Publisher: Centre for Behaviour and Wellness Advocacy, Ghana
Co-publisher: Cherkas Global University, USA
Has been issued since 2014
ISSN 2410-4981. E-ISSN 2508-1055
2024. 11(3): 412-423

DOI: 10.13187/jare.2024.3.412

Journal homepage:
http://kadint.net/our-journal.html

Mathematical Skills Applied in Finance and their Relationship with Academic And Personal Variables: Empirical Study in College Students

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Abstract

This research aims to determine the relationship between mathematical skills applied in finance and the academic and personal variables of college students. The results of the ordered Probit regression model show the mathematical competencies of the students according to their professional area of study, gender and employment condition. It is more likely that students in the "economic-administrative" area, compared to students in the engineering area, have mathematical skills to perform basic numerical operations, ratios and proportions, as well as apply formulas that involve financial concepts. The sample was 309 university students who were studying in the last semester of their bachelor's program. The sample is made up of students enrolled in public and private universities, belonging to the Municipality of Veracruz, Mexico. The questionnaire was structured in two sections. The first section includes questions about the student's personal and academic characteristics. The second section includes 23 questions, with multiple-choice answers, with only one answer being true. To explain the behavior of the dependent variable, as well as mathematical skills, with ordered response options, the ordered Probit response model is used. The results show the role of the students' employment status in relation to mathematical skills to perform basic arithmetic operations related to spending, personal budget and calculations of variation of quantities and amounts. The results of the research suggest strengthening the mathematical competencies of university students in personal finance topics, which allows them to promote informed financial decision-making.

Keywords: Mathematical Skills, Mexico, Ordered Probit, University Students.

1. Introduction

Several studies indicate that mathematical competence has gained significant attention in recent years (Adusei, Sarfo, 2020; Balbás, 2008; Figueroa-Rodríguez, 2017; Granados-Ramos et al., 2018; Ministerio de Educación, 2013; Muyo, Valdari, 2020; Nwosu et al., 2020; Sarfo et al., 2020). The challenges in financial economics are becoming increasingly complex, requiring the use of mathematical procedures. This has been evident in areas such as financial problem-solving, asset valuation, investment selection, asset management risks, and risk measurement, all of which are characterized by the application of mathematical methods (Balbás, 2008).

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Received: 14 August 2024 Revised: 20 November 2024 Accepted: 24 November 2024
Published: 31 December 2024

Today, people are immersed in daily activities that require basic or more advanced mathematical-financial calculations. These activities demand knowledge of calculus and, in some cases, more specialized skills, including algebra, probability, statistics, etc. In the educational context, both mathematical competencies and didactic strategies are necessary to help students develop sound judgment and make reasoned decisions when faced with mathematical problems in their everyday lives (Íñiguez, 2015). Therefore, students need more knowledge, particularly in science, but most importantly, in mathematics and finance. This foundational knowledge is essential for navigating various situations within their context, while also contributing to the overall educational development of the country. Such skills are crucial in daily life, aiding individuals in managing their finances and assets, including budgeting (Muyo, Valdari, 2020). The National Research Council (2001) emphasizes that all young people must learn to think mathematically and use this thinking to learn effectively.

In addition to the above, mathematics must be taught from a practical perspective, relevant to real-life situations, and not just abstract problems where processes are unclear. From a consumer standpoint, mathematics must be applied daily, for instance, in calculating interest rates, taxes, etc. These are areas where the mathematics learned in school will be directly applicable (Muyo, Valdari, 2020).

The National Research Council (2001) highlights the importance of young people understanding mathematics and adopting these skills to apply them effectively in their professional environments, through tools like computer graphics or in personal settings, such as using spreadsheets. Given market trends, there is an increasing need for agility in handling data tables, graphs, and formulas, which leads to clearer, more efficient, and effective decision-making.

