A Multivariate Analysis of Factors Influencing Postgraduate CGPA- Experience from a Developing Country

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Abstract

Understanding what drives postgraduate academic performance is important for improving admissions and supporting students. This study analyzed data from 110 students enrolled in civil and construction engineering master's programs at a public university. Four factors were examined gender, number of semesters to complete the degree, entry test scores, and undergraduate percentage marks. Data was processed using Microsoft Excel and RStudio, and analyzed through Welch's t-test, one-way ANOVA with Tukey's post-hoc test, and correlation methods. Results showed no significant difference in CGPA between male and female students (female: 3.405, male: 3.342; $p = 0.334$). However, program duration was significantly associated with performance. Students who completed their degrees in four semesters had significantly higher CGPAs than those taking seven semesters (mean difference = 0.486, $p = 0.039$). Entry test scores showed no meaningful relationship with postgraduate CGPA ($\rho = 0.042$, $p = 0.667$). In contrast, undergraduate percentage marks had a small but positive correlation with postgraduate CGPA ($r = 0.287$, $p = 0.002$). These findings suggest that timely completion and prior academic performance are better indicators of postgraduate success than entry test results. Universities can use this information to refine admissions criteria and provide early support to students who are at risk of taking longer to complete their programs.

Keywords: Postgraduate CGPA, Time-to-degree, Entry test score, Undergraduate performance, Engineering education

1. Introduction

Postgraduate academic performance is a key indicator of institutional quality and student success (Alexan & El-Damak, 2025). Understanding what influences postgraduate cumulative grade point average (PG CGPA) helps universities refine admissions processes, target student support, and improve program delivery. Prior research has examined a range of predictors, including gender (El Tantawi, 2009), prior academic records (Beneke & Beeming, 2011), admissions tests (Garwood, 2002), and institutional factors such as program duration (Ruete et al., 2021).

However, most of this evidence comes from Western countries and doctoral programs (Graham & Kim, 2011), where standardized exams like the GRE and well-resourced learning environments are common. In developing-country public universities, especially in civil and construction engineering master's programs, conditions are different. Students enter from diverse undergraduate institutions (Maphosa, 2014), face resource constraints, and are assessed using locally designed entrance exams. These differences raise questions about whether international findings hold in these contexts. This study addresses this gap by examining four potential predictors of PG CGPA: gender, the number of semesters required to complete the program, entrance exam scores, and undergraduate academic performance.

2. Literature Review

Gender differences in academic outcomes have been studied extensively (Voyer & Voyer, 2014). A meta-analysis of 1.6 million students found that females slightly outperformed males overall, with smaller gaps in STEM disciplines. At the postgraduate level, U.S. studies report little to no GPA difference once students are admitted (Ari et al., 2010). In contrast, regional studies from Asia and the Middle East suggest that local cultural and institutional factors can shape gender-related performance dynamics (Ilham, 2025). These mixed results highlight the need for localized investigation.

Program duration has also been linked to outcomes (Shaw et al., 2013). While doctoral studies show weak links between time-to-degree and GPA, research from African universities indicates that delays often stem from structural barriers such as limited resources or course scheduling, which can negatively impact final CGPA (Nkedishu et al., 2025). Entrance exams are widely used for admissions, but their predictive value varies. In Western contexts, standardized tests like the GRE show modest correlations with graduate GPA (Feldon et al., 2024). In developing countries, locally designed exams tend to predict performance less strongly, with undergraduate records often proving more reliable (Silva et al., 2020). Among all predictors, undergraduate academic performance is consistently the strongest (Kreiter & Kreiter, 2007). Studies across both developed and developing regions show that higher undergraduate grades are associated with stronger postgraduate outcomes (Darolia et al., 2014). However, where feeder institutions vary widely in quality and grading practices, this relationship may weaken (Barnes & Buring, 2012).

While these studies provide valuable insights, few focus on master's-level civil and construction engineering programs in developing-country public universities. This study addresses this gap by testing whether these four predictors gender, semesters to completion, entrance exam scores, and undergraduate percentage are associated with PG CGPA in a local context. Findings will inform admissions and program improvement efforts in similar institutions.

