The Relative Contribution of Academic Variables in Predicting Confidence in Mathematics Among University Students

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Abstract

This study aims to investigate the relative contribution of academic variables in predicting confidence in mathematics among university students. The sample of the study consisted of (N=313) students, including (222 males and 91 females, with a mean age of 21.15 years SD = 1.84). To achieve the objectives of the research, Math Confidence Rating Scale (MCS) developed by (Hendy et al., 2014), and it was validated by Alnaimi et al. (2024) to the Arab context, and has adequate psychometric properties to be used as a short measure of Math confidence in Arabic. Results revealed that academic variables (GAT, High school GPA, University cumulative GPA and Math Grade) affected university students' math confidence with a percentage of 15.6% based on the R square value, indicating that the combined academic variables accounted for 15.6% of the variance in math confidence. These findings suggest a substantial relationship between academic variables and math confidence. Of these academic variables, Math Grade makes the largest and statistically significant contribution (Beta= 0.388).

Keywords: *General Ability Test, High School GPA, University Cumulative GPA, Math Grade, Mathematical Confidence.*

Introduction

Mathematics is a challenging and demanding subject area for students beginning in elementary school, in part because of its complexity, but also due to negative feelings associated with it (Mamarella et al., 2019). These negative feelings associated with mathematics are referred to as mathematics anxiety, which includes worry, frustration, nervousness, and apprehension towards mathematics tests, mathematics classes, and mathematics problems (McMahon, 2019). Many children and adults are not confident in their ability to do mathematics, A lack of student confidence in mathematics may also stem from teacher discouragement. For example, when students hear teachers describing mathematics as difficult, it may lead them to make the same conclusions (Finlayson, 2014). Gender differences favoring males in confidence in mathematics are well recorded. Differences among teenagers have been reported, for example, by Bohlin (1994), Hannula and Malmivuori (1997), Pehkonen (1997), and Leder (1995). Many factors, both within and outside the classroom, are likely to be important in affecting a pupil's mathematical self-confidence. A meta-analysis of studies on gender differences in mathematics (Frost, Hyde, & Fennema, 1994) found that girls had lower mathematics self-concept/ confidence than boys and greater mathematics anxiety. It is noteworthy that self-confidence in learning mathematics is shaped by various cognitive and social factors, such as self-regulation, academic self-efficacy, beliefs about the mathematics course, math anxiety, motivational beliefs—including the intrinsic value of mathematics—and self-concept in mathematics (Champion, et,al.2010). Additionally, certain academic and social factors, such as parental education level, academic specialization, prior experience with learning mathematics, and gender, also play a role (Ganley& McGraw,2016).

Many students in Saudi Arabia complain that they achieve poor results in mathematics and appear to have a negative attitude toward the subject(Alharthi,2023). The poor performance of the students in mathematics in Saudi Arabia has attracted the attention of educational planners, teachers, and researchers. On this issue, researchers have shown tremendous concern about the poor performance of students in mathematics. This abysmal performance indicates poor academic achievement mostly in the domain of mathematics. With respect to mathematics education, in particular, research has shown that students' self-confidence in mathematics skills and in the learning, process is an important predictor of mathematics achievement, as

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the success or failure of the students in mathematics courses is generally in line with their level of self-confidence in mathematics(Çiftçi& Yıldız,2019). Accordingly, it is recognized that students who are successful in mathematics have higher self-confidence than other students (Hackett, 1985; Hackett & Betz, 1989; Honicke & Broadbent, 2016; Hosein & Harle, 2018; Pajares & Miller, 1994). Confidence has been found to be a predictor of math performance (Grootenboer & Hemmings, 2007). Hwang& Son(2021) discovered a positive relationship between students' attitudes toward mathematics and mathematics achievement. These results showed that the following students are more likely to have high mathematics achievement: (a) those who like to study mathematics and pursue mathematics-related activities, (b) those who believe that learning mathematics will result in a positive outcome (e.g., success in school and job opportunities), and (c) those who trust in their mathematical abilities. Ayebo& Dingel(2021) found that there is a positive relationship between mathematics attitude and achievement, And the confidence scale was found to significantly predict students' achievement . There is also a statistically significant gender difference for students liking of mathematics, with men reporting higher scores than women. Boys in Saudi Arabia consistently and significantly underperform compared to girls across different grades and subjects. For example, in the Trends in International Mathematics and Science Study (TIMSS) 2019, grade 4 boys in Saudi Arabia scored below girls by approximately 26 points in mathematics and 60 points in science. A similar gender gap exists in grade 8, where boys underperformed girls by approximately 17 points in mathematics and 47 points in science (Elsayed et al.,2022)