Thus, mathematical and financial competencies must be integrated into the training of university students, who should recognize the importance of acquiring this knowledge (Muyo, Valdari, 2020). Additionally, Jayaraman, Saigeetha, and Kenneth (2018) note that the level of financial literacy among young people worldwide remains low. These gaps in financial education have significant implications for both the broader economy and the financial well-being of individuals.

Question Research

From the above, the research question emerges: Is there a relationship between the mathematical skills that the university student has, to perform operations and calculations in finance, with academic and personal variables? Therefore, the following objective is established: determine the relationship between the mathematical skills applied in finance by university students, with academic and personal variables.

From the arguments presented, the following hypotheses emerge:

Hypotheses

H1. The basic arithmetic mathematical skills that college students have, for personal spending and budget operations, are related to academic and personal variables.

H2. The basic arithmetic mathematical skills that college students have, for financial charge operations of loans and investments, are related to academic and personal variables.

H3. The mathematical skills of sequences and algebraic operations that college students have, to calculate the return on an investment, are related to academic and personal variables.

H4. The mathematical skills of fractions and percentages that college students have, for calculating commissions of financial variables, are related to academic and personal variables.

H5. The mathematical skills of the concept of variation that college students have, for calculating variations of percentages or quantities, are related to academic and personal variables.

H6. The mathematical skills of the concept of ratio and proportion that college students have, to formulate and calculate proportions, are related to academic and personal variables.

H7. The mathematical skills of the concept of financial function that college students have Organization for Economic Co-operation and Development to make financial decisions that involve the interest rate are related to academic and personal variables.

2. Literature review

The mathematical skills of the population and its relationship with financial decision-making have gained relevance in recent years (Jayaraman et al., 2018; OECD, 2020; OECD, 2017). The results reported in several studies highlight a strong correlation between students' performance in financial topics and their mathematical skills (Liang et al., 2022; OECD, 2020;

Villagómez, Hidalgo, 2017). Financial decisions involve the use of money, which is why mathematical knowledge is required (OECD, 2019).

Mathematical competence is the ability of people to know and understand the role that mathematics plays in the world. In the same way, help to satisfy their needs regarding their personal life or, as responsible, constructive and reflective citizens, they transmit informed judgments using and relating mathematics (OECD, 2003).

Mathematics has been a crucial element for the development of several fundamental topics of financial economics; some topics are those related to financial markets, for example, the topic of investments, risk, among others (Balbás, 2008). In this regard, Liang et al. (2022) report that students' financial performance is positively related to mathematical skills (arithmetic, algebra, problem-solving process).

Knowledge in science and technology has always been an integral part of mathematics, therefore the instrumental and social role of mathematical competence has allowed it to be a key tool to interpret, understand and provide solutions to the problems of our environment (Ministerio de Educación, 2013). Consequently, numerical information revolves around people's daily lives (Granados-Ramos et al., 2018). In their work, Muyo and Valdari (2020) analyze mathematics and finance together, they suggest that to improve mathematical competence, it is essential to find where, when and how students should use the knowledge acquired to use it outside of school.

In the development of daily activities such as calculating the time to move from one point to another, the amount of money that must be paid for a certain product, etc., knowledge of mathematics is required. This knowledge is learned from early stages through their interaction and classification of objects with which they interact in their environment. This knowledge is strengthened and increased when entering school and learning to solve problems in their daily lives using numbers through; addition, subtraction, multiplication and division (Granados-Ramos et al., 2018).

Mathematical competence must be characterized by being applied in real or simulated contexts of the student's life (Rico, 2006; Alsina, 2009). Hence, the student who constantly has contact with mathematics in real life requires solving problems through mathematical modeling. To develop people's level of financial education, it is essential to know about financial problems that lead to making financial decisions and through this achieve appropriate financial behavior (Muyo, Valdari, 2020).