3. Scope and Objectives

The scope of the study can be ascertained with respect to the source of the data, the variables considered and the quantity of the data points. The data was acquired for a cohort of students from 2010-11 intake at a public sector engineering university from a developing country. The students were admitted to various post graduate disciplines specializing in Civil Engineering and Construction Management. After cleaning and consolidating the data, the final data count was 110 students. The study was able to acquire the following data undergraduate percentage (self-reported and verified), entrance test score, number of semesters taken by the student to complete the program, and post graduate cumulative grade point average at the completion of the program.

The study was undertaken with the following four objectives.

i. Objective 1: To investigate whether there is a significant difference between the postgraduate cumulative grade point average (PG CGPA) of male students and that of female students.
ii. Objective 2: To assess whether there is a substantial difference in the postgraduate cumulative grade point average (PG CGPA) depending on the number of semesters necessary to complete the program.
iii. Objective 3: To investigate the link between scores on entry exams and the cumulative grade point average of graduate students (PG CGPA).
iv. Objective 4: To assess the correlation between the cumulative grade point average of postgraduate students (PG CGPA) and the academic percentage of undergraduate students.

4. Research Methodology and Data Analysis Framework

This study analyzed five main variables: undergraduate percentage, entrance test scores, number of semesters to complete the program, gender of the applicant, and postgraduate CGPA. After cleaning and consolidating the data, it was processed using Microsoft Excel and RStudio for analysis.

Descriptive statistics and distribution plots were generated first. A t-test with Cohen's effect size was used to compare gender differences in CGPA. ANOVA with Tukey's HSD test examined CGPA differences based on program duration. Spearman's correlation assessed the relationship between entry test scores and CGPA, while Pearson's correlation measured the link between undergraduate percentage and CGPA.

The overall process, from data collection to analysis and interpretation, is shown in Figure 1.

