IMPACT OF MATHEMATICS SELF-EFFICACY ON STUDENTS' ACADEMIC ACHIEVEMENT IN UNDERGRADUATE CLASSES: A STUDY OF BALOCHISTAN, PAKISTAN

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Abstract

This study investigates the impact of mathematical self-efficacy on undergraduate students' overall mathematics grade point averages as a measure of academic achievement. This research did not examine the link between students' math apprehension, the independent variable, and their academic achievement, the dependent variable. Out of 10000 students, the study sample includes 640 individuals, 320 men and 320 females, from different postgraduate institutions in Balochistan. First, the investigators assessed students' overall mathematical grade norms based on the final report cards provided by the administrations. The researchers then applied a current five-point Likert survey form to self-test math self-efficacy as a study tool. The researchers used a quantitative method to run a multiple regression model to examine the relationship between students' overall mathematical grade point averages and math self-efficacy. The research stated that confidence greatly influenced the aggregate mathematics score averages of the study's undergraduate students. The researchers advised that instructors detect if math self-efficacy boosts students' academic performance and implement a student-centered strategy that promotes kids' intellectual development and accomplishments regarding self-efficacy. In addition, future studies should evaluate the influence of math self-efficacy in primary and intermediate math courses and identify the arithmetic chapters that suppress students' self-efficacy.

Keywords: Mathematics Self-Efficacy, Academic Achievement, Grade Point Average, Undergraduate Students, Multiple Regression Model.

1. INTRODUCTION

1.1 Background of the Study

Mathematics self-efficacy pertains to an individual's conviction in their capacity to comprehend, acquire knowledge, and execute mathematical assignments or undertakings. The idea in question is frequently linked to Albert Bandura's theory of self-efficacy, which underscores the significance of self-confidence

in an individual's capacity to successfully complete particular activities. Mathematics self-efficacy refers to an individual's own conviction in their capacity to effectively engage in mathematics-related activities, solve problems, and achieve desired mathematical outcomes (Pajares & Miller, 1994). Mathematics self-efficacy pertains to an individual's level of assurance in their capacity to participate in mathematical tasks, including arithmetic, algebra, geometry, and other complex mathematical principles (Usher & Pajares, 2008). Betz and Hackett (1983) propose that mathematics self-efficacy refers to an individual's subjective assessment of their ability to comprehend and excel in mathematical pursuits. This impression is shaped by previous encounters, cognitive aptitudes, and beliefs relevant to mathematical tasks.

1.2 Theoretical Framework

The education, psychology, and neuroscience ideas that have evolved now provide a solid explanation for mathematics self-efficacy. New hypotheses are investigated as our understanding of this subject expands. Zimmerman's Self-Regulated Learning (SRL) Theory (2000) and Self-Efficacy, as well as Social Cognition Theory, have lately been applied to studies on mathematics self-efficacy. Confidence in one's capacity for success was the cornerstone of Albert Bandura's Social Cognitive Theory. According to Bandura, self-efficacy beliefs are a person's expectations that they can complete the tasks necessary to achieve a goal. According to Bandura (1993), self-efficacy contributes to cognitive growth and functioning. Students' belief in their learning agency and academic competence sets the tone for their goals, motivation, and achievement in school. According to Bandura's theory of self-efficacy, mathematical self-efficacy is a person's belief in their ability to create and use efficient mathematical methods. According to Hackett and Betz (1982), there was only a minimal to moderate link between math self-efficacy and test results. The relationship between math self-efficacy and performance is weaker than the relationship between math self-efficacy and other measures of arithmetic performance, as we have found.

1.3 Research Question

What is the impact of mathematics self-efficacy on undergraduate students' academic achievement, as indicated by their overall mathematical grade point averages?

1.4 Research Hypothesis

The following hypotheses were formulated:

H_1. Maths Self-efficacy has significant effect on students’ academic achievement.

H_{1a}. Confidence to solve mathematics problems has significant effect on students’ A.A.

H_{1b}. Confidence to perform Math-R courses has significant effect on of students’ A.A.

H_{1c}. Confidence to perform math-related tasks has significant effect on of students’ A.A.

1.5 Rationale of the Study

Examining students' self-efficacy during timed mathematics examinations at all levels is necessary to maximize it as significantly as possible and address it during the beginning of classes.

