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TOWARDS STUDENTS' MATHEMATICS SELF-EFFICACY AND MATHEMATICS ANXIETY IN IRANIAN UNIVERSITY CONTEXT

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Abstract: Teaching is a dynamic process of communication in which students and instructors continually interact together based on the situations and objectives that must be satisfied in the academic context. Anxiety concerning a specific subject is experienced by most students in the academic context, particularly in mathematics. Teaching practices, self-efficacy, and students' anxiety in class settings directly contribute to the realization of educational objectives. Accordingly, in the university context mathematics attainment is commonly influenced by students' self-efficacy, and their level of anxiety. The current study tried to scrutinize the relationship between mathematics freshmen students' self-efficacy and their anxiety level on their academic enactment. This study was conducted on a group of 120 freshmen university students from different faculties who have experienced mathematics course in their classes in Islamic Azad University North Tehran Branch. In the questionnaires, students were asked to express their ideas related to different phases of teaching math in their classes. The questionnaires were adapted based on the Iranian teaching context to evaluate university students' mathematics self-efficacy and mathematics anxiety. The outcomes of Pearson Correlation ($r(118) = -.654$ represented a large effect size, $p < .05$) specified that there was a significant, negative, and large relationship between self-efficacy and anxiety. The outcomes of the current study are also helpful for instructors who wish to gain better insight in to their students' mathematics self-efficacy and anxiety to enhance their students' attainment.

Keywords: *Anxiety, Mathematic Performance, Self-efficacy*

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INTRODUCTION

Mathematics self-efficacy is defined as an individual's opinions or insights concerning his or her skills in mathematics (Bandura, 1997). It is also regarded as an individual's self-assurance about implementing a diversity of tasks to solve problems in mathematics. In general, self-efficacy is related to incentives. It has been recognized that undergraduates with developed stages of self-efficacy are likely to be more interested in learning in comparison with their classmates (Pajares & Graham, 1999; Zeldin, Britner & Pajares, 2008). In this regard, some researchers have steadily highlighted Bandura's (1997) key bases of self-efficacy as mastery experiences, mediated experiences, social inducement, and physiological statuses (Hampton & Mason, 2003; Usher & Pajares, 2009).

It is worth noting that students typically do activities when they believe they can organize them well and struggle those they do not have self-assurance (Bandura, 1997). Thus, learners' outlook concerning their skills affect their performance, and their self-confidence can inspire them for further participation. All in all, mathematics self-efficacy denotes the assessment of a learner's self-assurance to be successful in math problems (Hackett & Betz, 1989). Besides, mathematics anxiety can affect students' incentive to acquire new content in a class setting (Richardson & Suinn, 1972). It is worth noting that learners who suffer from mathematics apprehension do not essentially experience apprehension in other subject matters and learners with math anxiety are less likely to follow professions demanding mathematics.

LITERATURE REVIEW

Hypothetically, it is supposed that students' mathematics self-efficacy can affect their presentation, and their psychological behavior (Bandura, 1986; Bandura, 1997). In (2009) Usher and Pajares focused on scheming a scale to find out the foundations of mathematics self-efficacy. The findings showed that apparent mastery experience is an influential basis of students' mathematics self-efficacy. In the same vein Cates and Rhymer (2003) investigated university students' mathematical performance. The outcomes revealed that undergraduates with higher levels of anxiety had meaningfully lower computational confidence which in turn reduced their accomplishments in mathematics and contributed to negative outlooks to mathematics. Besides, Webb-Williams (2018) investigated students' self-efficacy grounded on gender specification. The findings revealed that although males and females had parallel academic performance, many

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females undervalued their competence. In the qualitative phase of the study, the bases of self-efficacy and self-regulation were apparent in the students' explanations. In line with Ashkenazi and Velner's (2023) study, males were more influenced by mastery experience and females by a mixture of mediated experience and biological and affective states. In the same line, Gao's (2020) findings via student interviews presented that female learner recalled more apprehension in comparison with male learners. Recently, Ding et al. (2022) examined the measurement invariance of mathematics self-concept and self-efficacy. The results specified that a large ratio of non-invariance was observed in mathematics self-concept and self-efficacy.

