academic excellence and skills help graduates secure better jobs, accelerate career progression, and open brighter futures. Nevertheless, universities and educators face significant challenges in helping students achieve optimal academic outcomes, especially in engineering programs.

A significant challenge in engineering is that many students need help with weaknesses in critical areas, such as calculations, physics principles, and graphical data analysis. This finding was discovered in a study by Nordin (2019). Additionally, there is a lack of student interest in science and mathematics courses in Malaysia (Latif et al., 2020). Despite these difficulties, educators must solve these problems (Saod et al., 2024). One approach is to identify student weaknesses at the early stage. Jaafar and Maat (2020) supported this idea, suggesting that educators can boost student interest and motivation in various subjects by pinpointing zones where students struggle. Early identification of weaknesses in science and mathematics allows instructors to implement remedial measures and help students improve their performance.

The diagnostic test is one of the suitable methods used as a formative assessment tool to detect student weakness and improve learning outcomes (LO) (Kanski, 2019). It helps guide instructional planning and supports the teaching and learning (T&L) processes. Early valuation of diagnostic tests is crucial to assessing student engineering course performance. It provides a valuable understanding of students' knowledge, skills, and readiness for academic challenges. These assessments can reveal misconceptions and help students solidify their foundation in mathematics and physics, leading to a deeper understanding of the subject matter. The output

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from the diagnostic test guides instructors in modifying their teaching methods to suit the student's needs and optimise academic success.

Research has consistently highlighted the role of diagnostic testing in promoting effective T&L strategies. For instance, Sanchez et al., (2023) emphasised using diagnostic testing to design differentiated instruction and promote student learning in engineering education. Hernandez Cardenas (2021) exposed how diagnostic data can support personalised learning approaches and improve student engagement in technical courses. The output from the diagnostic test guides instructors in modifying their teaching methods to suit the student's needs and optimise academic success. Similarly, Barlow and Barlow (2020), Comighud (2021) and Wang and Wang (2024) stressed on the importance of consistent practice and hands-on assignments. Their studies showed that regular practice improves understanding, critical thinking, academic performance, and memory retention.

Chen and Torre (2020) and Fan and Guan (2021) further underscored the benefits of using diagnostic data to adjust curriculum and instructional strategies that support student growth and academic achievement. Implementing intervention programs after obtaining data from diagnostic tests is a practical approach. These programs can be conducted in various ways, including regular exercises like weekly tutorials, additional assignments, and instructor feedback on exercises. These practices strengthen knowledge and problem-solving skills, making it easier for students to apply theoretical knowledge in the classroom to the real-world workplace. Similarly, a study by Abdi (2020) showed that hands-on learning activities positively influence student engagement and academic achievement in science education, demonstrating that practical experiences enhance understanding. Martin et al. (2023) emphasised that weekly exercises in engineering reinforce concepts and foster problem-solving abilities. Uwaifo and Omoregie (2023) and Hwang and Chang (2020) highlighted that interactive exercises can strengthen students' understanding cognitive skills in various domains. Lau and Lam (2023) and Shana and Abulibdeh (2020) stressed that practical work connecting theory and applications contributes to better academic achievements. All this research proved that engaging in continuous practical exercises improves student learning across various academic fields.

Like several other subjects, mathematics presents challenges in teaching and learning. Therefore, continuous guidance and diverse teaching methodologies are essential (Jamal et al., 2020). The effective use of contextual knowledge is also important, particularly in engineering and technology instruction (Adnan et al., 2024). Said et al. (2024) also supported this by highlighting that dedicated educators who prioritise professional development can improve teaching and learning effectiveness. Despite all these efforts, the performance of civil engineering students in the early semester has yet to be widely studied. This study aims to analyse students' performance of the civil engineering diploma program in Course SM through diagnostic tests that focus on mathematical and physics approaches.

Methodology

Participation of Students

The diagnostic test was conducted with male and female students enrolled in the diploma in civil engineering program for Course SM in 2023. A total of 38 students participated, with 20 females and 18 males. Figure 1 shows the percentage distribution of male and female students,

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illustrating the representation within the cohort and providing a clear summary of gender demographics in the study.

