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Enhancing Students' Mathematical Attitudes to Boost College Algebra Courses Success

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Abstract: This study uses five mathematical models to enhance students' mathematical attitudes towards academic achievement in college algebra at higher education institutions. The innovative graphical visualization of five models is what best captures this study's singularity. The five models are combined to assess a number of variables that contribute to students' enhanced mathematical attitudes towards academic achievement in college algebra. The suggested models will be helpful to higher education students, educators, and administrators everywhere. The research involved 120 female and 105 male students in various college algebra courses and was designed using a quantitative methodology. According to the findings, the top five models are, in order, the third, first, fifth, fourth, and second models. The third model explains 76% of the change in the mathematical motivation for academic achievement in college algebra. The first model accounts for 73.5% of the variation in mathematical motivation for academic achievement, followed by the fifth model (61.6%), the fourth model (58.8%), and the second model (50%).

Keywords: Academic achievement, college algebra, higher education, mathematical motivation

1 Introduction

Algebra is a substantial course that focuses on applying the four basic mathematical operations on variables and using mathematical equations to find the unknown numerical values of variables. It is very difficult to overstate how important algebra is in everyday life because it is used in a wide range of fields than just those related to Science, Technology, Engineering, and Mathematics (STEM), including those related to health, finance, accounting, economics, sports, and music. [1] suggest that algebra is beneficial in the field of health, i.e., the calculation of Body Mass Index (BMI) can't be performed without the use of certain algebraic equations.

It is emphasized by [2] that the calculation of market demand, supply, equilibrium status, income statement, balance sheet, and other financial statements is not possible without the close connection with algebra. [3] indicate that algebra is applied in the field of sports, i.e., the required force and distance are unintentionally calculated by football players to score a goal through the use of algebra. It is clarified by [4] that the speed and frequency of musical notes are unintentionally calculated by pianists through the use of algebra. In addition to scholars in the United States, Western civilizations, or other developed nations, the topic of the poor success rates in courses of college algebra has also drawn the attention of researchers in the United Arab Emirates and other Gulf Cooperation Council (GCC) nations. [5] indicate that factors like prior achievement, mathematics self-concept, perceptions of mathematics teachers, age, and high school grades are predictors of students' achievement in algebra at three Texas community colleges.

It is found by [6] that the best predictors of students' achievement in introductory college algebra are the past performance and experience factors of students including the Grade Point Average (GPA) and the number of accumulated credit hours. In order to predict students' performance in mathematics courses, [7] suggests a number of variables, including demographic data and the perception of students of their own arithmetic skills. According to [8], the largest influence on students' perceptions of autonomous support, competence, and accomplishment in college algebra is purposeful social support-building. It is emphasized by [9] that when some students are requested to solve a mathematical equation

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or complete a mathematical operation, they suffer from feelings like pressure, powerlessness, panic, paralysis, and lack of mental organization.

Therefore, this mathematics phobia causes students to have unfavorable attitudes toward arithmetic, stops them from being mathematically motivated, and eventually leads to subpar academic achievement in college algebra. [10] suggests that students' achievement in mathematics is influenced by students' motivation which has been studied by several researchers. Nevertheless, measuring students' mathematical motivation without taking into consideration other crucial elements like their judgments of their success in college algebra classes is quite difficult.

In spite of the fact that various studies analyzed several variables to forecast the academic achievement of students in college algebra [5], [6], [8], only a small number of studies paid enough attention to students' mathematical motivation for academic achievement in college algebra. As a result, the research study bridges the gap between students' attitudes and perceptions regarding their abilities and their mathematical motivation for academic achievement in college algebra courses.

The main contribution of this research study to the pertinent literature is emphasized by developing five mathematical models through a creative integration of graph-based visualizations to enhance students mathematical motivation for academic achievement in college algebra at institutions of higher education. Following the introduction, the paper has the following sections which include information about the significance of the research, literature review, research methodology, questionnaire design, factor analysis, regression analysis, mathematical modelling, findings, and recommendations. The study's limitations are presented in the paper's conclusion along with a summary of the research.