Lacking mathematical reasoning is synonymous with being excluded from the various areas and activities of the human being. Lack of mathematical skills limits their opportunities to be competent in everyday tasks (National Research Council, 2001). Regarding the relevance of mathematical skills applied in finance, Jayaraman et al. (2018) consider that there is a strong relationship between financial knowledge and arithmetic knowledge, therefore, the effective increase in arithmetic skills can help increase financial education.

For their part, Erner et al. (2016) point out that mathematical competency are related to basic financial education. In people's daily activities, it is essential to keep adequate control of their daily expenses, as well as planning future expenses in accordance with their monthly income received, by incurring basic purchases such as their expenses in cash or with bank cards, among others. If the person has mathematical and financial skills, this can contribute to appropriate behavior in terms of expense planning based on their income level (Muyo, Valdari, 2020).

Regarding the academic and personal variables, García (2016) states that the origins of the differences between genders may be due to the qualities, behaviors and identities that arise through the socialization process. These inequalities arise due to power relations, such as access to decisions and resources. The different positions of women with respect to men, are related by historical, economic, cultural and educational realities. In this idea, Indrahadi and Wardana (2020) reported the significant impact of sociodemographic, personal and academic variables on the academic performance of students; among their findings, they identified that those students belonging to public schools obtained better performance compared to those belonging to private schools.

Females have lower participation in the stock market and obtain lower scores in financial education than men (Almenberg, Dreber, 2012). Lemaster and Strough (2014) and Almenberg and Dreber (2012) agree that women are less intolerant of risk than men are, and the male sex takes greater risks. For their part, Liang et al. (2022) identify that male students obtain higher scores in problem-solving; likewise, students who have taken a calculus course at university obtain higher scores on mathematics tests compared to those who have not taken it.

3. Methods and Materials

Research Design

The objective of this research is to determine the relationship between mathematical skills applied in finance by university students, with academic and personal variables. The study is descriptive, correlational, and non-experimental. The sample was 3,098 university students who are studying the last semester of their bachelor's program during the semester January to June 2022. The sample is made up of students enrolled in public and private universities, belonging to the Municipality of Veracruz, Mexico.

Sample

The type of sampling is non-probabilistic due to self-determination. Data collection is carried out through the application of a questionnaire applied online, through the Google Forms tool. Information gathering is carried out during the months of May to November 2022.

Instrument

To obtain the data, a hybrid instrument is designed based on the scales proposed by Mandell and Kline (2009); Lusardi and Mitchell (2008, 2011); CFI Official Global Provider of the Financial Modeling and Valuation Analyst (FMVA)™; Certification Program (2015); Tecnológico de Costa Rica (TEC) (2017); and LearningExpress (2017).

The questionnaire was structured in two sections. The first section includes questions about the student's personal and academic characteristics (sex, age, family life, employment status, type of university where they study, and area of their profession). The second section includes 23 questions, with multiple choice answers, with only one answer being true. The questions allow us to identify the mathematical skills that the student has to perform calculations and operations in financial matters.

Table 1 presents the operationalization of the primary variable of this research, mathematical skills applied to finance topics.

Table 1. Operationalization of mathematical skills applied to finance topics

Mathematical knowledge	Kind of mathematical calculus	Ability	Applied to finance topics
Arithmetic basic	Basic numerical operations	Do addition and subtraction	3 questions related to the personal spending and income budget.
Arithmetic basic	Basic numerical operations	Solve arithmetic problems based on basic arithmetic	2 questions related to financial charges for loans and investments
Sequences and algebraic operations	Operations with sequences and obtaining the general term	Apply the concept of geometric sequences and perform algebraic operations	4 questions related to the performance of an investment
Fractions and percentage	Mathematical calculus with decimals and proportions	Calculate the percentage of a given amount in conjunction with arithmetic operations	3 questions related to the calculation of commissions
Variation	Basic numerical operations with decimals and proportions	Calculate the percentage and absolute variation of a quantity	3 questions related to the variation of percentages or amounts
Ratio and proportion	Ratio and proportion operations	Formulate expressions that involve the of ratio concept	3 questions related to the ratio and proportion of monetary quantities and amounts
Function	Apply pre-established financial functions	Apply financial functions for decision making	5 questions related to financial decision making that involves the interest rate

Analyzing of Data

For each mathematical knowledge, an indicator or unit of measurement is constructed, which is obtained from the sum of correct answers to questions on financial topics. The indicator can take the value 0,1,2,3,4,5 depending on the number of questions that make it up. (For example, the basic arithmetic indicator regarding basic numerical operations can take the value of 0, 1, 2 or 3).