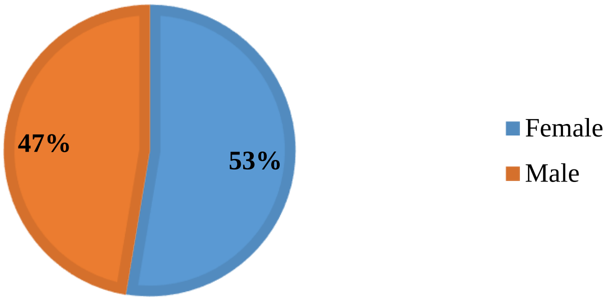

Figure 1: Percentage of Male and Female Students

Male and Female Students for each Grade Level Recorded in the Diagnostic Test

The students were given ten questions to answer, most focusing on the fundamentals of Course SM in a civil engineering diploma program. A firm grasp of these basics is crucial for mastering more complex concepts. Ensuring students comprehend these foundational principles facilitates a smoother transition to advanced topics and minimises the risk of misunderstandings that could impede overall learning. Evaluating basic skills offers insights into student readiness and helps identify gaps in their foundational knowledge. As shown in Table 1, the data displays the number of male and female students in each grade level determined by the diagnostic test. Six grades were identified, but no students received grades D and E. Therefore, the results are discussed solely for grades A, B, C, and F.

Table 1: Number of Male and Female Students for each Grade

Grade	Female	Male	Total
A	1	1	2
B	4	5	9
C	6	2	8
D	0	0	0
E	0	0	0
F	9	10	19

Analysing the data by gender enables a more detailed examination of possible variations in performance and comprehension between male and female students. This method seeks to uncover gender-specific patterns or differences in foundational knowledge within the course. Although the study did not detect significant performance gaps between genders, this analysis is a foundation for future research to investigate the factors that may influence any observed distinctions and formulate strategies for bridging knowledge gaps.

Analyses

The diagnostic test was administered at the start of the semester, typically within the first week of classes, to evaluate the students' fundamental knowledge of Course SM. The results were gathered and analysed after the test to assess each student's initial performance. This analysis offered insights into the students' preparedness levels and unveiled gaps in their foundational knowledge. A comparison was made between the diagnostic test results and the student's final grades at the end of the semester. This comparison enabled lecturers to determine if the

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diagnostic test accurately predicts student performance and identifies areas necessitating additional support or instructional adjustments. This process ensures that the diagnostic test is valuable for guiding and enhancing instruction.

Analyses were conducted separately for male and female students to evaluate the diagnostic test's effectiveness. Various statistical measures including minimum (min), mean, standard deviation, t-test score, and Pearson correlation were utilised to assess the diagnostic test's efficacy for the SM course. The minimum score represents the poorest performance of the diagnostic test and the SM course, indicating the least prepared students. The mean, an average of all students' scores, depicts the overall performance trend and compares the performance between the diagnostic test and final course results. The standard deviation measures the dispersion of results around the mean, indicating how uniformly students perform.

A paired t-test was employed to compare the diagnostic test's mean scores with the SM course's final grades, as illustrated in equation (1). In this equation, t represents the value of the paired t-test, (x - m) signifies the mean of the differences between paired observations (e.g., the diagnostic test result vs. the final grade for each student), and s denotes the standard deviation of these differences. N indicates the number of paired observations (students). This test is utilised to ascertain if the differences in mean scores hold statistical significance, determining if the diagnostic test reliably predicts student performance. A significant t-test outcome would suggest that the observed differences are not random, thus affirming the diagnostic test's validity as an assessment tool in education.

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$$ Equation (1)

The Pearson correlation coefficient was computed to evaluate the strength and direction of the relationship between the diagnostic test results and the final grades. A robust positive correlation coefficient would suggest that a higher score on the diagnostic test correlates with a better final grade, indicating the test's predictive accuracy. On the other hand, a weak or negative correlation coefficient would signify that the diagnostic test may not efficiently predict course performance. This analysis enables educators to scale the diagnostic test's efficacy and decide to enhance teaching strategies and student support in education.

Results and Discussion

The examination of both diagnostic test scores and final semester grades offers evidence of student performance progress in Course SM. Data in Table 2 display the diagnostic test results by showing the percentage of students achieving grades at the beginning of the semester. Subsequently, Table 3 demonstrates the distribution of final semester grades, which enables an evaluation of the intervention program's impact and student learning progression throughout the course.

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Table 2. Student's Diagnostic Test Achievement

DIAGNOSTIC TEST			
Grade	**Frequency**	**Percentage (%)**	**Cumulative Percentage (%)**
A	2	5.3	5.3
B	9	23.7	28.9
C	8	21.1	50.0
F	19	50.0	100.0
Total	38	100	

Table 3. Student's Course SM achievement

COURSE SM			
Grade	**Frequency**	**Percentage (%)**	**Cumulative Percentage (%)**
A	7	18	18
B	17	45	63
C	9	24	87
F	5	13	100
Total	38	100	

The evaluation of student performance in Course SM began with a comprehensive diagnostic test assessment in the first week of the semester. The test gauges students' initial grasp of the course material. The data from this diagnostic test offer an understanding of the strengths and weaknesses of the student, indicative of areas necessitating improvement. In response to the diagnostic test outcomes, the educators implemented a 14-week exercise enforcement program to identify weaknesses and student strengths. The impact of this intervention is evident in the Course SM results, showcasing a notable improvement in student performance.