2 Research Significance

In order to close the gap between students' attitudes and perceptions regarding their mathematical ability and their mathematical motivation for academic achievement in college algebra, five mathematical models are proposed in this research study. The creative integration of the five mathematical models through a graph-based representation lends this study its originality and makes a substantial contribution to the body of literature on students' mathematical motivation for academic achievement in college algebra. The proposed models are expected to benefit not only students but also higher education institutions as well as societies all over the world. Students majoring in STEM or other closely related fields must complete college algebra in order to build a strong foundation, progress to higher-level mathematical courses, and acquire their chosen degrees. The five mathematical models are proposed to measure how the change in students' attitudes and abilities is related to their mathematical motivation for academic achievement in college algebra. Hence, the measurement of students' mathematical motivation for academic achievement in college algebra through the proposed models can be utilized to enhance their performance in courses of college algebra.

In addition to that, the proposed models might be employed by different colleges and universities to improve students' retention in STEM majors because college algebra provides students with the basic foundation for further advanced courses of mathematics. Therefore, the proposed models can be used by administrators of colleges and universities to measure students' attitudes, abilities, and mathematical motivation for academic achievement in courses of college algebra. This measurement helps in identifying students who have high levels of mathematical motivation for academic achievement in college algebra and students who have low levels of mathematical motivation which eventually supports in diminishing failure and withdrawal rates in college algebra courses at different colleges and universities.

3 Literature Review

Numerous studies looked at how well students performed in college algebra courses and assessed a number of predicting variables that have major theoretical and practical ramifications on students' mathematical motivation for academic achievement in college algebra [6], [8], [11], [12], [13]. The results of the research study conducted by [14] on college algebra students show that students' achievement in college algebra is negatively influenced by their poor self-concept.

The relationship between class scheduling and students' achievements in college algebra was analyzed by [15] and it is found that compressed schedules like 1-day-per-week classes are not the optimal option for learning college algebra since students scored the lowest scores in units tests and final exams compared with other students who enrolled in 2-day-per-week or 3-day-per-week classes. A model of elementary algebraic reasoning was proposed by [16] in order to formulate standards to identify purely arithmetic mathematical activity and differentiate it from progressive levels of algebraization. [17] reported on a formative assessment of the Hildesheim Teaching Concept of abstract algebra through the use of acceptance surveys from non-mathematical science education into mathematics education which contributed to the creation of a local theory to enhance students' learning of abstract algebra. The use of the bar model in the German school was proposed by [18] in order to support students in developing conceptually based transformations of

algebraic equations. It is emphasized by [19] that students are provided with opportunities to scrutinize systems of linear equations geometrically and algebraically for all types of existing solutions for all orders through the use of more problems.

According to [20], age and gender are significant predictors of students' performance in face-to-face college algebra courses in south Texas, but they have no impact of students' performance in an equivalent online college algebra course. The reviewed literature indicates that several factors have significant impact on students' mathematical motivation for academic achievement in college algebra such as mathematics self-perceptions of students [5], [14], [21], students' past experience and performance factors [6], [9], students' social-support building system [8], students' extrinsic motivation [22], teachers' beliefs about factors influencing the transfer of algebraic skills to students [23], learners' affective characteristics [24], students' demographic information [20], and scheduling of college algebra classes [15].

The attitudes and beliefs of students in college algebra courses encompass both their unique notions and their mathematical expertise, i.e., the required steps to divide a polynomial by a binomial, the essential procedures to solve a system of mathematical inequalities with two variables, and the necessary series of actions to perform a partial fraction decomposition. Furthermore, plenty of studies investigated different measures that could possibly enhance students' academic achievement in college algebra course through the implementation of strategies that fuel their interest, thus motivational component. For instance, applying cooperative learning Oluwasanmi [25], using the didactive manipulative material algebraic tiles [26], providing supplemental practice [27], integrating history topics of relevance [28], exploring learning difficulties by assessing students' understanding of group theory [29], utilizing a computer simulation approach [30], implementing game-challenge strategy [31], or sending periodical motivational text messages [32]. All the mentioned endeavors are reportedly having positive outcomes on mathematical motivation for academic achievement.