Statistical procedure

According to the values that the indicator can take, the ordered Probit model is used, according to the proposal of Villagómez and Hidalgo (2017). The independent variables are categorical and are coded as follows: the sex variable takes the value of 1 if the respondent is a man and 0 if the respondent is a woman. The variable called family coexistence is made up of three categories (lives alone, lives with his parents, lives with his partner), for which a dichotomous variable is designed per category. The employment condition variable takes a value of 1 if the respondent studies and works, and a value of 0 if they only studies.

The dichotomous variable type of university takes the value of 1 if the respondent studies at a public university, and a value of 0 if the respondent studies at a private university. The professional area variable takes the value of 1 if the respondent studies a degree in the economic-administrative area and 0 if the respondent studies an engineering degree. Table 2 show the numerical characteristics of the sample.

Table 2. Numerical characteristics of the student sample

Variable	Category	Total cases	%
All		**294**	**100**
X1: gender	Female	177	60.2
	Male	117	39.8
X2: family coexistence	Live alone	35	11.9
	Live with parents	234	79.6
	Live with	25	8.5
X3: labor status	Only study	137	46.6
	Study and work	157	53.4
X4: University where study	Private University	182	61.9
	Public University	112	38.1
X5: Professional profile	Engineering	82	27.9
	Economic-Administrative	212	72.1

To explain the behavior of the dependent variable (y), as well as mathematical skills, with ordered response options, the ordered Probit response model is used (Wooldridge, 2010).

The observed variable takes integer values 0,1,2,3,4,...,J; y^* is a latent variable that is continuous, determined by the equation, $y^* = X\beta + e$; β is a vector size (Kx 1), X which denote the characteristics of the surveyed, $e \sim N(0,1)$, which is a stochastic term and N is the cumulative normal distribution function. Therefore, α_1<α_2<⋯<α_J, be cut-off points (threshold parameters) whose values are unknown. The relationship between the observed variable and the estimated variable is given as follows:

$$y = 0 \ \ if \ \ y^* \leq \alpha_1; \ \ y = 1 \ if \ \ \alpha_1 < y^* \leq \alpha_2 \ ; \ y = J \quad if \ \ y^* > \alpha_J.$$

The parameters $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ are estimated by the maximum likelihood method. For each knowledge of mathematical skills, a model is estimated (y_i):

Model (y_1): math skills for spending and budgeting operations
Model (y_2): mathematical skills to calculate financial charges for loans and investments
Model (y_3): mathematical skills to calculate the return on an investment
Model (y_4): mathematical skills for calculating commissions
Model (y_5): mathematical skills to calculate variations expressed in percentages
Model (y_6): mathematical skills for calculating proportions

Model (y_7): mathematical skills for calculating financial interest

The independents variables are: X1: gender, X2: family coexistence, X3: labor status, X4: type of university, X5: professional profile.

Table 3 shows the descriptive statistics of mathematical skills. For each mathematical skill, the value of the mean of correct answers, median, standard deviation, minimum and maximum value is presented.