The percentage of students achieving grade A revealed a significant increase from 5.3% in the diagnostic test to 18% by the end of the semester, indicating a notable improvement in academic proficiency. Additionally, the percentage of students attaining grade B rose from 23.7% to 45%, showcasing significant growth in understanding and applying course concepts. The increase in students scoring grade C from 21.1% to 24% further supported the positive influence of the exercise enforcement program on student learning outcomes. The decrease in the percentage of students receiving grade F, dropping from 50% to 13%, further strengthened the evidence of the intervention program's effectiveness. This successful exercise enforcement initiative has proven effective in addressing fundamental learning challenges, boosting student performance and fostering academic excellence.

Min, Mean, Standard Deviation, T-Test Value and Pearson Correlation Between Diagnostic Test and Course SM

The data in Table 4 present the students' performance in diagnostic tests and Course SM, providing valuable insights into the lecturer's involvement in improving student grades. The results demonstrate significant progress in academic achievement after implementing teaching strategies.

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Table 4. Min, Mean, Standard Deviation, T-Test Value and Pearson Correlation Between Diagnostic Test and Course SM

Descriptive Statistics					
	Min (%)	Mean (%)	Standard Deviation (%)	T-Test Value	Pearson Correlation (Sig. (2-tailed)
Diagnostic Test	10	50	21.97	0.00002	0.16
Course SM	40	65	12.18		

**Correlation is significant at the 0.01 level (2-tailed)

The diagnostic test results showed a minimum score of 10%, a mean score of 50%, and a standard deviation of 21.97%. On the contrary, Course SM exhibited significant developments with a minimum score of 40%, a mean score of 65%, and a standard deviation of 12.18%, demonstrating improvement in student performance. The t-test value of 0.00002 between the diagnostic test and Course SM indicates a statistically significant difference in performance levels, affirming the intervention's impact. This exceptionally low p-value suggests that the observed progress in Course SM is unlikely to be random, validating the effectiveness of the intervention.

Moreover, the Pearson correlation coefficient of 0.16 suggested a weak positive relationship between the two assessments. This weak positive correlation indicates a slight positive association between the diagnostic test and course outcomes, although not a strong one. The modest connection may be attributed to the 14-week intervention program following the diagnostic test, where the instructor personalised exercises, revisions, and support to address individual student weaknesses. Consequently, the diagnostic test may not strongly predict final grades, as the intervention program notably enhances student performance. This outcome implies that factors like the success of the intervention play a more substantial role in the results than the initial diagnostic test. These findings reinforce the effectiveness of the educator's intervention in fostering academic growth and highlight the significance of data-driven strategies in improving student learning outcomes and fostering student success in education.

Min, Mean, Standard Deviation, T-Test Value and Pearson Correlation Between Diagnostic Test and Course SM Based on Gender

The descriptive statistics in Table 5, detailing the performance of male and female participants in the diagnostic test and Course SM, provide insightful perspectives into their academic accomplishments of the semester after their involvement in the exercise enforcement program.

Table 5. Descriptive Statistics Based on Gender

Descriptive Statistics Based on Gender						
Gender	Result	Min (%)	Mean (%)	Standard Deviation (%)	T-Test Value	Pearson Correlation (Sig. (2-tailed)
Male	**Diagnostic Test**	10	44.5	23.6	0.009	0.27
	Course SM	40	62	12.98		
Female	**Diagnostic Test**	10	48.3	22.72	0.001	0.05
	Course SM	45	70.1	12.2		

**Correlation is significant at the 0.01 level (2-tailed)

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The diagnostic test results for male students displayed a minimum score of 10%, a mean score of 44.5%, and a standard deviation of 23.6%. In comparison, the Course SM performance for males showed improvement, with a minimum score of 40%, a mean score of 62%, and a standard deviation of 12.98%. The t-test value of 0.009 indicated a statistically significant difference between the diagnostic test and Course SM scores for male students. The Pearson correlation coefficient of 0.27 suggested a modest connection between the two assessments for this group.