No known studies have examined how academic variables can predict mathematics confidence. Educators, parents, and students need to know how these different factors are related and how they can impact the amount of one's mathematics confidence. Once educational stakeholders understand how these factors can influence mathematics confidence, they can better support students experiencing mathematics confidence while also promoting their mathematics achievement. Harwell et al. (2013) illustrate the effects of past experiences and achievements in mathematics on a student's persistence and future success. Confidence for any student begins when they have the opportunity to succeed mathematically. Post et al. (2010) further assert this truth, stating "... that high school mathematics curriculum was not a significant predictor of the number of college mathematics courses taken, but mathematics grade point average was a significant predictor of the number of college mathematics courses taken" (p. 299), meaning that students who succeed in their mathematics courses feel that they are capable enough to continue in their studies at the collegiate level, increasing their overall mathematical performance, and students with high math confidence believe their efforts are worthwhile, are unconcerned with challenging subjects, expect good grades, and enjoy math as a subject and vice versa(Foster,2016). However, not much research has examined the effect of academic variables such as the student's cumulative GPA, High school average, Grade in mathematics course and General Ability Test GAT, on students' math confidence and how these aspects affect students' math confidence. Previous research has focused more on the relationship between affective aspects and math performance for students and prospective teachers.

Purpose of the Study

The purpose of this study was to examine factors that impact mathematics confidence. because the current research lacks information about how academic variables are related and how they can impact a student's mathematics confidence, those variables were selected as predictor variables. As such, the current study examined how academic variables (The student's cumulative GPA, High school GPA, Grade in mathematics course and General ability test GAT) predicted the level of mathematics confidence among university students.

Method and Procedures

Participants

An online survey was conducted to collect data using a survey link created on a Google Form. It was then distributed via email and social media like Facebook, WhatsApp, etc. A total of 313 students completed the online survey, Among the 313 participants, 79.9% were male, 29.1% were female, with a mean age of 21.15 years (SD = 1.84). Detailed information about the participants is presented in Table 1.

Table 1. Characteristics of the Study Group (N = 313)

Gender	N	%
male	222	70.9
female	91	29.1
Age		
18-20	125	39.9
21-23	150	47.9
>23	38	12.2

Measures

Math Confidence Rating Scale

To achieve the objectives of the research, Math Confidence Rating Scale (MCS) developed by (Hendy et al., 2014), and it was validated by Alnaimi et al. (2024) to the Arab context, and has adequate psychometric properties to be used as a short measure of Math confidence in Arabic. The MCS is a 7-item Likert-type scale with answers ranging from 1 (strongly disagree) to 5 (strongly agree). These items include mathematics behaviors where students may be expected to vary in confidence, such as understanding mathematics concepts, earning good grades, and practicing problems on their homework. The internal reliability, convergent validity, and test-retest reliability of the MCS are reported as acceptable. Hendy et al (2014) conducted a study with 368 participants and the self-reported mathematics confidence was as follows: M = 3.79, SD = .90.

General Ability Test: It is a test provided by the National Center for Measurement and Evaluation in KSA, and its duration is two and a half hours. It is presented in Arabic, and assesses the student's analytical and deductive ability, and is divided into two parts: one Verbal (linguistic), the other quantitative (mathematical), and assessing the ability that naturally builds in students' day after day through learning and reading inside and outside school. This Test has a mean of (65), and standard deviation (10) (Al-Qatei and Al-Harbi, 2012).

High school GPA: It is the percentage of the weighted grades that the student obtained in Courses in the third year of secondary school, calculated with pre-determined weights based on hours Study for the course (Al-Shehri, 2007).

University Cumulative GPA: The result of dividing the total points obtained by the student in all courses on the total hours scheduled for those courses(Al-Qatei and Al-Harbi, 2012).

Math Grade: It is the grade obtained by the student while studying at the university for the mathematics course as one of the requirements in the first year

Data Analysis

Data were coded, entered, and subjected to statistical analysis using SPSS version 26 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including means, were calculated to characterize the sample. Independent sample t-tests were employed to examine the association between sociodemographic variables and levels of math confidence. A significance level of $p < .05$ was adopted. To explore the predictive relationship between multiple variables and math confidence, a multiple regression analysis was conducted, incorporating GAT, High school GPA, University cumulative GPA and Math Grade as predictors.

Results

Three hundred and thirteen university students filled out a math confidence questionnaire, and included their scores on GAT, High school GPA, University cumulative GPA and Math Grade. The results are demonstrated in Table 2.

Table 2: Descriptive statistics of GAT, High school GPA, University cumulative GPA, Math Grade, and math confidence (N = 313).