In other words, employing the mentioned approaches to engage students in the course emphasized their self-confidence through efficient understanding of algebraic concepts and increasing their overall enjoyment in mathematics. Several studies shed light on students' perceptions of themselves as learners of mathematics and the significant theoretical and practical ramifications in forecasting their mathematical motivation for academic achievement. It is reported by [33] that students' teams-achievement division instructional strategy enhanced students' attitudes toward mathematics and diminished their anxiety while studying quadratic functions in algebra courses. According to the results of [34], academically underprepared students with high levels of mathematics self-concept get higher final grades in college algebra than academically underprepared students with low levels of mathematics self-concept. The findings of [35] demonstrate that a number of factors, including students' mathematics self-concept, can predict both the intrinsic motivation and global motivation of students for success in calculus courses. Given that negative dispositions depreciate the academic achievement of students [36], improving the experience of students in college algebra is considerably a pivotal objective, which counteracts the negative impact college algebra has on students' mathematical disposition [37]. In light of previous studies, the central aim of this study is set to examine the impact of several factors in enhancing students' mathematical motivation for academic achievement in college algebra courses.

4 Research Methodology

A survey questionnaire was developed to collect the dataset for this study using a quantitative research methodology. In order to reach students taking algebra courses, numerous universities in UAE were contacted for this reason. The ethical permission was given by three institutions that accepted to participate in this research. One of the three universities is regarded as the earliest governmental higher education institution in UAE, while the remaining two are private universities. The study's participants were students taking algebra classes.

Using a simple random sampling procedure, students were asked to complete filling the survey questionnaire created for the study. There were 225 students in the sample, 105 of whom were male and 120 of whom were female. The self-determination theory [38], the attribution theory [39], and the mathematics self-concept theory [40] all served as the foundation for the questionnaire's design. These theories provided insight into students' motivation and mathematical self-concept in algebra courses. The questionnaire aimed at gauging how well students believe they are doing in their algebra courses in terms of their own knowledge, enjoyment, and success. The questionnaire's items were customized using a number of validated instruments, in addition to supplementary questions created to meet the study's main goal.

The validated instruments include the Intrinsic Motivation Inventory (IMI), the Motivated Strategies for Learning Questionnaire (MSLQ), the Self-Description Questionnaire (SDQ), and the Attitude Toward Mathematics Inventory (ATMI). The survey questionnaire was created by incorporating questions to gather demographic information about students and 55 items to collect the quantitative data. The items of the questionnaire were clustered into six sections to measure a total of six major variables. A 5-point Likert scale with

options ranging from strongly disagree (1) to strongly agree (5) was provided to students so they can choose how they want to respond to all 55 items. The SPSS 26.0 program was used to conduct the quantitative analysis.

5 Quantitative Results

This section analyzes the impact of five factors, embedded in five models, on students' mathematical motivation for academic achievement in college algebra, and compares the different extents of influence of each factor to one another. Each proposed factor is framed in a single model. It is worth noting that this study recognizes the dependent variable, as students' mathematical motivation for academic achievement in college algebra, whereas the independent variables are the importance of college algebra factor, perception of success factor, enjoyment of college algebra factor, expectations of potential jobs factor, and mathematics self-concept factor, framed in models I, II, III, IV, and V respectively.
Model I intends to study the impact of the importance and necessity of algebra courses on the study's main variable. Accordingly, the following hypothesis is formulated.
H_0: There is no relationship between the importance and necessity of algebra courses and students' mathematical motivation for academic achievement in algebra courses $(b = 0)$. Tables 1, 2 and 3 provide statistical insights into

Table 1: Model I Summary

R	R^2	Adjusted R^2	Std. Error of Estimate
.858[a]	.735	.734	9.90503

[a] Predictors: (Constant), Importance of College Algebra

Table 2: Model I ANOVA[a]

	Sum of Squares	DF	Mean Square	F	Sig.
Regression	59706.403	1	59706.403	608.56	.000[b]
Residual	21486.023	219	98.110		
Total	81192.425	220			