Female students achieved a minimum diagnostic test score of 10%, an average score of 48.3%, and a standard deviation of 22.72%. Their overall performance in Course SM showed a remarkable improvement, with a minimum score of 45%, an average score of 70.1%, and a standard deviation of 12.2%. The t-test value of 0.001 indicated a significant difference between female students' diagnostic test scores and Course SM scores. Additionally, the Pearson correlation coefficient of 0.05 suggested a weak relationship between these assessments, meaning that the diagnostic test scores cannot accurately predict Course SM scores.

Separating data by gender enables tracking gender-specific trends, offering more profound insights into how different student groups respond to educational interventions. In this study, female students displayed higher mean scores and more consistent results, indicating superior academic achievement overall. This fact demonstrates that the intervention program may have been more effective for female students, possibly due to their responses to personalised exercises, feedback, or instructional methods.

The data disclosed that female students achieved lower standard deviations, indicating greater performance consistency than male students. The statistics proposed that female students may have improved successfully towards the intervention program, leading to better academic success. By analysing gender differences, instructors can refine their strategies to provide tailored support addressing male and female students' unique needs, ensuring equitable benefits from future interventions.

Evaluation of Student's Grade and Overall Performance

The data depicted in Figure 2 offer a detailed breakdown of the diagnostic test grades among all students, along with a comparison based on gender. In the overall student cohort, the outcomes revealed that merely 5.3% of the students attained an A grade, while a majority of 50% received an F, indicating a substantial necessity for intervention. This high failure rate underscores the deficiencies in foundational knowledge among students at the course's commencement, emphasising the significance of early assessment.

A similar distribution emerged with some notable distinctions after examining the gender-specific data. Among female students, 2.6% achieved an A, 10.5% secured a B, and 23.7% obtained an F. In contrast, male students had 13.2% scoring a B and a higher failure rate of 26.3%, yet a notably lower percentage of C grades (5.3% compared to 15.8% for females). The data suggested that while male students showed slight improvement at the top end of the grade spectrum, they encountered more challenges overall, as evidenced by their higher failure rate.

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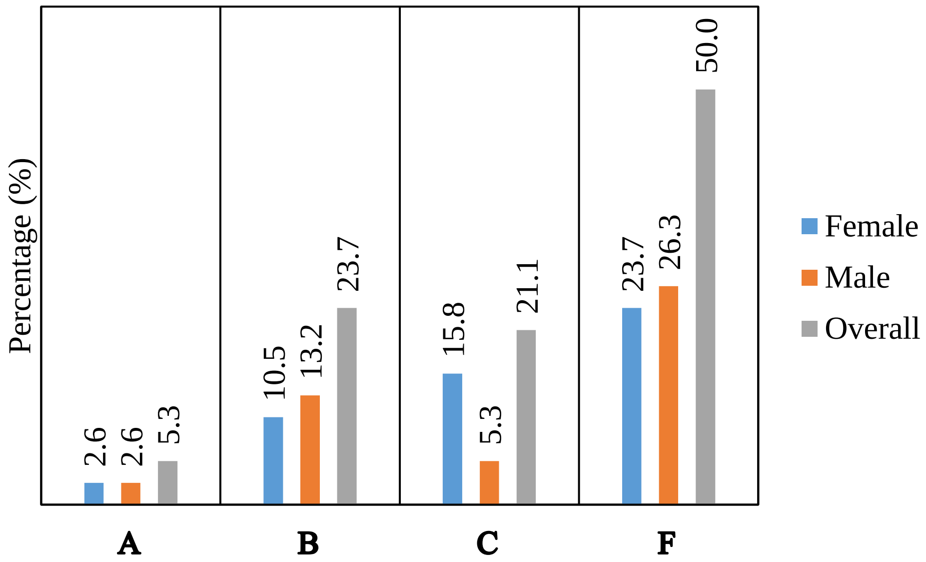

Figure 2: Diagnostic Test Grade by Gender and Overall Performance

A gender-specific breakdown of the grade distribution in Course SM is illustrated in Figure 3. This figure shifts focus to the final grades in Course SM, illustrating the impact of the intervention program over the semester. The data indicated significant improvement compared to the diagnostic test results, with 18.4% of students achieving an A grade and only 13.2% receiving an F. This substantial decrease in failure rates suggests that the interventions, including tailored exercises and ongoing support, effectively enhanced student performance.

When examined by gender, female students obtained a higher percentage of B grades (21.1%), although their share of A grades was slightly lower (13.2%) than the overall average. In contrast, male students had a lower percentage of A grades (5.3%) but a higher percentage of B grades (23.7%). Notably, the failure rate for males decreased to 7.9%, indicating that the intervention mitigated the academic challenges faced by male students, even though their top-end performance did not improve as significantly as that of females.