Table 3. Descriptive statistics of mathematical skills applied to finance topics

Variable	Mean	Median	Std Dev.	Mínimum	Maximum
y_1	2.37	3.00	0.798	0.000	3.00
y_2	0.459	0.000	0.587	0.000	2.00
y_3	2.40	3.00	1.15	0.000	4.00
y_4	1.79	2.00	0.761	0.000	3.00
y_5	1.73	2.00	0.846	0.000	3.00
y_6	1.44	1.00	0.909	0.000	3.00
y_7	2.46	2.00	1.13	0.000	5.00

Table 4 shows the results of the estimation of the ordered Logit regression model for each of the mathematical skills related to the characteristics of the students. The results of each of the models are described below, emphasizing those significant variables. From model 1, it is found that students in the work condition "study and work", compared to students who only study, is less likely to ($\beta = -0.61, p < 0.01$) who have the mathematical skills to perform basic arithmetic operations related to personal spending and budget. While that the students in the economic-administrative professional area, compared to those students who study engineering, are more likely ($\beta = 0.64, p < 0.05$) that they do have these skills. The previous results support hypothesis 1, regarding the relationship of basic arithmetic mathematical skills with the student's employment status and their professional profile.

From model 2, it is found that male students, compared to female students, are more likely to have basic arithmetic mathematical skills to calculate financial charges for loans and investments($\beta = 0.51, p < 0.05$). In addition, students in the "economic-administrative" professional profile, compared to those students who study engineering, are more likely to have these skills. The result supports hypothesis 2, regarding the relationship between the basic arithmetic mathematical skills that the student has and its relationship with the student's gender and professional profile($\beta = 0.69, p < 0.05$). Regarding model 3, evidence was obtained that students in the economic-administrative professional profile, compared to students in the engineering area, are more likely to have mathematical skills. This math skill allow them to perform operations with geometric sequences and apply formulas to make algebraic calculations that involve financial concepts as simple and compound interest rate on a bank deposit or loan and inflation and its effect on the time value of money ($\beta = 0.73, p < 0.05$). The result supports hypothesis 3, regarding the relationship between the mathematical skills of succession and application of formulas that the student has and its relationship with the professional profile.

Regarding model 4, evidence was obtained that students belonging to the "study and work" employment condition, compared to students who only study, are less likely to have mathematical skills to perform operations with fractions and calculation of percentages of commissions on costs, profits, prices and sales of goods (β = -0.49, $p<0.05$). The result supports hypothesis 4, regarding the relationship between the mathematical skills of operations with fractions and percentages that the student has and its relationship with employment status.

Regarding the model 5, it was possible to verify that the group of men, compared to female students, is more likely ($\beta = 0.47$, $p < 0.05$) to have mathematical skills to calculate the variation of an absolute quantity and that expressed in percentage terms. The result supports hypothesis 5, regarding the relationship between the mathematical skills for calculating variations that the student has and its relationship with gender.

Finally in model 6, evidence was obtained that students in the family coexistence condition, live with a partner, compared to students who live alone, are less likely to have mathematical skills

to perform calculations that involve the concept of ratio and proportions in buying and selling activities (β = -1.22, p<0.05). While, students in the economic-administrative professional profile, compared to those students who study engineering, are more likely to have these skills (β=0.71, p < 0.05). The result supports hypothesis 6, regarding the relationship of mathematical skills to formulate expressions that involve the concept of ratio and proportions that the student has and its relationship with the condition of family coexistence and the professional area. In model 7, there is no significant differences by groups, regarding the mathematical skills to apply financial functions for making savings and investment decisions.

Table 4. Ordered Logit estimates: dependent variable (mathematical skill)