[a] Dependent Variable: Mathematical Motivation for Academic Achievement in College Algebra
[b] Predictors: (Constant), Importance of College Algebra

the functional link between students' perception of the importance and necessity of college algebra courses and their motivation for academic achievement. This is achieved by examining the model against multiple goodness-of-fit indicators to validate its reliability. According to Table 1, the coefficient of determination is 0.735, in turn, indicates that 73.5% of the variation in students' motivation for academic achievement in college

Table 3: Model I Coefficients[a]

	Unstandardized Coefficients B	Std. Error	St. Coefficients Beta (β)	F	Sig.
Constant	29.984	3.917		7.655	.000
Importance of College Algebra	2.828	.115	.858	24.669	.000

a. Dependent Variable: Mathematical Motivation for Academic Achievement in College Algebra

algebra courses is attributed to students' perception of algebra's importance and necessity. The value of the adjusted coefficient of determination, $(R^2_{Adj} = 0.734)$, exhibits a noticeable coherence with the value of the unadjusted one, which reflects well-grounded results. Hence, it is deduced that the data fit to the model is quite strong.

The relatively small value of the standard estimate of error also adds support to the solidity of the model. Furthermore, Table 2 suggests an excellent fit to the data through a high numerical F value equivalent to 608.568, and a p-value equal to zero. As a result of the p-value less than 0.01, the null hypothesis is rejected and the existence of a statistically significant relationship between the perception of the importance and necessity of algebra courses and students mathematical motivation for academic achievement in algebra courses is supported. Based on Table 3 , the values of the unstandardized, and standardized coefficients are 2.828, and 0.858 respectively. A diagrammatic representation of model I is shown in Figure 1. As shown in Figure 1, the significant influence of the importance and necessity of college algebra with $\beta = 0.858$ accounts for 73.5% of the enhancement in students' mathematical motivation for academic achievement in college algebra. A mathematical

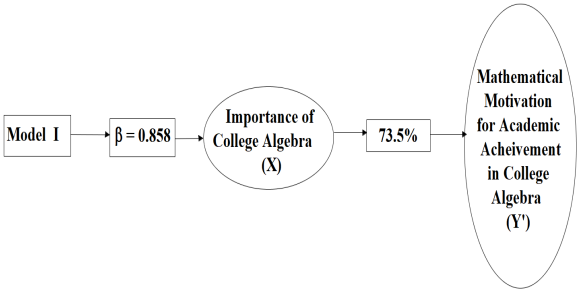

Fig. 1: Visualization of Model I Graph

linear model is formulated utilizing the regression analysis as the following:

$$Y' = a + bX + u,$$

$$Y' = 29.984 + 2.828X + u$$

Where Y' is the response variable; a is the intercept; b is the coefficient illustrating the extent of dependency of the response variable on the explanatory one; X is the independent variable; u is the stochastic error estimating the significance of additional probable explanatory variables.

Model II is designed to explore the impact of students perception of success in algebra courses on the study's main variable. Accordingly, the following hypothesis is proposed.
H_0: There is no relationship between students perception of success in algebra courses and students mathematical motivation for academic achievement in algebra courses $(b = 0)$.

Table 4: Model II Summary

R	R^2	Adjusted R^2	Std. Error of Estimate
.707[a]	.500	.489	13.6113

[a] Predictors: (Constant), Perception of Success in College Algebra

Table 5: Model II ANOVA[a]

	Sum of Squares	DF	Mean Square	F	Sig.
Regression	40619.861	1	40619.861	219.20	.000[b]
Residual	40572.5643	219	185.263		
Total	81192.425	220			

[a] Dependent Variable: Mathematical Motivation for Academic Achievement in College Algebra
[b] Predictors: (Constant), Perception of Success in College Algebra

Table 6: Model II Coefficients[a]

	Unstandardized Coefficients B	Std. Error	St. Coefficients Beta (β)	F	Sig.
Constant	28.435	6.599		4.309	.000
Importance of College Algebra	2.550	.172	.707	14.807	.000

a. Dependent Variable: Mathematical Motivation for Academic Achievement in College Algebra