1.6 Significance of the Study

The present study aims to expand the current scholarly discourse by examining the impact of math self-efficacy on students' academic achievement, as assessed by their cumulative grade point averages. The results obtained from this investigation make a valuable addition to the existing pool of information.

1.7 Delimitations of the Study

The researcher has restricted the study to encompass undergraduate students from Balochistan only.

2. LITERATURE REVIEW

Academic performance in mathematics is connected to math self-efficacy, or a person's confidence in their capacity to do arithmetic activities. Children who feel more capable in math have been found to do better academically. According to Spanish researchers, pupils' assessments of their mathematical prowess were remarkably predictive of their actual performance (Rodriguez et al., 2020). According to Recber et al. (2018), students' confidence in their mathematical abilities was the main factor influencing academic success in Turkey. Self-efficacy in mathematics greatly impacted the students' academic success in Bhutan (Norbu & Dukpa, 2021). Their feeling of self-efficacy is one of the psychological aspects impacting pupils' arithmetic success (Masitoh & Fitriyani, 2018). Students are more inclined to seek mathematical knowledge and have more success due to their efforts if they have confidence in their abilities to excel in mathematics (Lee et al., 2020). In his seminal work, Bandura (1997) provided a comprehensive examination of self-efficacy theory and its many applications across multiple areas, including the realm of academic accomplishment. This paper examines the influence of self-efficacy beliefs on a person's motivation, performance, and accomplishment results. It presents empirical data from several research papers that substantiate the association between self-efficacy and academic success. According to Thompson et al. (2022), there exists a significant association between self-efficacy beliefs and individuals' ability to effectively solve mathematical problems. Additionally, it was observed that self-concept beliefs exerted an indirect influence on performance by affecting self-efficacy. These findings underscore the critical role of math self-efficacy in accurately predicting academic achievement in the field of mathematics. In their study, Lee et al. (2020) undertook a meta-analysis with the aim of investigating the influence of self-efficacy beliefs on the performance of problem-solving in mathematics tasks. The study revealed a significant correlation between beliefs about self-efficacy and mathematical problem-solving skills, indicating that those with greater levels of self-efficacy in mathematics tend to exhibit superior scholastic achievement in the subject. According to a study conducted by Hackett and Betz (1989), there exists a significant association between an individual's degree of math self-efficacy and their academic performance in mathematics. The findings suggest that those with greater levels of mathematics self-efficacy tend to exhibit superior performance in the subject.

Ozcan and Kontaş (2017) also looked at the relationship between test performance and math self-efficacy. Mathematical competence has increased confidence in one's ability to do well in mathematics (Talsma et al., 2018). Research looking at the roots of self-efficacy found that the sensation of mastery was the best indicator of later success in mathematics (Ahn et al., 2017). Self-efficacy views in mathematics were highly predictive of social influences (Lau et al., 2018). It was shown that prior academic success has a far more significant impact on self-efficacy than self-efficacy itself on academic achievement (Talsma et al., 2018).

METHODOLOGY

3.1 Sample of the Study

The study centred on the mean mathematical scores of students aged 17 to 22 across all levels of tertiary education. Mathematics is a compulsory subject in the academic program of any tertiary institution. As students advance through their mathematical studies, the content becomes progressively more abstract, potentially impacting their academic achievement.

3.2 Research Design

The present study is based on a non-experimental research design; survey methods were used to collect the data. This study analyzed the impact of graduate students' anxiety, and their total mathematical score averages were analyzed.

3.3 Research Instruments

The researchers utilized a questionnaire that they developed themselves, which followed a standardized format and was based on the Five-Point-Likert scale. The survey had a total of twenty-two items, which were assessed using a scoring system that ranged from one to five in a certain manner. The scale employed within this particular context spans from 1 to 5, with 1 denoting a robust state of disagreement, 2 indicating a dispute, 3 signifying a state of doubt, 4 representing an agreement, and 5 denoting a firm state of agreement.

3.4 Validity and Reliability

To uphold the integrity of the survey instrument, the investigators employed identical standardized items and refrained from making any alterations to the articles. To evaluate the reliability and consistency of the survey questionnaire, a sample of 640 students was asked to complete the survey twice, with a two-week interval between each administration. Subsequently, the scholars juxtaposed the answers provided by each pupil in both iterations and computed the aggregate score for each individual. Upon finding that each participant responded with near-identical answers on two separate occasions and that their overall scores did not exhibit significant variation between the initial and subsequent iterations of the survey, the investigators concluded that the questionnaire possessed a high degree of reliability.