Independent variables	**Model (y_1)**	**Model (y_2):**	**Model (y_3):**	**Model (y_4):**	**Model (y_5):**	**Model (y_6):**	**Model (y_7):**
X1: Gender (REF=Female)							
Male	−0.25 (0.24)	0.51** (0.25)	0.33 (0.22)	0.09 (0.24)	0.47** (0.23)	-0.15 (0.22)	0.18 (0.22)
X2: Family coexistence (REF= live alone, live with his parents	0.41 (0.35)	0.42 (0.40)	-0.29 (0.31)	0.43 (0.35)	-0.07 (0.35)	-0.06 (0.32)	0.27 (0.35)
lives with his partner	0.10 (0.51)	0.84 (0.55)	-0.80 (0.49)	-0.11 (0.49)	0.10 (0.51)	-1.22** (0.50)	0.13 (0.50)
X3: labor status (REF= only study)							
Study and work	−0.61*** (0.23)	-0.20 (0.24)	-0.17 (0.21)	-0.49** (0.23)	-0.05 (0.22)	-0.26 (0.21)	0.10 (0.21)
X4: University							
(REF=private, public	−0.05 (0.27)	0.35 (0.28)	-0.28 (0.25)	0.08 (0.26)	-0.002 (0.25)	0.04 (0.25)	0.03 (0.25)
X5: professional profile							
(REF= engineering; economic-administrative)	0.64** (0.30)	0.69** (0.32)	0.73** (0.28)	0.38 (0.30)	0.52* (0.29)	0.71** (0.28)	0.46* (0.27)
Mean of the dependent variable	2.37	0.45	2.39	1.78	1.73	1.78	2.46
number of cases correctly predicted	164 (55.8%)	175 (59.5%)	98 (33.3%)	171 (58.2%)	144 (49.0 %)	171 (58.2%)	98 (33.3%)
Likelihood ratio test: Chi-square (d.f.)	Chi-squared (6)= 65.11 [0.0000]	Chi-squared (6)=48.95 [0.000]	Chi-squared (6) = 84.48 [0.000]	Chi-squared (6) = 83.16 [0.000]	Chi-squared (6) = 72.66 [0.000]	Chi-squared (6) = 83.16 [0.000]	Chi-squared (6) = 98.80 [0.000]

Notes: *,**;***: statistical significance at 10%, 5%, 1% respectively. Standard errors in parentheses. REF=reference categories.

4. Discussion

The relationship between the mathematical skills of university students and academic and personal variables has gained increasing relevance from both a theoretical and empirical perspective. Various studies report a significant correlation between students' mathematical competencies and their performance in financial matters (Jayaraman et al., 2018; OECD, 2020; Liang et al., 2022). Arithmetic skills, such as the ability to perform basic budgeting calculations and compute simple and compound interest, are essential for making informed decisions in both personal and professional finance (OECD, 2017; OECD, 2020).

The econometric analysis in this study reveals several factors that affect mathematical skills applied to finance, with gender differences standing out. The results show that men are more likely to possess the mathematical skills needed to perform financial calculations, such as those related to loans and investments. This finding is consistent with the OECD (2020), which identifies a gender gap in financial literacy, favoring men. In this regard, Al-Bahrani et al. (2020) suggest that the gender knowledge gap develops early in university before individuals have had the opportunity to acquire practical skills through experience or role-related activities.

Regarding professional profiles, the results indicate that students from the "economic-administrative" field are more likely to develop mathematical skills related to financial decision-making, such as interest calculations and asset valuation. Liang et al. (2022) report that students in the economics and finance field score higher in mathematical skills, associated with prior knowledge in calculus and statistical methods. Similarly, Muyo and Valdari (2020) suggest that integrating mathematics and finance into curricula can enhance student performance in financial topics.

On the other hand, it was found that students' employment conditions negatively affect their ability to solve operations related to spending and budgeting, as well as calculations involving fractions and percentages. This result contrasts with Tejada-Peña et al. (2023), who report a positive effect of the student's work-study condition on their mathematical ability in percentage variations (such as inflation and investment returns). This discrepancy may be explained by differences in students' socioeconomic contexts or the level of educational support they receive.

The results also show that the type of university (private or public) does not significantly impact students' mathematical skills, which contrasts with the findings of Indrahadi and Wardana (2020), who report that students from public institutions performed better compared to those from private schools.