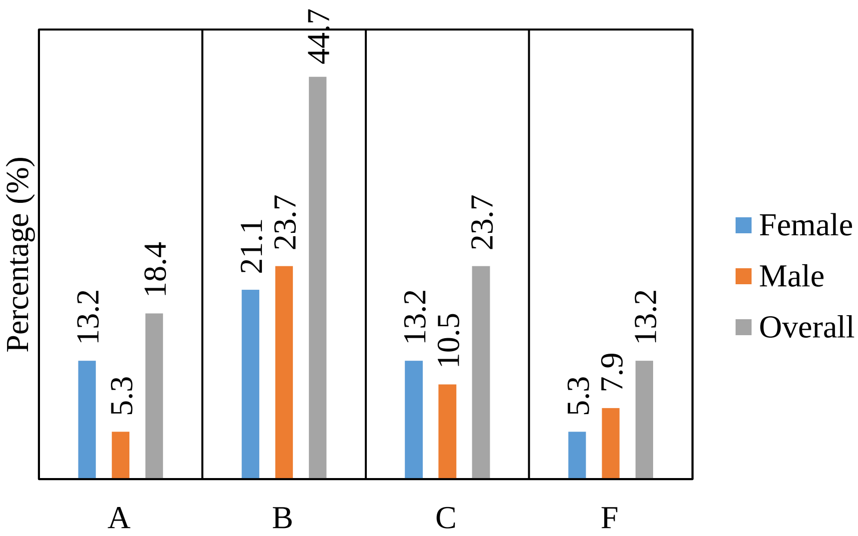

Figure 3: Course SM Grade by Gender and Overall Performance

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On the other hand, Figure 4 delves into student performance trends throughout the semester, assessing whether students progressed, maintained, or regressed in their academic performance. Overall, 78.95% of students exhibited a performance improvement reflecting the overall effectiveness of the intervention. Female students displayed a 75% improvement rate, while male students slightly surpassed them with an 83.3% improvement rate. However, the higher improvement rate among male students must be viewed by considering their lower initial performance in the diagnostic test, indicating that many male students have more room for enhancement.

This trend is further emphasised by the lower decrease rate of 16.67% for male students compared to 20% for females, suggesting that while male students show progress, they are also prone to performance fluctuations. Moreover, while 5% of female students maintained their performance level from the diagnostic test to the final grades, no male students achieved this, indicating that female students exhibited more consistent performance throughout the course.

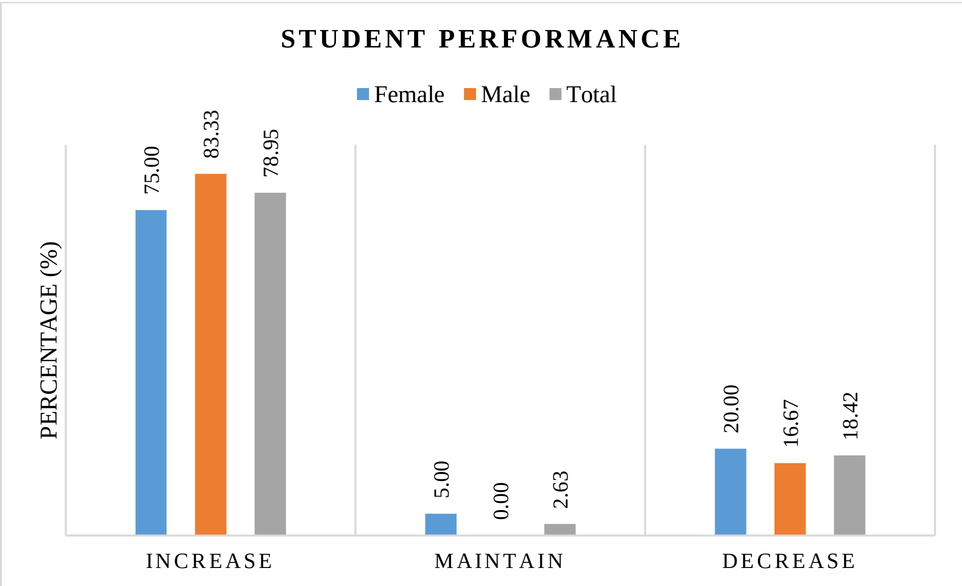

Figure 4: Student Performance Trend

The data revealed gender-specific trends in academic performance, with male students displaying more variability in their improvements that declined. Conversely, female students showed slightly lesser top-end improvements but demonstrated more consistency in maintaining or gradually enhancing their performance. The statistics showed that 2.63% of all students sustained their performance across both assessments, indicating the importance of consistent support and targeted interventions in stabilising student outcomes.