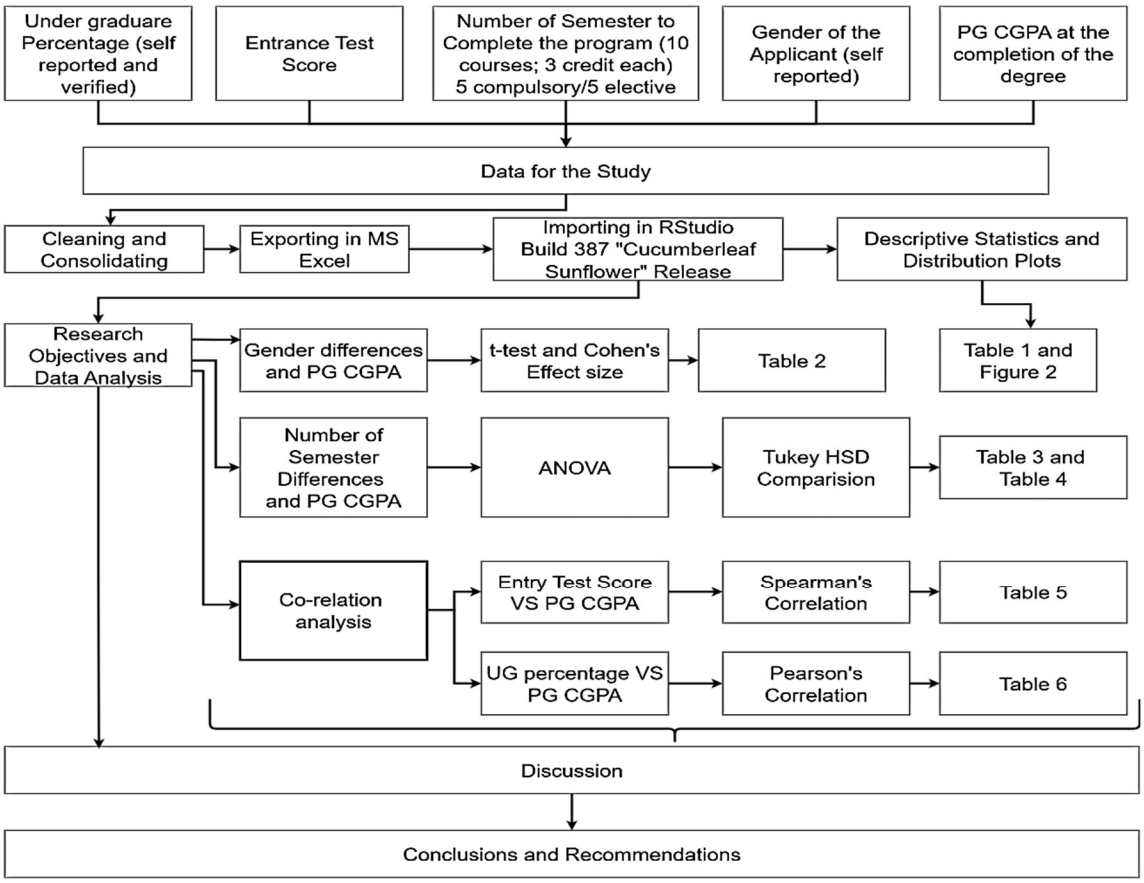

Figure 1: Study Methodology

The comprehensive analytical methodology that was used in this study to investigate the links between postgraduate academic performance and a variety of demographic and academic characteristics is presented in Figure 1.

4.1.1 Collection and Preparation of Data

The study made use of five main factors that were obtained from student records. These variables were the gender of the applicants (self-reported), the entrance exam scores, the number of semesters that were necessary for the completion of the program, the percentage of students who were undergraduates (verified and self-reported), and the postgraduate CGPA at the time of degree completion. After the data gathering procedure was completed, a systematic cleaning and consolidation process was followed. The data was then exported to Microsoft Excel for preliminary analysis. Following that, it was imported into RStudio Build 397 "Cucumber Leaf Sunflower" Release for extensive statistical analysis.

4.1.2 Analytical Approach

Four separate investigative streams were used in the research, and these were organized into a multi-faceted analytical technique.

- **Stream 1:** Gender Analysis investigated the differences in postgraduate CGPA between male and female students using independent samples t-tests and Cohen's effect size estimates. The findings of this investigation were provided in Table 2, along with descriptive statistics and distribution graphs (Table 1, Figure 2).
- **Stream 2:** Temporal Analysis examined the connection between the duration of time it takes to complete a program (measured by the number of semesters) and academic achievement. This was done through the use

of one-way ANOVA, which was then followed by Tukey HSD post-hoc tests in order to determine the precise differences that existed between groups (Tables 3 and 4).

- **Stream 3:** Correlation Analysis investigated two key relationships using both parametric and non-parametric approaches: (a) the association between entrance test scores and postgraduate CGPA using Spearman's rank correlation (Table 5), and (b) the relationship between undergraduate percentage and postgraduate CGPA using Pearson's product-moment correlation (Table 6).

This methodical approach guaranteed that a thorough investigation of potential determinants of academic achievement in postgraduate studies was conducted, all while upholding methodological rigor by using statistical tests that were appropriate for the various distributions and types of variables.

4.2 Data Analysis and Discussion

4.2.1 Descriptive Statistics of the Data

Table 1 summarizes the descriptive statistics for the data.

Table 1: Descriptive Statistics of the Data

Gender	n	Mean UG%	SD UG%	Mean Test Score	SD Test Score	Mean PG CGPA	SD PG CGPA
F	23	76.395	6.232	55.043	9.344	3.405	0.270
M	87	72.563	7.258	54.448	7.966	3.342	0.282

These statistics show slight but constant gender patterns across academic variables. Female students, despite accounting for only 21% of the sample (n=23), outperformed their male counterparts (n=87) on all academic indicators. Female students had higher mean undergraduate percentages (76.40% vs. 72.56%), indicating better pre-entry academic credentials. This 3.8 percentage point difference, albeit significant, was accompanied by decreased variability among females (SD = 6.23 vs. 7.26), indicating more consistent undergraduate performance in the female group.

Gender variations in test scores were minor, with females scoring slightly higher (55.04 vs. 54.45), although this 0.6-point difference is practically insignificant. Interestingly, females demonstrated larger diversity in test performance (SD = 9.34 vs. 7.97), implying more different test-taking outcomes while having more uniform undergraduate grades. This pattern reverses the variability trend seen in undergraduate performance, possibly showing differing test response patterns between genders.

Females retained their performance edge at the postgraduate level, with a higher mean CGPA (3.405 vs. 3.342), despite a 0.063-point difference that accounts for less than 2% of the scale range. Both groups demonstrated very similar variability in postgraduate performance (SD = 0.270 vs. 0.282), implying that once enrolled, students confront comparable academic hurdles regardless of gender. The pronounced gender imbalance in enrollment (79% male) raises serious concerns about recruitment, selection processes, and systemic factors influencing female participation in postgraduate education, especially since female students who do enroll tend to perform slightly better across all measured outcomes.