Tables 4, 5 and 6 demonstrate statistical analysis of the relation between the perception of success in algebra courses and students mathematical motivation for academic achievement in algebra courses. Identical procedures to model I were performed to verify the reliability of the current model. According to Table 4 , the coefficient of determination for model II is 0.5, which suggests that 50% of the variation in students mathematical motivation for academic achievement in college algebra courses is accounted for students perception of success. The value of the adjusted coefficient of determination $(R^2_{Adj} = 0.498)$ reflects that the data fit to the model is fair. Correspondingly, the dependency of the response variable on the explanatory variable is considered relatively weak. Clearly, it can be interpreted that the effect of the second model on the response variable is by far weaker than the first model. Furthermore, Table 5 suggests a reasonable fit to the data through a numerical F value equivalent to 219.20, and a p-value equal to zero. Therefore, the null hypothesis is refuted, while the alternative hypothesis which dictates that a statistically significant relationship exists between the perception of success in algebra courses and students mathematical motivation for academic achievement in algebra courses is accepted. To add, based on Table 6 , the values of the unstandardized, and standardized coefficients are 2.550, and 0.707 respectively. Figure 2 displays a diagrammatic representation of model II. According to Figure 2, the augmentation in students mathematical motivation for academic achievement in college algebra is significantly influenced by their impression of success in college algebra, with $\beta = 0.707$ accounting for 50% of the enhancement. The following is a mathematical linear model created using regression analysis:

$$Y' = a + bX + u,$$

$$Y' = 28.435 + 2.550X + u$$

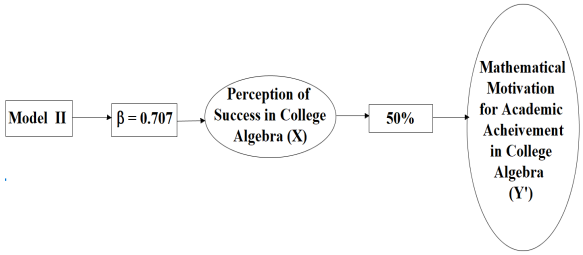

Fig. 2: Visualization of Model II Graph

Model III aims to interpret the impact of enjoyment of algebra courses on the study's dependent variable. Accordingly, the following hypothesis is formulated.
H_0: There is no relationship between the enjoyment of algebra courses and students mathematical motivation for academic achievement in algebra courses $(b = 0)$. Through the statistical analysis results tabulated in Tables 7, 8, and 9, students enjoyment factor contribution to their mathematical motivation for academic achievement in algebra courses is investigated. According to Table 7, the coefficient of determination for model III is 0.760, and the value of the adjusted coefficient of determination is 0.759, in turn reflecting that the data fitting to the model

Table 7: Model III Summary

R	R^2	Adjusted R^2	Std. Error of Estimate
.872[a]	.760	.759	9.43105

[a] Predictors: (Constant), Enjoyment of College Algebra

Table 8: Model III ANOVA[a]

	Sum of Squares	DF	Mean Square	F	Sig.
Regression	61713.533	1	61713.533	693.84	.000[b]
Residual	19478.892	219	88.945		
Total	81192.425	220			

[a] Dependent Variable: Mathematical Motivation for Academic Achievement in College Algebra
[b] Predictors: (Constant), Enjoyment of College Algebra

Table 9: Model III Coefficients[a]

	Unstandardized Coefficients B	Std. Error	St. Coefficients Beta (β)	F	Sig.
Constant	54.613	2.754		19.830	.000
Enjoyment of success in College Algebra	1.950	.074	.872	26.341	.000

a. Dependent Variable: Mathematical Motivation for Academic Achievement in College Algebra

is strong. It could be interpreted that of 76% of the variation in the response variable is attributed to the explanatory variable. Furthermore, ANOVA analysis suggests a robust fit of the regression model to the data through a high numerical F value equivalent to 693.84, and a p-value equal to zero. Comparatively, it can be concluded that the effect of the third model on the response variable is slightly stronger than the first, and by far stronger than the second. Hence, the null hypothesis is rejected, and the alternative hypothesis is accepted. Moreover, based on Table 9, the values of the unstandardized, and standardized coefficients are 1.950, and 0.872 respectively. Figure 3 illustrates model III in diagrammatic format. Figure 3 demonstrates that the large impact of college algebra enjoyment, with $\beta = 0.872$, accounts for 76% of the enhancement in students mathematical motivation for academic accomplishment in college algebra. A mathematical linear model is generated utilizing the regression analysis as the following:

$$Y' = a + bX + u,$$

$$Y' = 54.613 + 1.950X + u$$

Model IV aims to interpret the impact of prospective income and career expectations on the study's main variable. Accordingly, the following hypothesis is proposed.