Regarding gender, the findings of this study align with previous research showing that men are more likely to possess better mathematical skills in financial contexts, which is also related to a greater willingness to take financial risks (Almenberg, Dreber, 2012; Liang et al., 2022; Jayaraman et al., 2018). In this sense, students from economic-administrative fields are more likely to possess mathematical skills applied to concepts such as compound interest and the time value of money, which supports the hypothesis that academic training positively influences financial competencies. Regarding cohabitation factors, a relevant finding is that students living with a partner are less likely to possess mathematical skills related to calculations of proportions and ratios in purchases and sales. This result differs from existing literature, which has not sufficiently addressed the influence of cohabitation conditions on mathematical skills, suggesting that factors such as family support or household structure may influence the development of these skills.

In summary, the findings of this study reinforce the idea that mathematical skills have a significant impact on financial decision-making. Gender differences and professional profiles are key factors explaining variations in students' mathematical competencies, while employment and cohabitation conditions yield unexpected results, opening new avenues for future research.

5. Conclusion

The results of this research confirm the existence of a significant relationship between mathematical skills and the financial decisions of university students, particularly in areas related to economics and business administration. Additionally, gender differences and students' professional profiles align with findings from previous studies (Almenberg, Dreber, 2012; Liang et al., 2022), highlighting that men and students from economic-administrative fields are more likely to possess better mathematical skills applied to finance. However, notable discrepancies were identified concerning employment status and living conditions, suggesting that factors such as stress levels or family responsibilities may influence the development of mathematical skills in

practical contexts. These differences should be considered in future research to provide a more comprehensive understanding of how mathematical skills are developed and applied in financial decision-making across various contexts.

In this regard, the primary objective of this study was to determine the relationship between mathematical skills applied to finance by university students and their academic and personal variables. The results provide evidence of a relationship between the mathematical skills necessary to perform basic arithmetic operations related to personal spending and budgeting, and the student's employment status as well as their professional profile, which supports hypothesis H1. Additionally, evidence of a gender difference in favor of men regarding basic arithmetic skills required to calculate financial charges for loans and investments was found, which supports hypothesis H2.

Furthermore, a positive relationship was found between students' mathematical skills in sequences and formula application and their professional training in economic-administrative fields, which supports hypothesis H3. A relationship was also identified between students' mathematical skills in operations with fractions and percentages and their employment status, which supports hypothesis H4. Regarding gender, a relationship between students' skills in calculating variations and their gender was found, which supports hypothesis H5. Lastly, a relationship between students' skills in formulating expressions related to ratios and proportions and their family living conditions and professional field was observed, which supports hypothesis H6.

Finally, the results of the model did not support the relationship between mathematical skills needed to apply financial functions in decision-making, savings, investment, and the students' individual characteristics. These findings highlight the importance of strengthening the mathematical competencies of university students, particularly in personal finance, to promote more informed and responsible financial decision-making.

6. Implications of the Study

Regarding the theoretical implications, this study provides evidence supporting the relationship between mathematical skills and financial decision-making. The theory behind this relationship is based on the idea that mathematical competencies allow individuals to make informed and responsible financial decisions using mathematical tools such as interest calculations and understanding the time value of money. The connection between these skills and financial performance is crucial to understanding how mathematical education can influence individuals' economic management in different personal and professional contexts. Moreover, it is confirmed that students in economic-administrative fields, who typically receive more mathematical training, have better skills in performing complex financial calculations. This reinforces the theory that specialized mathematical education can enhance competence in both personal and professional finance.

From a practical perspective, the evidence obtained in this study suggests that greater integration of financial mathematics into curricula could improve students' financial performance, particularly those preparing for careers in economics and administration. The ability to handle mathematical concepts such as percentage calculations, interest rates, and financial planning is essential for effective resource management, both personally and professionally. On the other hand, observed differences based on gender and work experience suggest that some groups, such as men and students not working, may have advantages in developing these skills. Therefore, educational programs should consider inclusive strategies to mitigate disadvantages observed in other groups, such as women or students balancing work and study.