In the same vein, Larsen and Jang (2021) applied factor score path analysis on multiple levels to quantify the relationship among mathematical attainment, instructional enactments, and self-efficacy of learners. The outcome confirmed the secondary result of instructional enactment on math attainment through its effect on students' self-efficacy. Undeniably, direct instruction was negatively related to self-efficacy. Besides, Liu et al. (2020) in their study highlighted the relationship between task domain, self-efficacy, and math problems. The findings showed that as the level of difficulty enhanced, the association between self-efficacy and problem-posing diminished.

Earlier investigations have recommended that higher self-efficacy leads to better and more dynamic academic performance (Pajares & Valiante, 1997; Wong et al., 2021). All in all, previous studies provided some directions for the study of discipline self-efficacy in an academic context. It is worth noting that high self-efficacy is specified by confidence in one's capabilities, setting ambitious objectives, and perseverance in facing challenges. On the other hand, low self-efficacy is highlighted by doubt, avoidance of thought-provoking tasks, and reduced motivation and performance (Moreno et al., 2021 & Naibert et al, 2021). In nutshell, past experiences, social support, mastery experiences, and vicarious learning affect self-efficacy in an educational context (Bandura et al,1980; Hood et al.,2021). Hence, evaluating self-efficacy in an academic context is crucial as it influences students' beliefs and abilities to engage in tasks and communications necessary for retaining relationships (Aune et al., 2022).

On the other hand, the most severe outcome of math anxiety is a reduced level of attainment and persistent anxiety which can lead to challenges in learning and university dropout; thus, emotional states can meaningfully influence students' overall well-being (Azizi et al.,2022; Naibert et al, 2021). The key point is that in the academic context, instructors often fail to identify

such students with higher levels of anxiety and differentiate their performance from those who are not anxious which leads to academic failure (Passiatore et al.,2019; Jaramillo et al., 2020). As highlighted in the literature review the dominant aspects that have been associated with students' mathematics attainment are teachers' enactments, students' self-efficacy and their level of anxiety. However, these features are typically considered in isolation in diverse studies. Concerning this research gap, the current study probed into students' math self-efficacy and math anxiety levels and the relationship between these two constructs in the Iranian university context. Thus, the main objective of this study was to inspect and find out the relationship among mathematics learners' self-efficacy, and their stress levels in the academic context. Accordingly, the following null hypothesis was raised:

H0: There is no significant relationship between mathematics students' self-efficacy and anxiety.

RESEARCH METHODOLOGY

Participants

One hundred twenty Iranian freshmen mathematics students aged 20 to 25 years were selected from Islamic Azad University North Tehran Branch based on convenience sampling. They had already passed the mathematics course.

Instruments

The researchers applied the subsequent instruments to achieve the goal of the study. The mathematics self-efficacy and mathematics anxiety questionnaires (May, 2009)
were used to gain a better insight in to students' attitudes towards mathematics self-efficacy and students' mathematics anxiety.

Procedure

The researchers nominated the students from Islamic Azad University. No precise training was mandatory for the administration of any of the questionnaires applied in this investigation. They were all self-report instruments and once the contributors were presented a short meeting in Persian on the purpose of the study, they were demanded to fill in the questionnaires online. The questionnaire items were on a five-point Likert scale, with the options ranging from "strongly agree" to "strongly disagree". Once the completed forms were received, the data analysis was directed.

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FINDINGS

This study was undertaken to probe any significant association between self-efficacy and anxiety among Iranian university students. To attain the aims of the present study, 120 students were selected based on convenience sampling. They filled out and returned the self-efficacy and anxiety questionnaires. Table 1 shows the distribution of the respondents based on their gender. The findings indicated that mainstream of the respondents were male (66.70 %). Figure 1 shows the percentages of respondents based on their gender.