Figure 2 presents the distribution of various elements in the dataset.

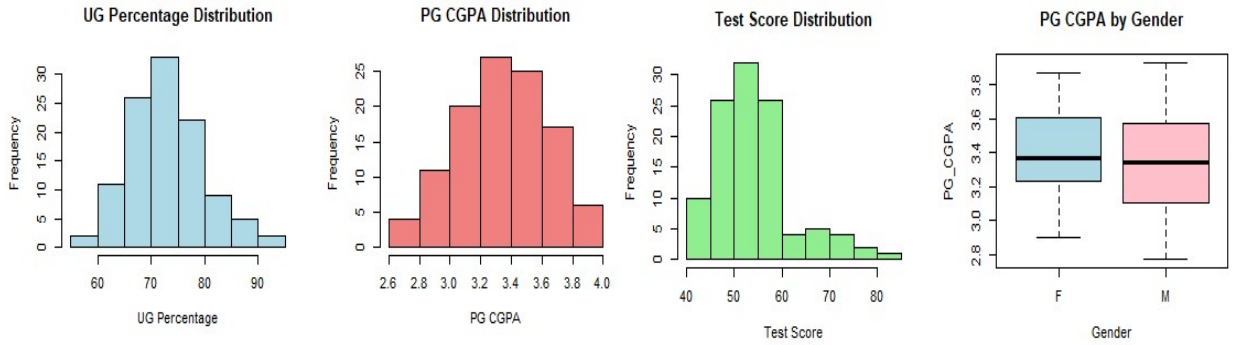

Figure 2: Distribution Plots of the Study Data

The distributional analysis of study factors indicates significant patterns in the academic profiles of postgraduate students. The undergraduate percentage distribution is roughly normal, concentrated around 70-75%, indicating a generally homogeneous cohort of students with strong undergraduate academic foundations. The minor negative skew suggests that there are more students in the upper-middle performance range than at the extremes. Similarly, the PG CGPA distribution is nearly normal, with a central tendency of 3.2-3.4, indicating that the majority of students achieve satisfactory to good postgraduate performance, with a moderate spread across the performance spectrum.

The test score distribution, on the other hand, has a distinct pattern with substantial negative skew and probable bimodality. The concentration of scores in the 50-60 range, followed by a precipitous decrease, suggests either a ceiling effect in the test instrument or a threshold-based selection process, calling into doubt the entrance examination's discriminative validity. This compressed distribution may help to explain the lack of correlation between test results and PG CGPA, as limiting variability reduces the opportunity for meaningful relationships.

The gender comparison boxplot shows striking similarities in the PG CGPA distributions of female and male students, with virtually equal medians and overlapping interquartile ranges. The comparable spread and central tendencies visually confirm the non-significant gender differences discovered after inferential testing. Both groups exhibit similar variability, with a few outliers in the lower performance range, indicating that academic obstacles affect both genders similarly. This visual evidence underscores the fact that gender variations in postgraduate academic performance are minor, supporting institutional strategies that prioritize talent over demographics in academic support and resource allocation.

5. Result Analysis and Discussion

5.1 Gender Differences and PG CGPA

Table 2 presents the results of t-test which was conducted to evaluate if post graduate cumulative grade point average (PG CGPA) differs by gender.

Table 2: t-test for Gender Differences and PG CGPA

estimate	estimate1	estimate2	statistic	p.value	parameter
0.0625	3.405	3.342	0.979	0.334	35.76
conf.low	**conf.high**	**method**	**alternative**		
-0.067	0.192	Welch Two Sample t-test	Two sided		

The study of gender disparities in postgraduate academic performance found a tiny, non-significant influence. Female students had slightly higher mean PG CGPA scores (M = 3.405) than male students (M = 3.342), but the difference was not statistically significant ($t(35.76) = 0.979$, $p = 0.334$). The effect size analysis produced a Cohen's d of -0.224, indicating a minor practical difference of around 0.224 standard deviations across groups. This effect size, which is just slightly above Cohen's threshold for a small impact ($d = 0.2$), indicates that while females perform slightly better academically on average, the difference is neither statistically reliable nor practically significant. In practice, Cohen's

d of -0.224 equates to about a 56% chance that a randomly picked female student will have a higher PG CGPA than a randomly selected male student, only slightly better than chance. These data suggest that gender is not a significant predictor of postgraduate academic achievement in this cohort, with observed variations likely due to sampling variation rather than systematic gender-based performance discrepancies.