Percentage Change Between Diagnostic Test and Course SM

The box and whisker plot in Figure 5 displays a wide range of percentage changes between the diagnostic test and Course SM grades for all students. The data revealed significant variability, with the maximum percentage change reaching 302% and the minimum dropping to -50%. This diversity underscores the varied student improvement levels of post-intervention. The median percentage change of 45% serves as the midpoint, indicating that half of the students achieved changes above this value. The upper quartile (75th percentile) at 125% and the lower quartile (25th percentile) at 7% further demonstrate this variability, showing that 25% of

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students improved by over 125%, while another 25% improved by less than 7% or experienced a decline. The mean percentage change of 112% suggested that, on average, students doubled their performance, stressing the overall effectiveness of the intervention.

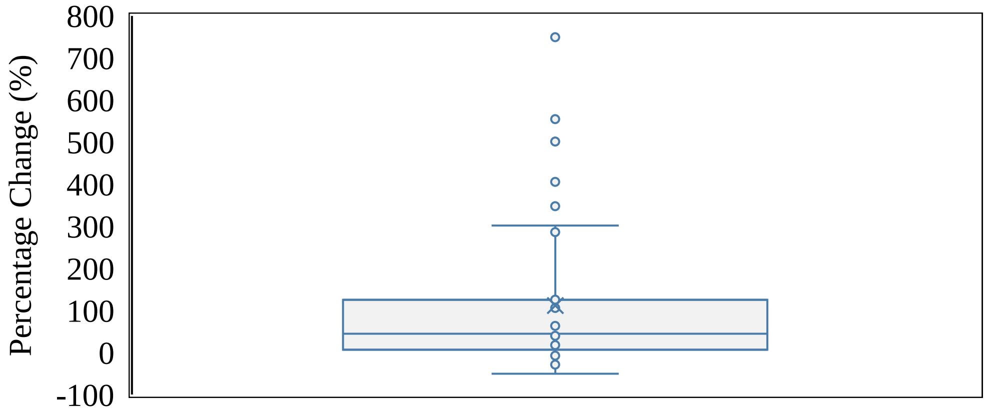

Figure 5: Percentage Change between Diagnostic Test and Student Performance (Overall)

The analysis of female student's performance is presented in Figure 6. The maximum percentage change for females is 125%, while the minimum is -28%. Remarkably, the mean percentage change for females stood significantly higher at 129%, indicating on average, female students exhibited more substantial performance improvements than their male counterparts. The median percentage change of 42% showed that at least half of the female students improved by this amount, with the upper quartile (113%) showcasing a notable increase in grades for the top 25% of female students. Conversely, the lower quartile at 2% suggested that some female students experienced minor improvements or slight declines. This trend explains that, on average, female students responded more positively to the intervention program, displaying more significant improvements between the diagnostic test and final grades.

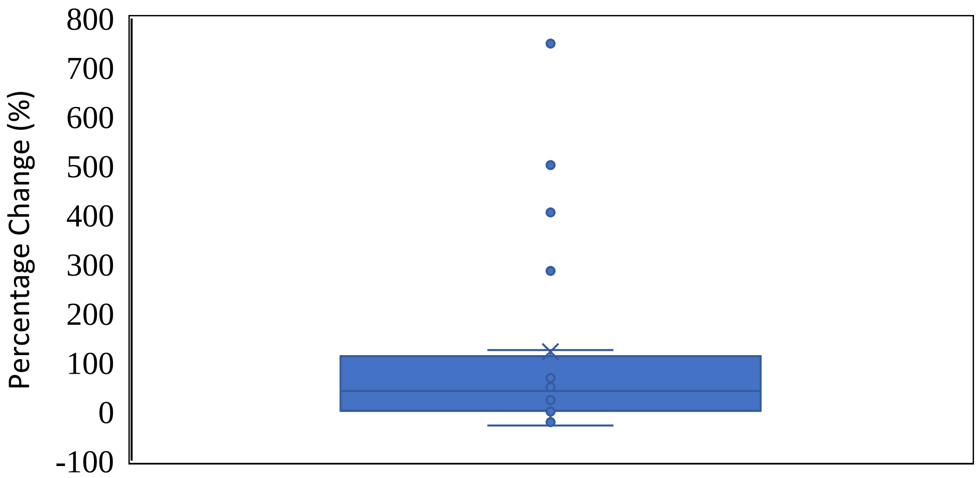

Figure 6: Percentage Change between Diagnostic Test and Student Performance (Female)