H_0: There is no relationship between the prospective income and career expectations and students' mathematical motivation for academic achievement in algebra courses $(b = 0)$. The relationship between

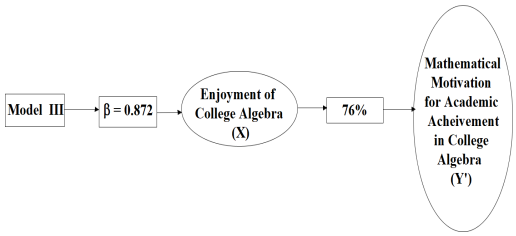

Fig. 3: Visualization of Model III Graph

Table 10: Model IV Summary

R	R^2	Adjusted R^2	Std. Error of Estimate
.766[a]	.588	.586	12.36631

[a] Predictors: (Constant), Prospective Income and Career Expectations

Table 11: Model IV ANOVA[a]

	Sum of Squares	DF	Mean Square	F	Sig.
Regression	47701.693	1	47701.693	311.92	.000[b]
Residual	33490.732	219	152.926		
Total	81192.425	220			

[a] Dependent Variable: Mathematical Motivation for Academic Achievement in College Algebra
[b] Predictors: (Constant), Prospective Income and Career Expectations

Table 12: Model IV Coefficients[a]

	Unstandardized Coefficients B	Std. Error	St. Coefficients Beta (β)	F	Sig.
Constant	58.884	3.846		15.309	.000
Prospective Income and Career Expectations	3.813	.216	.766	17.661	.000

a. Dependent Variable: Mathematical Motivation for Academic Achievement in College Algebra

students expectations factor for their prospective income and career and their mathematical motivation for academic achievement college algebra is analyzed in Tables 10, 11, and 12. Primarily, the coefficient of determination is 0.588, and the adjusted coefficient of determination is 0.586. This suggests that a minor proportion, almost 0.2%, of the mathematical motivation component is attributed to chance. Correspondingly, the dependency of the response variable on the explanatory variable is considered good. Furthermore, Table 11 suggests a reasonable fit to the data through a moderate numerical F value equivalent to 311.926, and a p-value equal to zero. To deduce, an inferior relationship exists between the response variable and the explanatory one, sharing roughly the same rank of influence as model II. A diagrammatic depiction of model IV is shown in Figure 4. As indicated in Figure 4, the change in students'

mathematical motivation for academic achievement in college algebra is influenced by their prospective income and career expectations, with $\beta = 0.766$ accounting for 58.8% of the enhancement. The regression analysis is used to create the following mathematical linear model:

$$Y' = a + bX + u,$$

$$Y' = 58.884 + 3.813X + u$$

Model V aims to interpret the impact of the global

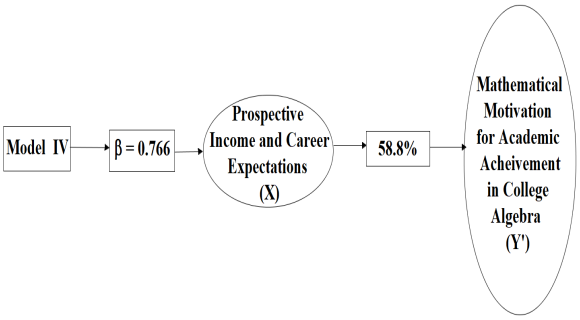

Fig. 4: Visualization of Model IV Graph

self-concept on the study's dependent variable. Accordingly, the following hypothesis is formulated.
H_0: There is no relationship between the mathematics self-concept and students' mathematical motivation for academic achievement in algebra courses $(b = 0)$. The