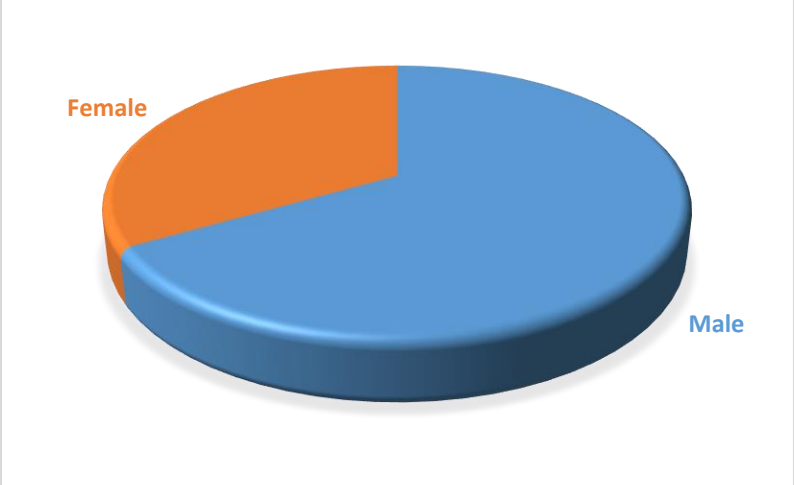
Table 1

Frequencies and Percentages for Distribution of Respondents by Gender

	Frequency	Percent
Male	80	66.70
Female	40	33.30
Total	120	100.00

Figure 1

Percentages for Distribution of Respondents by Gender



Testing Assumption of Normality

The merely research query raised in this study was explored via Pearson Correlation which assumes normality of data, linearity of relationship between the two variables, and homoscedasticity (homogeneity of variances). The latter two assumptions will be checked when probing the null hypothesis. The normality of self-efficacy and anxiety was examined using skewness and kurtosis indices which test the relative symmetry and peaked-Ness of the data. As shown in Table 2 the skewness and kurtosis indices were within the ranges of ±2. Thus; it was concluded self-efficacy and anxiety did not show any significant deviation from normality. George and Mallery (2020) suggested the criteria of ±2. It should also be noted that Zhu et al, 2019; suggested the criteria of ±3. However, Watkins, 2021; suggested different criteria for skewness and kurtosis. He believed that skewness values should be less than ±2; while kurtosis indices should be evaluated against the criteria of ±7.

Table 2

Skewness and Kurtosis Indices of Normality

	N	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
Self-Efficacy	120	-.810	.221	.809	.438
Anxiety	120	.163	.221	-.404	.438

Cronbach's Alpha Reliability Indices

Table 3 shows Cronbach's Alpha reliability indices for self-efficacy and anxiety. The two questionnaires showed reliability indices of .924, and .936 respectively. The reliability indices for self-efficacy and anxiety can be considered as appropriate; as noted by Dörnyei & Taguchi, 2009; and Harrison et al., 2021; who supposed that a Cronbach's alpha value of .70 is the satisfactory reliability index for an instrument.

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Table 3

Cronbach's Alpha Reliability Statistics

	Cronbach's Alpha	N of Items
Self-Efficacy	.924	13
Anxiety	.936	15

Construct Validity of Self-Efficacy Questionnaire

An Exploratory Factor Analysis (EFA) was run using Principal Axis Factoring to probe the underlying constructs of the 13 items of the self-efficacy questionnaire. Since EFA extracted a single factor, none of the rotation techniques could be selected; however, the extraction of a single factor should be justified. Parallel Analysis Scree Plot (Figure 3) shows the number of factors to be extracted. The plot confirmed a single factor as the underlying construct of self-efficacy. It is worth mentioning that the Parallel Analysis Scree Plot 4-1 was drawn using R Package "psych" (Revelle, 2021).

Figure 3

Parallel Analysis Scree Plot for Self-Efficacy Questionnaire

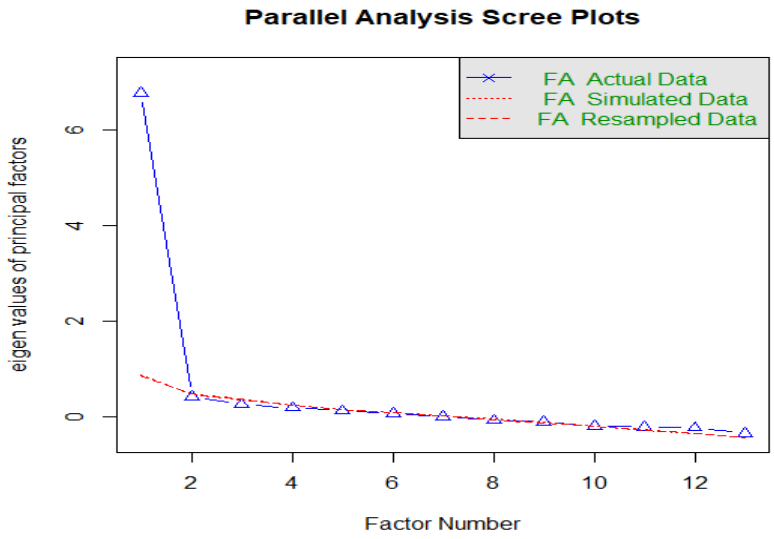

Table 4 shows the KMO index of sampling adequacy and Bartlett's Test of Sphericity. The KMO index of .918 indicated that the present sample size was "excellent". Field (2018) believes that KMO indices higher than .90 indicate that the sample size is excellent for running EFA.