Gender	Mean	SD
GAT	78.32	8.96
High school GPA	93.46	6.69
University cumulative GPA	4.12	0.54
Math Grade	87.93	10.55
Math confidence	3.55	1.01

From Table 2, the average math confidence of the subjects is 3.55, and the average of GAT, High school GPA, University cumulative GPA and Math Grade are78.32, 93.46, 4.12, 87.93respectively, the result yields that Students who feel confident in mathematics get reasonable grades on tests, whether at school or university**.** A multiple regression statistical test was utilized to determine the impact of academic variables (GAT, High school GPA ,University cumulative GPA and Math Grade) on math confidence. Before using the multiple regression test, the classical assumption test must be fulfilled first, including normality, linearity, homoscedasticity, and no multicollinearity.

The regression residuals must have a normal distribution, which may be met by employing a normal distribution and predictable probability plots. Figure 1 is a normal prediction probability (PP) data plot on math confidence values. In Figure 1, it can be seen that the dots move along a diagonal line. It shows that the math confidence data is normally distributed
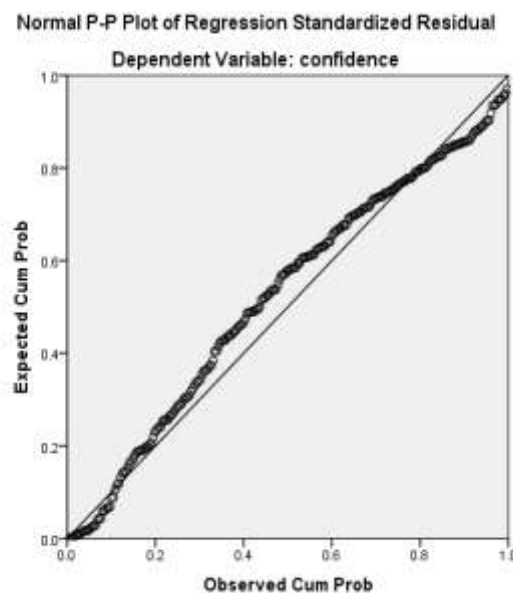

Figure 1. Normal Predicted Probability Plot

Homoscedasticity refers to the points evenly distributed, and a scatter plot of the residues examines this condition. Figure 2 shows that a clear pattern is not present in the scatterplots, and the points spread above and below the number 0 on the Y axis; as a result, the homoscedasticity criteria is fulfilled. Because the residuals are regularly homoscedastic and distributed, it shows that the predictor variable has a linear relationship with the outcome variable in the regression.
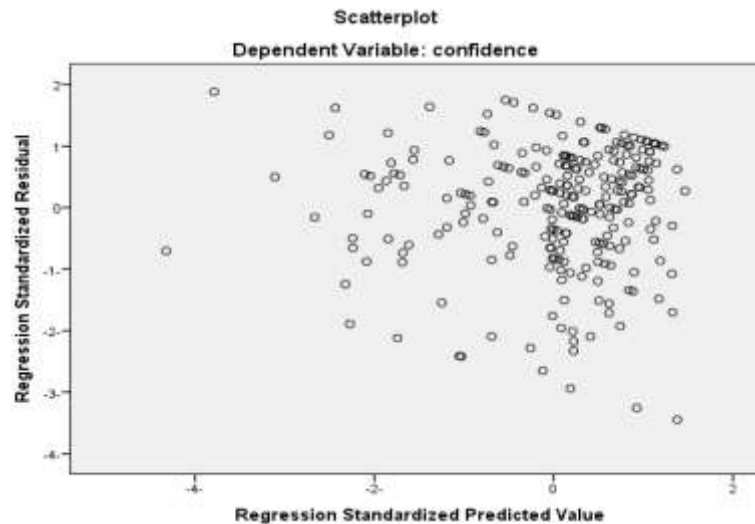

Figure 2. The Scatter Plots of the Residuals

Multicollinearity was carried out to see whether each independent variable (GAT, High school GPA, University cumulative GPA and Math Grade) is independent or has a relationship. The condition of multicollinearity occurs when the independent variables are significantly associated with one another. It should be noted that this condition is not anticipated in multiple linear regression. The criteria for not having multicollinearity can be seen based on the tolerance value, which have to be greater than 0.8, and the VIF (Variance Inflation Factor) value of less than 10(Wahyuni, Juniati&Wijayanti,2024)

Table 3. Collinearity Statistics of Math Confidence

Collinearity Statistics	GAT	High school GPA	University cumulative GPA	Math Grade
Tolerance	0.958	0.949	0.925	0.927
VIF	1.044	1.054	1.080	1.079

Dependent Variable: Math Confidence

Based on the table 3, it is apparent that the tolerance values for GAT, High school GPA, University cumulative GPA and Math Grade are 0.958, 0.949, 0.925 and 0.927 respectively, and based on the VIF values, it is found that GAT, High school GPA, University cumulative GPA and Math Grade are 1.044, 1.054, 1.080 and 1.079 respectively.

Based on the tolerance and VIF values, it can be concluded that there is no multicollinearity. Thus, the classical assumption test has been fulfilled so that it can be continued with multiple regression tests.