Table No. 3.2 *Reliability Statistics of Variables*

Construct	Cronbach's Alpha	N of Items
	.904	22
Mathematics Self-efficacy		
CSMP	.905	06
CPMC	.898	10
CPMT	.909	06

4. DATA COLLECTION PROCEDURE

The researcher visited colleges and universities in person to collect information from students. The researcher delivered printed versions of the survey questionnaire to all undergraduate students, and all undergraduates completed the survey. Following the implementation, the researchers organized the collected data for analysis.

4.1 Data Analysis

The researchers utilized Excel and Statistical Software. Social Science Research (SPSS) was used to analyze the gathered data. Descriptive statistics and a multiple regression model were used in the study.

4.1.1 Regression

A multiple regression model was used to determine the effect of variables on the mathematical grade averages of undergraduate students and their anxiety levels.

4.1.2 Descriptive Statistics

Table No. 4.1 *level of mathematics self-efficacy among undergraduate college students*

	CSMP	CPMC	CPMT
N	640	640	640
Mean	3.5768	3.5680	3.5730
SD	0.9948	0.9767	1.0460

The findings of the study are presented in Table 4.2. The objective of the study was to assess the levels of mathematics self-efficacy among undergraduate college students, focusing on three dimensions: confidence in solving mathematical problems, confidence in performing in math-related courses, and confidence in doing math-related tasks. The mean values for self-perceived confidence in solving math problems, confidence in course performance, and confidence in task performance in the field of mathematics are 3.5768, 3.5680, and 3.5730, respectively. The variables representing confidence levels in answering math problems, performing well in math classes, and completing math tasks have a range between 1.00 and 5.00. Confidence in one's capacity to solve mathematical issues, performance in mathematically relevant courses, and performance in mathematically associated activities all had standard deviations of 0.9948, 0.9767, and 1.0460, respectively.

4.2 Assumptions of Multiple Linear Regression

In order to address the research inquiry, this study aims to examine the impact of math anxiety, mathematics self-efficacy, and procrastination on academic accomplishment. The study employed a multiple linear regression model (MLRM) to examine the anticipated impact of math anxiety, mathematics self-efficacy, and procrastination on the academic performance of undergraduate students. Considering this, the assumptions associated with using the regression model were studied. Gelman (2020) proposed that before utilizing MLR analyses, the following assumptions be verified:

4.2.1 Dependent Variable

There is just one dependent variable that must be determined at the continuous level. This prediction was confirmed when the dependent variable academic performance scores were calculated on a continuous scale.

4.2.2 Independent variable

In the current study, there were three independent variables, such as math anxiety, math self-efficacy, and procrastination, and one dependent variable, academic achievement. In the study, only one independent variable must be measured continuously.

4.2.3 Homoscedasticity

Ugwuanyi et al. (2020) conducted an analysis that suggests a potential association by examining a secondary regression model in which the residuals consist of mathematics anxiety, mathematics self-efficacy, and procrastination. The Glejser test was employed to detect heteroscedasticity, utilizing coefficient estimations. When the p-value is more than 0.05, it is necessary to ensure the homoscedasticity of the data.

4.2.4 Heteroscedasticity

When the value of independent variable is less than 0.05.

4.2.5 Normality curve

In the study, this assumption shows that the underlying residuals are normally distributed, or approximately so.

4.2.6 Autocorrelation

The Durbin-Watson test is used to determine observational independence. The value is larger than the lower limit of 1.5 but less than 2. Due to the absence of autocorrelation, no autocorrelation exists.

4.2.7 Linearity

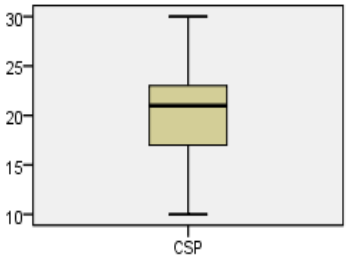
A correlation was observed between the independent and dependent variables, indicating a linear connection. Scatterplots were employed to validate the association. In the context of this connection, residual cures were graphed.