5.2. Number of Semesters Differences and PG CGPA

5.2.1. ANOVA Test if PG CGPA differs by Number of Semesters

Table 3 presents the ANOVA results which was carried out to test if post graduate cumulative grade point average (PG CGPA) was statistically significant across various number of semesters to complete the program.

Table 3: ANOVA for PG CGPA differs by Number of Semesters

term	df	Sum sq	Mean sq	statistic	p.value
Number of Semesters	4	0.886	0.222	3.06	0.020
Residuals	105	7.603	0.072		

The association between program duration and academic achievement showed statistically significant differences ($F(4,105) = 3.06$, $p = .020$). Students who completed their programs over differing semester durations had diverse PG CGPA results, implying that the rate of program completion is a useful indication of academic accomplishment. This finding has significant implications for interpreting student achievement trends. The large diversity across semester groups suggests that program duration is more than just an administrative variable; it also reflects fundamental disparities in student participation, learning methodologies, and institutional support systems. Students who move through their programs at varying rates; accelerated, standard, or extended, have significantly diverse academic achievements.

However, the small impact size requires careful interpretation. While statistically significant, the number of semesters accounts for around 10% of the variance in PG CGPA, implying that program duration is one of several factors influencing academic achievement. This shows that, while temporal progression through the curriculum is important, other variables such as prior academic preparation, engagement quality, or individual circumstances have a significant impact on eventual academic attainment. For institutional policymakers, these data suggest that "one-size-fits-all" approaches to program duration may not enhance student outcomes. Understanding which program durations correlate with optimal performance could help institutions develop academic advising strategies and support interventions, potentially identifying students who would benefit from adjusted academic pacing or additional support services based on their progression timeline.

5.2.2. Tukey HSD Comparison Results

Table 4 presents Tukey HSD comparison between different semesters. It offered some key findings as follows.

Table 4: Tukey HSD Comparison Results

Semester Comparison	diff	lwr	upr	p adj	Significance
4-3	0.172	-0.246	0.589	0.784	Not Significant
5-3	0.032	-0.351	0.415	0.999	Not Significant
6-3	-0.107	-0.543	0.330	0.961	Not Significant
7-3	-0.314	-0.885	0.256	0.546	Not Significant
5-4	-0.140	-0.345	0.066	0.329	Not Significant
6-4	-0.279	-0.571	0.014	0.070	**
7-4	-0.486	-0.956	-0.016	0.039	*
6-5	-0.139	-0.380	0.102	0.503	Not Significant
7-5	-0.346	-0.786	0.094	0.193	Not Significant

7-6	-0.208	-0.694	0.279	0.760	Not Significant

**Marginally Significant Difference * Statistically Significant Difference

- A statistically significant difference was observed between 7 and 4 semesters (p = 0.039). Students who completed four semesters had a 0.486 point better PG CGPA than those who completed seven semesters. This is a significant difference, representing nearly half a grade point and providing convincing proof that faster completion correlates with greater academic success.
- A marginally significant difference appeared between 6 and 4 semesters (p = 0.070). Despite not achieving conventional significance, 4-semester students scored 0.279 points higher than 6-semester students, indicating a relevant pattern.
- If we notice the pattern, then 4 semesters outperform the reference group in terms of positive differences (diff column). The performance drops gradually with increasing duration, i.e. 5 semesters: -0.140 versus 4 semesters; 6 semesters: -0.279 against 4 semesters; 7 semesters: -0.486 vs 4 semesters (significant).

The findings show a clear adverse link between program duration and academic attainment.

- Students who complete their program most efficiently (4 semesters) surpass those who need more time (7 semesters). Although only statistically significant at extremes, the fall in performance with each semester shows that high-performing students' complete programs faster and receive higher grades.
- Extended duration may imply academic difficulties, course failures, or external challenges.
- The difference becomes significant (>0.25 points) when comparing 4 to 6+ semesters.