A partial t-test (multiple regression) was conducted to see how the independent variable partially influences the dependent variable. In this research, it was seen how GAT, High school GPA, University cumulative GPA and Math Grade partially affected math confidence in Table 4.

Table 4. Multiple Linear Regression Analysis

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	**Std. Error**	**Beta**		
	(Constant)	3.544	7.733		.458	.647
	GPA	.148	.845	.011	.175	.861
	GAT	.039	.047	.050	.830	.407
	High school GPA	-.049-	.070	-.042-	-.692-	.489
	Math Grade	.256	.041	.388	6.290	.000

Table 4 shows that only one of the academic variables, which is the student's grade in the mathematics course, is statistically significant, while the rest of the variables (GAT, High school GPA, University cumulative GPA) were not statistically significant. Based on the formula, if the Sig value is < 0.05, then it can be said that the independent variable (X) partially affects the dependent variable (Y). Therefore, it can be concluded that: obtaining high grades in mathematics (X4) has a positive effect on math confidence. Generally, high mathematics achievement demonstrates a stronger positive relationship with math confidence (Yildiz& Ciftci,2019).

After seeing how the influence of each independent variable (GAT, High school GPA, University cumulative GPA and Math Grade) partially affects math confidence, it can be stated how the four independent variables simultaneously affects the math confidence using the F test. If the value of Sig. is <0.05, then the independent variable (X) simultaneously influences the dependent variable (Y) in Table 5.

Table 5. Anova Test

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	1801.921	4	450.480	11.036	.000[b]
	Residual	9755.997	239	40.820		
	Total	11557.918	243			
a. Dependent Variable: math confidence						
b. Predictors: (Constant), GAT, High school GPA, University cumulative GPA and Math Grade						

As seen in Table 5, the results indicated that the P value was statistically significant, then it can be inferred that GAT, High school GPA, University cumulative GPA and Math Grade simultaneously affects math confidence. From Table 4, it is obtained that $y = 3.544+0.148x_1+0.039x_2-0.049x_3+0.256x_4$, where $x_1 =$ University cumulative GPA, $x_2 =$ GAT, $x_3 =$ High school GPA and $x_4 =$ Math Grade.

Table 6. Model Summary: GAT, High School GPA, University Cumulative GPA, Math Grade and Math Confidenc

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
	.395[a]	.156	.142	6.389
a. Predictors: (Constant), GAT, High school GPA, University cumulative GPA and Math Grade				
b. Dependent Variable: math confidence				

Based on Table 6, the effect GAT, High school GPA, University cumulative GPA and Math Grade on math confidence for university students is 15.6% based on the value of R square, indicating that the

combined academic variables accounted for 15.6% of the variance in math confidence. These findings suggest a substantial relationship between academic variables and math confidence

Discussion

Based on the study's results, it was found that academic variables (GAT, High school GPA, University cumulative GPA and Math Grade) affected university students' math confidence with a percentage of 15.6% based on the R square value, indicating that the combined academic variables accounted for 15.6% of the variance in math confidence. Of these academic variables, Math Grade makes the largest and statistically significant contribution (Beta= 0.388). A person's performance in mathematics can affect their emotions in learning mathematics and feeling confident in mathematics; previous research has demonstrated that the emotions of students are related to their academic achievement (Pekrun et al.,2017). It is recognized that students who are successful in mathematics have higher self-confidence than other students (Hackett, 1985; Hackett & Betz, 1989; Honicke & Broadbent, 2016; Hosein & Harle, 2018; Pajares & Miller, 1994). The results of this research suggest that students with high performance in mathematics generates a high sense of confidence in mathematics, which means that students' performance in mathematics affects their self-confidence in mathematics (Riboroso, et al.,2018; Wahyuni et al.,2024). The results of this study are consistent with the results of the Wourms (2022) study, which indicated that confidence has a stronger correlation to university mathematics success. This means that, while there are many other considerations and moving pieces to serving students, confidence is one particular factor that is now better researched and something that can be fostered within classrooms.

Limitations and Future Research

This study has a few limitations. First, the study used students' self-reported survey data to examine their confidence in mathematics, which is very prevalent in quantitative research. However, it is possible that students manipulated their responses to the survey to give the researchers the impression they were good students. Second, the study only focused on university students in the city of Riyadh, especially students at Imam Muhammad Ibn Saud Islamic University. Therefore, a study of students in other universities might reveal different outcomes, and the findings of this study cannot be generalized to other contexts.

Further studies should therefore be conducted in light of the aforementioned limitations. First, future studies might use additional data, such as interview and classroom observation data, to validate the results of the study. Second, more studies are required to examine the relationship between math confidence and academic variables using students in other contexts. Third, further efforts are required to identify different demographic variables such as parents' education level, cultural background, socioeconomic status, and other variables contribute to predicting confidence in mathematics.

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