4.2.8 Multicollinearity

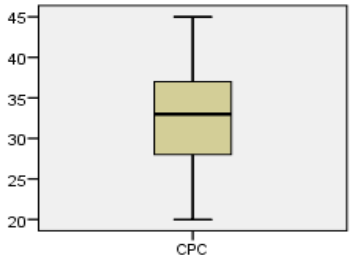
The absence of multicollinearity is a necessary condition in multiple linear regression, and it may be assessed by examining the variance inflation factor (VIF) values. According to Stevens (2009), it is suggested that the Value of Variance Inflation Factors (VIFs) should be below ten, indicating a weak linear connection among the independent variables. The low values of the Variance Inflation Factor (VIF), with each value being less than 10, provide empirical evidence supporting the premise of the absence of multicollinearity.

Figure 4.1 Data Without Outliers

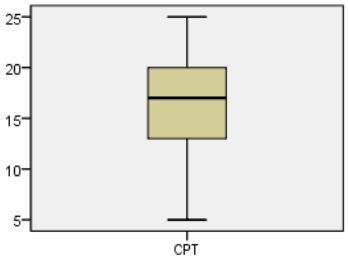
Confidence to Solve Math-related Problems



Confidence to Perform Math-related Courses



Confidence to Perform Math-related Tasks



Test Scores

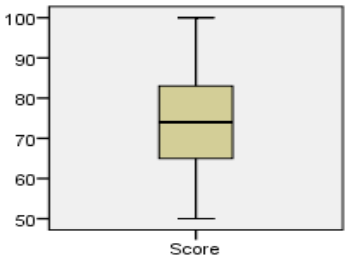
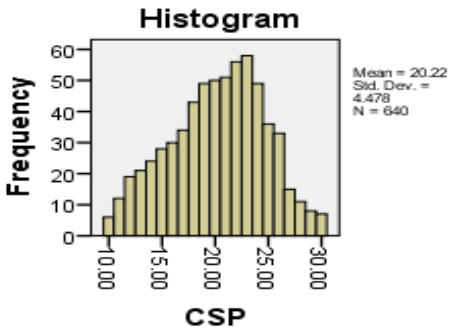
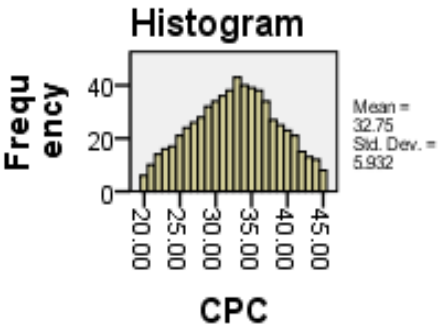


Figure 4.2 Histograms

Confidence to Solve Math-related Problems

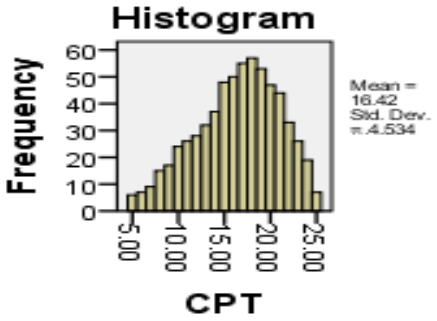


Confidence to Perform Math-related Courses



Confidence to Perform Math-related Tasks

Test Scores



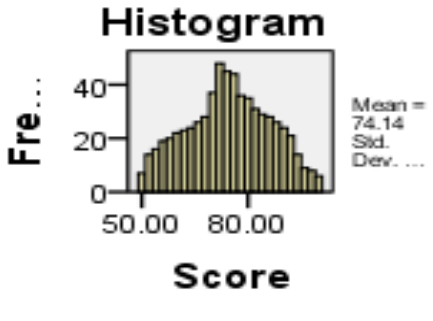


Table No. 4.2 *Impact of Mathematics Self-Efficacy on the Academic Achievement of undergraduate college students (Model Summary)*

Model	R	R Square	Adj R Square	SEE
1	0.763	0.582	0.580	10.47648

a. Dependent Variable: Academic Achievement

b. Predictors: Confidence to Perform Math-Related Tasks, Confidence to Solve Maths, Confidence to Perform Maths Courses

The R-value in Table 4.2 is 0.763, indicating that mathematics self-efficacy is strongly related to Academic Achievement. The R square value is 0.582, and the adjusted R square value is 0.580, indicating that Math Anxiety accounts for 58.2% of the variance in Academic Achievement.