Based on the results obtained regarding mathematical skills and financial decision-making, as well as the limitations and discrepancies found, several suggestions for future studies can be made: A longitudinal study on the impact of the work-study balance on the development of mathematical skills would be valuable. This type of research could explore how different types of employment (part-time work, field jobs, jobs related to the economic field, etc.) influence the development of mathematical skills over time. It would be helpful to investigate how work experience and practical contexts either support or hinder learning and applying mathematical concepts in financial decisions.

Comparative studies between groups with different work and educational conditions could provide deeper insights. A more in-depth comparison of students who work versus those who do not, controlling for factors like job type, educational level, and family responsibilities, could shed light on how the work environment influences mathematical and financial skills. Further studies on

the gender gap in mathematical skills and financial decision-making are also important. Although a difference in mathematical skills between men and women has already been identified, it is essential to understand the underlying causes of this gap. This could involve exploring cultural, educational, and psychological factors influencing attitudes toward mathematics and finance in each gender. Additionally, examining how gender roles affect personal and professional financial decisions would be insightful. To address the gender gap, it would be valuable to explore how different educational approaches can empower women in mathematics and finance, through inclusive teaching strategies or awareness programs.

Given that marital status was part of the participants' profile, it could be relevant to study the impact of living arrangements on the development of mathematical skills. Research on how living conditions (e.g., living with a partner or family) affect mathematical skills in financial contexts could be an interesting avenue to explore. This study could consider factors like family support, household responsibilities, or even stress associated with family dynamics as elements influencing the learning and application of mathematics in financial decision-making.

7. Study Limitations

Regarding the limitations, the study faces several factors that may affect the validity of its results and the generalization of its findings. One of the key limitations is the limited resources available for the study, which led to a relatively small sample size due to financial and material constraints. This could limit the ability to generalize the results to a broader population. This limitation is particularly relevant when considering the relationship between mathematical skills and financial decision-making in different contexts. Another important factor is time: the study's duration may have influenced the depth with which certain variables were explored. A longer period would have allowed for a better observation of the development of mathematical skills over time, particularly in work and social contexts.

It is also important to note that the study does not address all socioeconomic factors that could influence mathematical skills. Therefore, the discrepancy observed between students with work experience and those without it could be influenced by contextual factors, such as stress or additional responsibilities, which were not fully controlled in the study. Additionally, selection bias in the sample may have affected the results, especially if not all demographic and socioeconomic groups were considered. This could influence findings related to gender and work context. These limitations should be considered when interpreting the results, and addressing them in future research would provide a broader and more accurate understanding of the link between mathematical skills and financial decision-making.

8. Declarations

Ethics approval and consent to participate

This study is carried out in accordance with the recommendations of the Code of Ethics of the National Technology of Mexico. The Research Ethics Committee of the Division of Graduate Studies and Research approved the protocol. In accordance with the Declaration of Helsinki, all workers gave their consent for participation in the study.

Consent for publication

Not applicable.

Availability of data and materials

Data and materials associated with this study are available upon request.

Conflict of interest statement

The author declares no conflict of interest.

Funding

The study did not receive external funding. However, the authors sincerely thank the Centre for Behaviour and Wellness Advocacy, Ghana, for providing financial support through the Institutional Open Access Publication Fund.

Author contributions

This document is the work of the authors, as an intellectual contribution of the academic work, which they approved for publication. Conceptualization: LVM, SHM, methodology, data curation, data analysis: LVM, SHM and DMN, writing – original draft preparation, writing: LVM, SHM, and DMN;

writing – review and editing: LVM, SHM; writing – supervision: LVM, SHM and DMN funding – LVM. All authors have read and agreed to the final version of the manuscript for publication.

Acknowledgements

Our gratitude goes to Prof. Arturo García-Santillán, Ph.D. for his recommendation in this manuscript.

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