Table 4

KMO and Bartlett's Test for Self-Efficacy Questionnaire

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.918
Bartlett's Test of Sphericity	Approx. Chi-Square	986.047
	Df	78
	Sig.	.000

The correlation matrix, based on which EFA is computed, should be suitable for running factor analysis. That is to say, the items (variables) that are supposed to measure a construct should have high correlations with each other; consequently, they should have low correlations with items loading under different factors. Bartlett's Test of Sphericity examines the correlation matrix to find if it is suitable for running EFA. If the results are significant, as is the case in Table 4.5 (χ^2 (78) = 986.047, $p < .001$), it can be determined that the self-efficacy data were factorable. It is worth pointing out that the outcomes of Bartlett's Test should be reported at .001 levels (Field, 2018; Tabachnick & Fidell, 2019).

Table 5 presents the number of factors extracted and the percentages of variance accounted for by the extracted factors. The results showed that a single factor was extracted as the underlying construct of self-efficacy which accounted for 55.11 percent of total variance.

Table 5

Total Variance Explained for Self-Efficacy Questionnaire

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.205	55.421	55.421	6.775	52.112	52.112
2	.951	7.316	62.737			
3	.928	7.139	69.876			

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Table 5

Total Variance Explained for Self-Efficacy Questionnaire

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
4	.807	6.209	76.085			
5	.604	4.646	80.731			
6	.537	4.129	84.860			
7	.446	3.431	88.291			
8	.356	2.735	91.025			
9	.277	2.134	93.159			
10	.260	2.001	95.160			
11	.238	1.830	96.990			
12	.205	1.574	98.564			
13	.187	1.436	100.000			

Extraction Method: Principal Axis Factoring.

Lastly, Table 6 shows the factor loadings of the 13 items of self-efficacy under the only extracted factor. Before considering the outcomes, it should be noted the factor loadings are similar to Pearson Correlations between the items and constructs; thus, they can be interpreted similar to the Pearson Correlation; i.e. .10 = weak, .30 = moderate, and .50 = large (Field, 2018). The results indicated that all items enjoyed large factor loadings; except for item 5 which showed a moderate factor loading.

Table 7 also shows the composite reliability (CR), and average variance extracted (AVE) indices which estimate the reliability of the construct, and percentages of convergent validity. The CR value of .932 was higher than .70 (Hair et. al, 2017) indicating that the extracted factor enjoyed an appropriate construct reliability index. The AVE for the factor; i.e., .711, was higher than .50 (Garson, 2016) indicating that there was a 71.1 percent chance that the extracted factor measured self-efficacy.

Table 6

Factor Matrix for Self-Efficacy Questionnaire

	Factor
	1
Self-Efficacy Factor; CR = .932, AVE = .711	
S12	.844
S11	.825
S10	.816
S4	.809
S7	.800
S6	.775
S8	.756
S2	.753
S9	.710
S3	.614
S13	.573
S1	.520
S5	.450

Construct Validity of Anxiety Questionnaire

An Exploratory Factor Analysis (EFA) was run using Principal Axis Factoring and Varimax rotation to probe the underlying constructs of the 15 items of the anxiety questionnaire. Since EFA extracted two factors, the selection of the Varimax rotation as the extraction method should justified.

It should be considered that EFA can be run via two rotation approaches; i.e. orthogonal and oblique. The former assumes that the factors underlying the instrument are independent; while the oblique rotation assumes that the factors are correlated. Varimax, Quartimax, and Equamax are methods of orthogonal rotation; while direct Oblimin and Promax are members of oblique rotation.

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The Component Correlation Matrix (Table 8) should be consulted to decide which rotation method should be employed. As noted by Dagdag et al. (2020), if all elements of the correlation matrix are all higher than ±.32, oblique rotation should be chosen; otherwise, orthogonal rotation should be selected. The Varimax Rotation method was applied because the result of the Component Correlation Matrix (Table 7) was lower than ±.32. These results indicated that there was a correlation of .01 between the two extracted factors.