Table No. 4.3 *Impact of Mathematics Self-Efficacy on the Academic Achievement of undergraduate college students (ANOVA)*

Model	Sum of Squares	DF	MS	F	Sig.
Regression	97121.816	3	32373.939	294.961	.000
Residual	69805.284	636	109.757		
Total	166927.100	639			

a. Dependent Variable: Academic Achievement

b. Predictors: Confidence to Perform Math-Related Tasks, Confidence to Solve Maths, Confidence to Perform Maths Courses

Table 4.3 shows F=294.961, and the 0.000 alpha value shows that accurate expectation and profound influence of the model is made.

Table No. 4.4 *Impact of Mathematics Self-Efficacy on the Academic Achievement of undergraduate college students (Coefficients)*

Model	USC		SC	T	Sig.
	B	SE	Beta		
(Constant)	25.902	1.596		16.234	.000
CSMP	3.346	1.042	0.206	3.212	.001
CPMC	8.543	1.146	0.516	7.458	.000
CPMT	0.927	0.946	0.060	0.980	.003
Durban Watson= 1.488, VIF= 2.247, 1.842, 2.072					

a. Dependent Variable: Academic Achievement

b. Predictors: Confidence to Perform Math-Related Tasks, Confidence to Solve Maths, Confidence to Perform Maths Courses

Table 4.4 presents the regression analysis results examining mathematics self-efficacy's effects on academic achievement (AA) among undergraduate college students. The analysis includes three independent variables: confidence to solve math problems, confidence to perform in math-related courses, and confidence to perform math-related tasks.

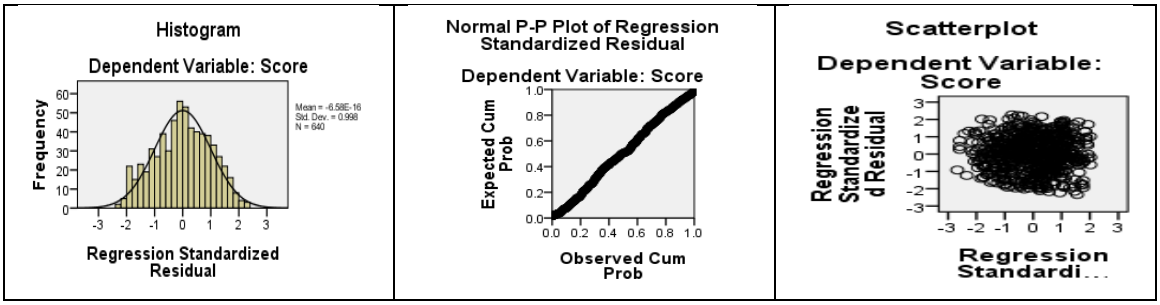
The beta value (β) for Confidence to Solve Math Problems is 3.346, with a standard error of 1.042, indicating that Confidence to Solve Math Problems has a robust and encouraging outcome for Academic Achievement in students. The standardized coefficient (Beta) of 0.206 reflects the direct proportionality of Confidence to Solve Math Problems with Academic Achievement. The t-value of 3.212 and α =0.001 show statistical significance in the same direction. $H_{1a.}$ Confidence to solve mathematics problems has significant effect on students' A.A, has been accepted.

Similarly, the beta value (β) for Confidence to Perform in Math-Related Courses is -8.543, with a standard error of 1.146, indicating that Confidence to Perform in Math-Related Courses has a solid, encouraging outcome for Academic Achievement in students. The standardized coefficient (Beta) of 0.516 reflects the direct proportionality of Confidence to Perform in Math-Related Courses with Academic Achievement. The t-value of 7.458 and α =0.000 show statistical significance in the same direction. $H_{1b.}$ Confidence to perform Math-R courses has significant effect on of students' A.A, has been accepted.

In conclusion, the beta value (β) for Confidence to Perform in Math-Related Tasks is 0.927, with a standard error of 0.946, indicating that Confidence to Perform in Math-Related Tasks has a robust and positive effect on Academic Achievement in students. The standardized coefficient (Beta) of 0.060 demonstrates the direct correlation between Math-Related Task Confidence and Academic Achievement. The t-value of 0.98 and the value of 0.003 indicate statistical significance in the same direction. H_{1c}. Confidence to perform math-related tasks has significant effect on of students' A.A, has been accepted.