Table 13: Model V Summary

R	R^2	Adjusted R^2	Std. Error of Estimate
.785[a]	.616	.614	11.92831

[a] Predictors: (Constant), Global Mathematics Self-Concept

Table 14: Model V ANOVA[a]

	Sum of Squares	DF	Mean Square	F	Sig.
Regression	49439.641	1	49439.641	347.48	.000[b]
Residual	30874.797	217	142.280		
Total	80314.438	218			

[a] Dependent Variable: Mathematical Motivation for Academic Achievement in College Algebra
[b] Predictors: (Constant), Global Mathematics Self-Concept

proposed hypothesis is tested by the statistical analysis presented in Tables 13, 14, and 15. The adjusted and unadjusted coefficients of determination are 0.614 and 0.616 respectively. It is interpreted that 0.2% of the

Table 15: Model V Coefficients[a]

	Unstandardized Coefficients B	Std. Error	St. Coefficients Beta (β)	F	Sig.
Constant	45.498	4.361		10.432	.000
Global Mathematics Self-Concept	1.136	.061	.785	18.641	.000

a. Dependent Variable: Mathematical Motivation for Academic Achievement in College Algebra

mathematical motivation component is attributed to other factors. Correspondingly, the dependency of the response variable on the explanatory variable is moderately strong. Furthermore, Table 14 suggests a reasonable fit to the data through a numerical F value from ANOVA analysis is equivalent to 347.481, and a p-value equal to zero. Hence, a statistically significant relationship exists. Accordingly, the rank of self-concept influence on mathematical motivation is intermediating between the highly influential factors in models I and III, and the minimally influencing ones in models II and IV. A diagrammatic representation of model V is shown in Figure 5. As shown in Figure 5, the significant influence of the global mathematics self-concept with $\beta = 0.785$ accounts for 61.6% of the enhancement in students mathematical motivation for academic achievement in college algebra.

The following is a mathematical linear model prepared using regression analysis:

$$Y' = a + bX + u,$$

$$Y' = 45.498 + 1.136X + u$$

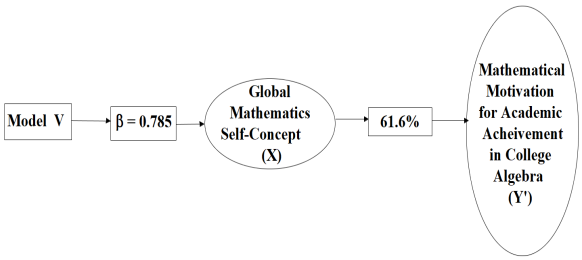

Fig. 5: Visualization of Model V Graph

6 Discussion

Through creating and combining five mathematical models, this study assesses the relation of students' perception of importance of college algebra courses, students' perception of success in college algebra courses,

students' enjoyment in learning college algebra courses, students' expectations of future careers and incomes, and students' mathematical self-concept, with motivation for academic achievement in college algebra courses. Mathematicians, instructors, STEM program administrators, and higher education institutions may utilize the impact of these five strands of motivation and self-concept on academic achievement in college algebra courses. Thus, they can earn the ability to analyze the impact of the measured achievement precursors on students' success. Models I, II, III, IV, and V study five variables impact, as demonstrated in Figure 6. It is deduced from the ANOVA analysis that the models impacts arranged from highest to lowest is model III, model I, model V, model IV, followed by model II. Firstly, model I provides insights into the functional link between students' perception of the importance and necessity of college algebra courses and motivation for academic achievement. Statistical analysis indicates that 73.5% of the variation in students motivation for success in college algebra courses is attributed to students' perception of algebra's importance and necessity. These results agree with [41] which dictated that recognition of the importance of courses, and acknowledgement of their significance to complement other courses positively contribute to students motivational component, thus academic achievement in the course. Also, [42] share the same findings. Secondly, model II suggests that a weak relationship exists between students perception of success and mathematical motivation for academic achievement. This relation is explicitly emphasized in the self-determination theory by [38], suggesting that the identification regulation level displays a considerable internal motive contribution which is caused by the personal perception of the value of the activity. Hence, the existence of the relationship between the perception of success and motivation for academic success was indicated earlier and confirmed in this study [43].