For institutional policymakers, these findings imply that students who are on pace for extended completion times should be identified early, as they are at risk of inferior academic accomplishment and could benefit from focused support interventions.

5.3. Spearman's rank Correlation Test Between Entry Test Score and Post Graduate CGPA

Table 5 presents the summary of Spearman's rank correlation test results for entry test scores and postgraduate CGPA.

Table 5: Spearman's rank Correlation Results

estimate	statistic	p.value	method	alternative
0.042	212605.6	0.667	Spearman's rank correlation rho	two.sided

The Spearman's rank correlation analysis of the relationship between entry test scores and postgraduate CGPA revealed a low and non-significant association ($\rho = 0.042$, $p = 0.667$). This correlation coefficient, which is nearly identical to zero, implies that there is no significant monotonic link between students' entrance test performance and future postgraduate academic achievement. The high p-value of 0.667 gives no statistical evidence to reject the null hypothesis of zero correlation, implying that the observed weak correlation might be easily explained by random chance. This research has significant consequences for admissions processes since it shows that test scores, which are commonly employed as screening criteria for postgraduate programs, have no predictive validity for academic achievement at the postgraduate level in this cohort. The lack of even a small association shows that the abilities or knowledge measured by the test do not translate into postgraduate academic performance, calling into doubt the efficacy of such standardized assessments in forecasting student success. This lack of correlation between test results and PG CGPA highlights the complex, varied nature of postgraduate academic accomplishment, which appears to be influenced by factors other than those reflected by standardized entry examinations. These findings show that relying heavily on test scores for admissions decisions may be unjustified, as they fail to identify students who will flourish in postgraduate courses.

5.4 Pearson's Product-Moment Correlation Between Undergraduate Percentage and Postgraduate CGPA

Table 6 provides a summary of Pearson's Product-Moment Correlation Test for testing the relationship between undergraduate percentage and postgraduate CGPA.

Table 6: Pearson's Product-Moment Correlation Test

estimate	statistic	p. value	parameter	conf. low	conf. high
0.287	3.109	0.002	108	0.105	0.450

method	alternative
Pearson's product-moment correlation	Two sided

The Pearson correlation analysis demonstrated a statistically significant positive relationship between undergraduate percentage and postgraduate CGPA ($r = 0.287$, $t(108) = 3.109$, $p = 0.002$, 95% confidence interval [0.105, 0.450]). The correlation coefficient of 0.287 indicates a weak-to-moderate positive relationship, implying that stronger undergraduate academic achievement is linked to better postgraduate outcomes. The test statistic of 3.109 with 108 degrees of freedom gives strong evidence against the null hypothesis of no association, with a p-value of 0.002 indicating a less than 0.2% possibility that this link occurred by coincidence. The confidence interval, which ranges from 0.105 to 0.450 and is totally above zero, demonstrates the association's positive direction as well as its statistical reliability. Although statistically significant, undergraduate performance only accounts for 8.2% of postgraduate CGPA variance ($R^2 = 0.082$). This conclusion shows that, while undergraduate academic achievement is a statistically reliable predictor of postgraduate success, its predictive ability is limited, with the bulk of variation in postgraduate performance due to factors other than prior academic achievement. The findings support the use of undergraduate percentage as a meaningful but not dominating criterion in postgraduate admissions, emphasizing the need of taking into account many characteristics when assessing individuals' chances for postgraduate academic achievement.

Conclusions and Recommendations

For policymakers in higher education, these findings suggest that student success may not be fully achieved if all programs are kept to the same fixed length. A rigid, “one-size-fits-all” structure assumes that every student can progress at the same pace, but in reality, students come with different strengths, learning styles, and personal challenges. Some may need more time and guidance, while others may be able to move faster if given the chance.

Understanding which program durations are linked to the best academic outcomes can help institutions design more flexible policies. This knowledge makes it easier to identify students who might benefit from an adjusted academic pace or from additional support services, such as mentoring, counseling, or tailored study plans. It can also guide academic advising and help universities plan resources more effectively.

These results further highlight the importance of identifying at-risk students early in their academic journey. Students who are likely to take longer to complete their programs often face greater academic struggles and are more likely to achieve lower overall performance. By recognizing these students in the early stages, institutions can step in with targeted support and interventions. This proactive approach not only helps individual students succeed but also strengthens the overall quality and effectiveness of the academic programs.

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