Table 7

Component Correlation Matrix for Anxiety Questionnaire

Component	1	2
1	---	
2	.010	---

The number of factors being extracted was decided based on the findings of the Parallel Analysis Scree Plot (Figure 4). The plot suggested two factors to be extracted as underlying factors of self-efficacy.

Figure 4

Parallel Analysis Scree Plot for Anxiety Questionnaire

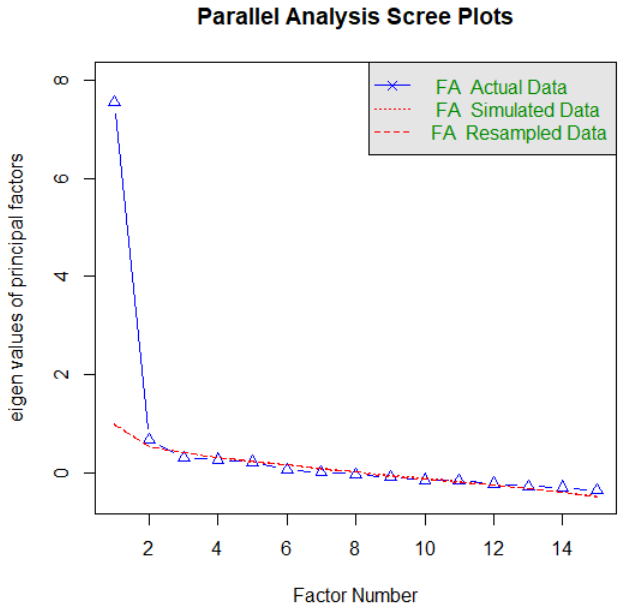

Table 8 shows the KMO index of sampling adequacy and Bartlett's Test of Sphericity. The KMO index of .901 indicated that the present sample size was "excellent" (Field, 2018).

Table 8

KMO and Bartlett's Test for Anxiety Questionnaire

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.901
Bartlett's Test of Sphericity	Approx. Chi-Square	1188.496
	Df	105
	Sig.	.000

The Bartlett's Test of Sphericity (χ^2 (105) = 1188.496, p < .001), it can be concluded that the anxiety data were factorable. It is worth pointing that the results of the Bartlett's Test should be reported at .001 levels; Pallant, 2016; Field, 2018; Tabachnick & Fidell, 2019).

Table 9 shows the number of factors extracted and the percentages of variance accounted for by the extracted factors. The results showed that two factors were extracted as the underlying construct of anxiety which accounted for 56.31 percent of total variance.

Table 9

Total Variance Explained for Anxiety Questionnaire

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.016	53.437	53.437	7.609	50.725	50.725
2	1.171	7.807	61.244	.838	5.587	56.311
3	.871	5.805	67.049			
4	.788	5.251	72.300			
5	.726	4.838	77.137			
6	.636	4.242	81.380			
7	.557	3.711	85.091			
8	.454	3.027	88.118			
9	.397	2.648	90.766			

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Table 9

Total Variance Explained for Anxiety Questionnaire

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
10	.376	2.509	93.275			
11	.307	2.045	95.320			
12	.237	1.577	96.897			
13	.213	1.420	98.317			
14	.136	.910	99.227			
15	.116	.773	100.000			

Extraction Method: Principal Axis Factoring.

Lastly, Table 10 shows the factor loadings of the 15 items of anxiety under the two extracted factors. The results indicated that all items enjoyed large factor loadings; except for items 1 and 3 which showed a moderate factor loading. Almost all items loaded under two factors; except for items 2, 4, 5, 6, 7, and 8. An inspection of the stems revealed that these five items tapped in to different topics; i.e. items 4 and 5 “fear of math exam”, item 2 “application of math knowledge”, item 6 “listening to teachers’ lecture”, item 7 “asking questions”, and item 8 “anxiety when solving problems”. Although no clear borderline can be drawn between the two factors, their CR indices were .855 and .821; while their AVE indices were .605 and .683.