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In Figure 7, male students' performance revealed a distinct pattern. The maximum percentage change aligned with that of females at 128%, yet the minimum change is notably lower at -50%, indicating that some male students encountered significant declines. The mean percentage change for males, at 59%, is considerably lower than for females, implying that male students, on average, did not benefit as much from the intervention program. The median percentage change of 47% indicated that half of the male students achieved changes surpassing this value, with the upper quartile (126%) suggesting that the top 25% of male students performed similarly to their female counterparts. Nevertheless, the lower quartile at 14% reflected more significant variability in the improvements among male students, with some showing minimal progress.

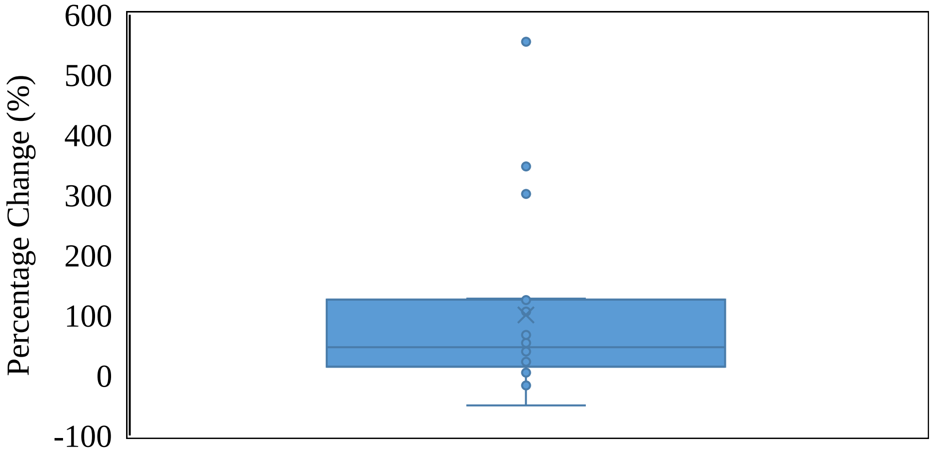

Figure 7: Percentage Change between Diagnostic Test and Student Performance (Male)

The comparison of Figures 5, 6, and 7 reveals critical differences on how male and female students responded to the educational intervention. Female students, on average, displayed a significantly higher mean percentage change of 129%, contrasting with 59% for male students. This discrepancy suggests that female students underwent a more pronounced shift in their academic performance between the diagnostic test and Course SM grades. Moreover, while both genders displayed a range of improvements, the consistency in female performance, lower variability and higher mean changes indicated better adaptation to intervention strategies.

These results underline the importance of considering gender-specific trends when assessing academic performances. The progressions observed imply that the intervention program is more effective for female students, potentially due to varying engagement levels with the exercise program. In contrast, the diverse outcomes among male students suggest they might benefit from additional or alternative forms of support to achieve similar progress. This analysis offers a comprehensive interpretation of the intervention program's impact and valuable insights into areas for further enhancement for male students.

Analysing the Relationship Between Diagnostic Test and Course SM

The relationship between diagnostic test scores and final Course SM grades is analysed in Figures 8 to 10 with separate regression analyses for the overall student population and female and male students. In the overall course, the regression equation $y = 0.0894x + 58.646$ depicts a weak linear relationship, indicating that each unit increase in the diagnostic test score (x) corresponds to a 0.0894 unit increase in the final Course SM grade (y). Nonetheless, the R-

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squared value of 0.0254 reveals that only 2.54% of the variability in final grades can be elucidated by diagnostic test scores. This low R-squared value suggests that numerous other factors beyond diagnostic test results influence student performance in the course.

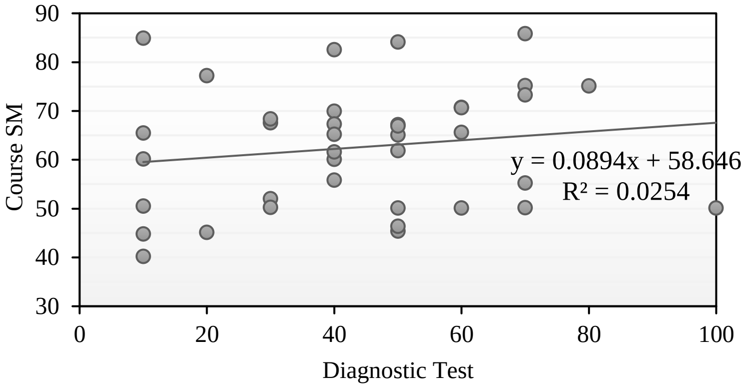

Figure 8: Relationship Between Course SM and Diagnostic Test Performance (Overall)