For heteroscedastic p should be less than 0.05, here p is less than 0.05 for (LMA), (MEA) and (EA) so that is heteroscedastic. The value of VIF should be less than 10 here values are 2.247, 1.842, 2.072; so there is no multicollinearity.

Figure 4.3 Scatterplot of Maths Self-Efficacy



4.3 Discussion

The findings indicate a highly substantial influence of self-perceived competence in mathematics on one's academic performance. There is a negative correlation between mathematics self-efficacy and mathematics achievement, as seen by the lower scores obtained by students who have poor mathematics self-efficacy and the higher scores achieved by those with strong mathematics self-efficacy. The sub-factors that contribute to math self-efficacy, namely the confidence to solve problems in mathematics, confidence to perform math-related courses, and confidence to perform math-related tasks, as well as environmental anxiety, exert a substantial influence on students' academic achievement. Therefore,

hypotheses 1a, 1b, and 1c are supported. In research conducted by Johnson and Smith (2023), the relationship between self-confidence in mathematics and academic success among high school students was examined, with similar findings. The results of the study demonstrated a statistically significant and positive association between individuals' views in their own ability to do well in mathematics (math self-efficacy) and their overall performance in mathematics. This suggests that students who have greater confidence in their mathematical abilities tend to achieve higher marks in the subject. In a separate study, Chen and Lee (2023) conducted an investigation to examine the impact of mathematics self-efficacy on the problem-solving abilities of students. There is a positive correlation between students' levels of math self-efficacy and their problem-solving ability, with students who possess higher levels of math self-efficacy exhibiting superior performance in problem-solving tasks. Individuals with higher levels of math self-efficacy had more proficiency in resolving intricate mathematical problems in comparison to their counterparts with lower levels of math self-efficacy. Furthermore, the findings of this investigation align with those of the current study.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The research highlighted the significance of math self-efficacy in forecasting academic performance. There is a positive correlation between students' mathematics self-efficacy and their academic performance, indicating that interventions aimed at improving students' confidence and conviction in their mathematical ability may lead to favorable outcomes. The female participants shown higher levels of self-efficacy in relation to their confidence in solving mathematical issues, engaging in math-related coursework, and performing math-related tasks.

5.2 Recommendations

In order to cultivate a favorable influence of self-efficacy on students' scholastic accomplishments, it is advisable to provide assistance to students in establishing pragmatic and achievable objectives that are congruent with their aptitudes and personal preferences. To foster a sense of achievement and advancement, it is advisable to deconstruct overarching objectives into smaller, more feasible undertakings. Students may be encouraged to monitor their progress and adjust their plans. They should be provided explicit instruction and feedback by offering clear and precise education when teaching new concepts and skills. Constructive feedback may focus on students' efforts, progress, and specific areas for improvement; this helps students build confidence in their abilities and develop a growth mindset. Long-term research may examine how academic procrastination, math anxiety, and math self-efficacy relate to academic success. By tracking students' experiences and academic performance over time, researchers can better understand how these factors interact and influence educational outcomes. Addressing academic procrastination and increasing math self-efficacy among students can significantly improve their math performance and overall learning experience. In order to cultivate an inclusive and supportive learning environment, it is imperative for educational leaders to promote open communication and collaboration among students. This can be achieved by creating a classroom atmosphere that encourages students to freely express their thoughts and ideas. Additionally, institution heads should establish a safe space wherein students feel comfortable seeking assistance and posing questions without apprehension of being judged. Constructive feedback plays a crucial role in fostering a positive learning environment. By providing feedback that highlights students' strengths and areas for improvement, educators can guide students towards growth and development. Furthermore, it is important for institution heads to acknowledge and commend students for their efforts, persistence, and progress, rather than solely focusing on the outcomes they achieve. Promoting a growth mindset is another essential aspect of creating an inclusive and supportive learning environment. By emphasizing

that intelligence and mathematical skills can be enhanced through practice and learning, educators can instill a belief in students that they have the capacity to improve and succeed. In summary, institution heads bear the responsibility of cultivating an inclusive and supportive learning environment by encouraging open communication and collaboration, providing a safe space for students to seek help, offering constructive feedback, praising students for their efforts and progress, and fostering a growth mindset.

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