Table 10

Factor Matrix for Anxiety Questionnaire

	Factor	
	1	2
First Factor; CR = .855, AVE = .605		
A6	.802	
A8	.768	
A7	.684	
A12	.606	.475

Table 10

Factor Matrix for Anxiety Questionnaire

	Factor	
	1	2
A11	.601	.530
A13	.578	.549
A10	.555	.411
A2	.514	
A3	.498	.322
A1	.443	.369
Second Factor; CR = .821, AVE = .683		
A5		.876
A4		.857
A14	.362	.636
A9	.534	.537
A15	.432	.511

Exploring Null-Hypothesis

The only null hypothesis raised in this study stated there was no significant relationship between self-efficacy and anxiety. The results of Pearson Correlation ($r\ (118^{1}) = -.654$ representing a large effect size[2], $p < .05$) (Table 12) specified that there was a significant, negative, and large relationship between self-efficacy and anxiety. Thus; the null hypothesis was rejected.

[1] It should be noted that the degree of freedom for Independent-Samples t-test equals n-2. Since the present sample size was 120, the degree of freedom was 118.

[2] Pearson correlation itself is an index of effect size, and can be reported using the following criteria; .10 = Weak, .30 = Moderate, and .50 = Large (Gray and Kinnear, 2012; p. 407; Pallant; 2016, p. 159; and Field, 2018, p. 179.

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Table 11

Pearson Correlation between Self-Efficacy and Anxiety

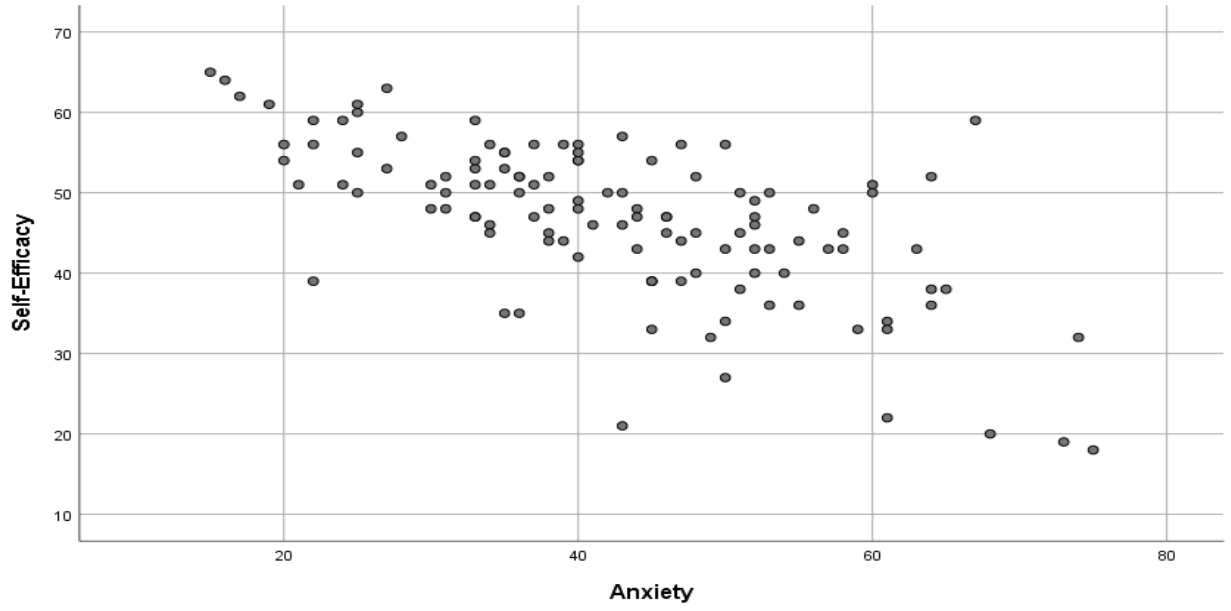
		Anxiety
Self-Efficacy	Pearson Correlation	-.654**
	Sig. (2-tailed)	.000
	N	120

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

It was mentioned earlier that Pearson Correlation, besides the assumption of normality, has two more assumptions i.e. linearity and homoscedasticity (homogeneity of variances). These two assumptions were examined through Figure 5. Based on this plot it can be determined that the statement of linearity was reserved. The spread of dots did not show any curve pattern. The spread of dots also did not pile up on one side of the plot leaving a narrow tail at the other end. These results supported the homoscedasticity assumption.