When broken down by gender in Figures 9 and 10, the correlation becomes even weaker. For female students, the regression equation y = 0.0256x + 61.993 produces an R-squared value of 0.002, indicating that only 0.2% of the variability in final grades can be attributed to diagnostic test scores. Similarly, the regression equation y = 0.149x + 55.362 for male students yields an R-squared value of 0.00733, explaining merely 0.73% of the variance in final grades. These low R-squared values underscore the limited predictive capacity of the diagnostic test in forecasting final academic outcomes for both male and female students.

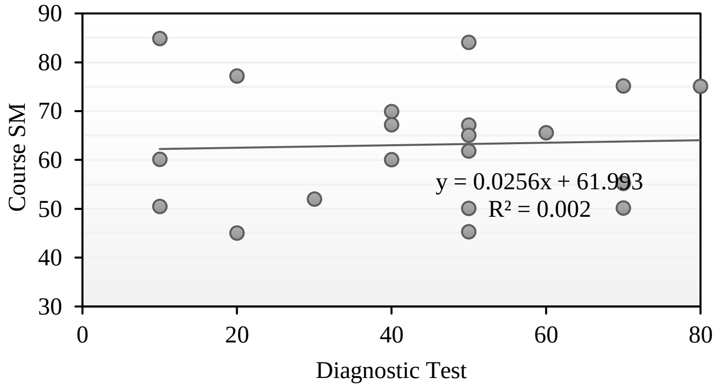

Figure 9: Relationship Between Course SM and Diagnostic Test Performance (Female)

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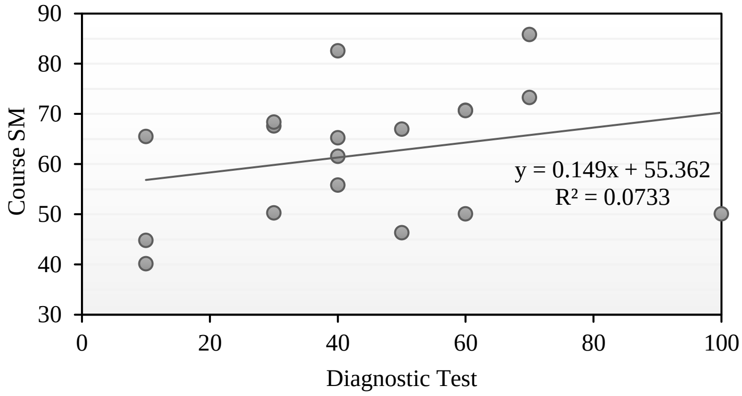

Figure 10: Relationship Between Course SM and Diagnostic Test Performance (Male)

The analysis reveals a weaker-than-expected correlation between diagnostic tests and academic performance, which may be attributed to various external factors, including the 14-week exercise intervention program implemented after the diagnostic tests. This program assisted and supported students, helping those struggling to improve their final grades. Furthermore, individual learning styles and motivation levels also play a significant role. Students whose learning preferences align with the intervention methods, such as hands-on practice and frequent feedback, tend to perform better.

Conversely, students facing external challenges such as low motivation, family responsibilities, or work commitments may need to be fully engaged, leading to consistent academic outcomes. These factors are likely found to influence and reduce the direct impact of diagnostic test scores on overall course scores.

The weak correlation between diagnostic test scores and final grades suggests no significant relationship between the diagnostic test and students' final grades. A more detailed analysis using advanced statistical methods could further explain these dynamics. By considering factors like gender and initial skill levels, researchers could see how different groups responded to the intervention.

Conclusion

This study demonstrates a positive increase in academic performance, with more students achieving A grades and fewer receiving F grades. Generally, female students perform better than their male counterparts. However, the low R-squared value of the model suggests that diagnostic test scores alone cannot accurately predict final grades, whereas other factors such as continuous effort, practice exercises, and hands-on activities implemented intensively may influence student academic success.

Diagnostic tests have proven effective in identifying student strengths and weaknesses. The success of structured interventions, such as weekly engineering exercises, suggests the potential for similar approaches to improve performance in other courses that address students' diverse backgrounds and abilities. Future research should explore the effectiveness of these interventions in greater depth and across various academic disciplines to help enhance student and university success. This study offers valuable insights for improving academic programs and student outcomes in different educational fields.

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