Thirdly, model III related the students enjoyment in learning college algebra courses, and their motivation for academic achievement. Statistical analysis displayed maximum relatedness between the factor and study variable, with 76% of the variance in the study variable being due to changes in the factor. Multiple research articles proposed and verified this strong and positive relation, by reinforcing the enjoyment factor through integrating interesting supplemental material into the coursework and evaluating the subsequent academic success rates [32], [44], [12]. Furthermore, model IV assesses the relationship between students' expectations factor for their prospective income and career and their mathematical motivation for academic achievement in college algebra.

Correspondingly, the dependency of the response variable on the explanatory variable is weak, sharing roughly the same rank of model II. This finding is analogous to corresponding research studies that evaluated the same relation [45]. [46] found positive small to medium correlations between the students' expectations factor for their prospective income and career and their mathematical motivation for academic achievement. Lastly, model V investigated the impact of global self-concept on the study variable. Accordingly, 61.6% of the variance in the mathematical motivation component is attributed to the global self-concept variations among students. This intermediate impact of approximately 60% is supported by several literature [47], [48], [49].

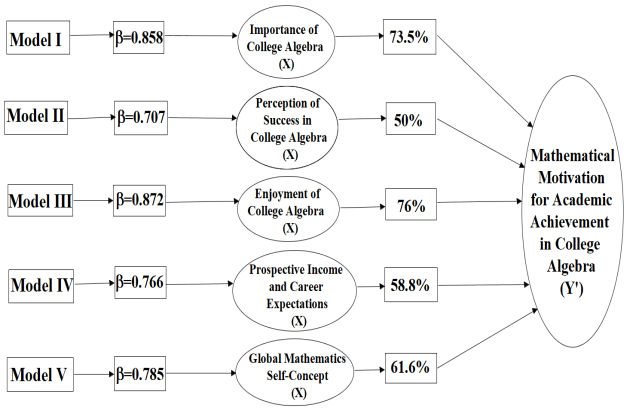

Fig. 6: Visualization of Five Integrated Models

7 Conclusion

In mathematics education research, examining factors that affect academic achievement has garnered empirical attention because it might reveal potential areas for improvement in teaching and learning methods. Accordingly, the aim of this research revolves around scrutinizing the effect of self-concept, and motivational strands on the academic achievement of students in college algebra courses, in STEM programs at higher education. Graph-based visualizations (Figure 6) of the five models gauge students motivation, and self-concept levels and forecast their success in college algebra courses.

Five predictors, perception of importance of college algebra, perception of success in college algebra, enjoyment level, future income and career expectations, and global mathematical self-concept, were studied in detail and their influence on the motivation for academic achievement in college algebra courses was statistically analyzed by collecting 225 responses from students studying college algebra courses in three different institutions in UAE. It is concluded that all the studied

factors have positive impacts of various magnitudes on the study's dependent variable. Delight of learning college algebra courses has the highest predictive ability (73.5%), while the least influential is students perception of success in college algebra (50%). The below-proposed recommendations aim to highlight certain important aspects for supporting an efficient learning process. 1. Demonstrating to students the value and significance of college algebra courses by having them to practically apply it. 2. Enhancing students perceptions in college algebra by exposing and aiding them in solving all levels of questions from easy to difficult. 3. Raising students interest bar by delving into new and challenging aspects in college algebra coursework. 4. Inspiring children to pre-set future goals and visualize their careers and living standards while they prepare for it. 5. Nurturing students self-confidence in their ability to learn college algebra courses, thereby improving the cognitive aspect of their perceptions of algebra.

8 Limitation

This study was conducted on students in UAE to evaluate their extent of motivation for academic achievement based on several factors. As a result, all responses are extracted from individuals belonging to an identical community, which may not be necessarily applicable to other regional areas. Accordingly, performing this study in other regions could significantly verify our results and reinforce their applicability.

9 Ethical Statement

The study was approved by the Research Ethics Committee at one university. The other three universities did not have specific protocols. The approvals were given by the research directors either in person or via email. The students gave their informed consent after being told that their participation was completely voluntary and they can withdraw at any time. The responses provided by students were treated with strictest confidentiality and were used for research purposes only.

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