Figure 5

Correlation between Self-Efficacy and Anxiety



Descriptive Statistics for Items of Self-Efficacy Questionnaire

Table 12 shows the mean and standard deviations for the self-efficacy items. The results showed that items 6 (M = 4.01), and item 13 (M = 3.03) had the highest and the lowest means. Items 5 (SD = 1.26), and 6 (SD = .810) had the highest and lowest standard deviations.

Table 12

Descriptive Statistics for Self-Efficacy Items

	N	Mean	Std. Deviation
S1	120	3.86	1.169
S2	120	3.62	.989
S3	120	3.49	1.077
S4	120	3.59	1.057
S5	120	3.39	1.266
S6	120	4.01	.815
S7	120	3.58	.984
S8	120	3.98	.864
S9	120	3.24	1.077
S10	120	3.68	.909
S11	120	3.54	1.036
S12	120	3.71	.883
S13	120	3.03	1.104

Descriptive Statistics for Items of Anxiety Questionnaire

Table 13 shows the mean and standard deviations for the anxiety items. The results showed that items 5 (M = 3.55), and item 6 (M = 2.14) had the highest and the lowest means. Items 7 (SD = 1.312), and 6 (SD = 1.08) had the highest and lowest standard deviations.

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Table 13

Descriptive Statistics for Self-Efficacy Items

	N	Mean	Std. Deviation
A1	120	3.37	1.263
A2	120	2.44	1.114
A3	120	2.78	1.086
A4	120	3.43	1.288
A5	120	3.55	1.229
A6	120	2.14	1.183
A7	120	2.40	1.312
A8	120	2.46	1.180
A9	120	2.83	1.234
A10	120	2.95	1.215
A11	120	2.53	1.202
A12	120	2.62	1.264
A13	120	2.56	1.215
A14	120	3.31	1.333
A15	120	3.16	1.309

DISCUSSION

The findings of the investigation designated that there was a noteworthy association between anxiety and self-efficacy among students. It is associated with the point that as anxiety surges, self-efficacy beliefs decline. Consequently, the outcomes indicated that various features of anxiety interact differentially with self-efficacy principles. The outcomes are in line with earlier research findings which specified that anxiety is associated with reduced awareness of self-efficacy (Kavanagh, & Bower 1985; Stanley 2002). The findings of the present investigation are additionally in line with previous research which designated that anxiety is associated with self-efficacy beliefs (Grimm & Nachmias, 1977). Likewise, the effect is in the same vein with other experimental surveys which highlight similar associations in other academic contexts (e.g., Luo et

al., 2021; Moreno et al, 2021 & Naibert et al, 2021). The findings similarly support Kasapoğlu's (2022) results that self-efficacy becomes positive when convoyed by positive influence and good presentation in an academic setting. In addition, the findings are in line with Jaramillo et al.'s (2020) investigation that self-efficacy and anxiety levels are entirely related. In this vein, low self-confidence and self-efficacy with greater anxiety levels, enhanced the likelihood of failure in class settings and students' attainments.

CONCLUSION

The objective of the present study was to examine mathematics freshmen students' self-efficacy and their anxiety level and the relationship between these two constructs on students' academic performance. The overall result implied that there was a noteworthy, negative, and large association between self-efficacy and anxiety. The findings of this existing research could be effective in improving and enhancing mathematics students' decision-making ability and their skill to self-regulate during the learning process. Hence, learning as a cognitive process needs affective components (Passiatore et al.,2019). Since mathematics education vigorously offers scientific knowledge as it trains innovative thinking patterns to solve everyday problems, mathematics education needs to develop students' intellectual thinking. Thus, individuals' emotional experiences during mathematics learning are crucial to consider in an academic context. Students' mathematics learning experiences are determined using the learning model chosen by the teacher (Fitri et al., 2023; Chityadewi,2019). As the findings of the study revealed self-efficacy is an individual's belief in their ability to perform tasks and attain anticipated outcomes effectively. Besides, it stimulates students' motivation, effort, and academic attainment (Pajares & Schunk,2001). Thus, instructors can enhance students' self-efficacy and reduce their level of anxiety by providing opportunities for success, creating a helpful learning environment, and providing constructive feedback. All in all, inadequate and stressful learning experiences can lead to a lack of self-efficacy, which results in negative impressions such as anxiety (Hayat et al., 2021). This study was limited on the grounds that the students' motivation, age, and IQ could not be controlled by the researchers, though they might affect the outcomes.

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