Mathematical Skills Demand for Financial Decision Making in Companies

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Abstract **– The aim of the research is to analyze companies' demand of workforce with mathematical skills. The type of sample was not probabilistic by self-determination and 255 companies' managers were surveyed. The data matrix was analyzed using exploratory factor analysis and the use of polychoric matrices. The results show that companies require their employees to know and remember mathematical operations that allow them to be fast and precise in their calculations; a better understanding of mathematics to improve their calculations in computer applications. They also need employees capable of performing calculations that allow them to solve complicated financial problems for better financial decision making.**

Keywords **– labor force, mathematics, skills, Mexico.**

1. Introduction

Understanding, interpretation, analysis and communication of information in complex communication environments, are some of the skills demanded by the new labor market in order to improve decision-making, reason, communicate and interact successfully between individuals and companies [1], [2].

Some international organizations have recognized that young graduates are not prepared with the necessary skills required by the new labor market [3] and [4]. Similarly, they recognize the importance of developing knowledge, skills and competencies that reach good levels of literacy and arithmetic, so as to integrate a workforce with skills that favor economic growth [5], [6].

Mathematical and financial skills development in the staff is especially important to get ahead in a period of economic instability such as the current crisis generated by the COVID-19 pandemic. Among others, the consequences that companies have suffered have to do with closed premises, reduced operating hours, job cuts, interruptions in the supply chain, jeopardizing R&D processes, cessation of operations, changes in the business model, loss of key customers and restrictions on products and services [7].

In Mexico, Veracruz has been one of the most affected states by the economic crisis resulting from the pandemic. In the first year of the pandemic, more than 50,000 jobs were lost in the state according to data generated by the Mexican Social Security Institute [8]. The extraction, tourism and commercial industries were the most affected by the imposed lockdown.

The objective of this study is to identify if there is a set of mathematical skills that the business sector demands, specifically in medium and large Veracruz companies. The document is structured as follows: the next section presents the literature review, section three describes the research methodology, section four analyzes the results and finally the conclusions are presented.

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2. Literature Review

The term mathematical ability means to perform a mathematical activity efficiently, to act appropriately in situations where mathematics is present [9]. In addition, in their analysis of the theoretical definitions of mathematical ability, problem solving is highlighted as a characteristic element [10], [11], [12], [9], [13], [14], [15], since the basis of mathematics lies in solving everyday life and professional problems.

The new labor market trend, regarding skills demand, is also focused on tasks that involve problem solving in a context of complex communication. Some of these abilities are: reasoning, communicating, interacting and interpretation. Mathematics is the discipline that can help and serve as a support tool for solving complex problems or complex tasks [1], [2].

Therefore, people with a mathematical education are required to be independent, critical and with their own reasoning [11], as well as having mathematical literacy [15]. A country requires that its inhabitants have mathematical knowledge with permanent practice [16]. The function of mathematics is to build educational information and skills in students so they can face daily life problems and in their work environment [17]. Mathematics is a useful and valuable tool [18], since it helps in decision-making reasoning and plays a primary role in the performance of the economy. Mathematical thinking is considered an important goal of education throughout the world [19].

Research [20] has shown that the mathematical discipline has links with digital technology knowledge, causing students to use mathematical and digital skills at the same time. In this way, the trends anticipated worldwide in the technological field of some productive sectors, are towards the demand for skills with characteristic elements to analyze and integrate data.

In a study carried out in Chile, authors identified that economy and digital transformation of society demand digital skills in certain productive sectors. It is a challenge that the workforce with sufficient digital skills has to guarantee [21]. In this sense, companies in the information technology sector demand more mathematical, linguistic and project management skills from their collaborators than companies belonging to other sectors [22].

International studies show that the skills related to data analysis and data integration required by the productive sector, have a connection with statistics knowledge. Some of the findings reported by studies on general knowledge and skills required by the job position were: being an expert on data collection, analysis and integration process, an expert in statistics, computers, science or operational business research [23].

An Italian study explored the gap between Italian study programs and labor demand to verify whether the university educational offer of knowledge and skills are aligned with the requirements for the data scientist position requested by Italian companies. Results show that the specific skills that companies need are knowledge in statistics, information technology and computing. In addition, other companies requested analytical skills experience; ability to develop transversal knowledge with traditional domains, innovation and data. Interdisciplinary knowledge integrated with STEM disciplines (for its acronym in English: science, technology, engineering and mathematics) it is also requested, creativity, critical thinking and communication skills [23]. In another study, [24] point out that a data scientist has to have knowledge of both mathematics and statistics.

In order to find out the future job prospects of people with STEM skills, specifically skills in mathematical sciences, [25] used information from the Australian government page (Labor Market Information Portal, LMIP) and statistical data from Australian censuses (Australian Bureau of Statistics, ABS) from 2006, 2011 and 2016, and obtained projections from the year 2018 to May 2023. The result shows a trend towards an increase in the demand for STEM skills, particularly mathematics.

A similar research conducted by [28] identify the gap between college graduates skills and the skills required by the industry. They analyzed the 2017 biennial UK Employer Skills Survey (ESS). Employers identified that the staff surveyed required more skills development, particularly 49% needed to develop digital skills and the 44% needed complex analytical skills such as complex problem solving, numerical and statistical skills, among others.

Overall, the 2023 employment outlook for almost all of the top 20 mathematicians and statisticians' occupations is in line with the 7.1% projected average growth rate [26].

When analyzing the current trends in relation to digital demand and future job prospects that demand personnel with STEM skills, the results seem to indicate that the current demand is directed towards digital skills and that these analytical skills are connected to mathematical ability [24], [23], [20].

Based on the above, the hypothesis is raised that the business sector demands a set of mathematical skills in its collaborators that contribute to financial decision-making.

3. Methodology

This research is a non-experimental study without manipulation of variables (X), and cross-sectioned. It is a hypothetical-deductive method, since it seeks to contrast the hypothesis that suggests that there is a set of mathematical skills applied to finance that the business sector demands. The type of study is descriptive, correlational and explanatory. The factorial structure obtained will be the basis to demonstrate that the data matrix is not an identity matrix, in order to explain the variance of the component matrix that the results yield.

According to the latest INEGI (The National Institute of Statistics and Geography), the Mexican Economic Census 2019 [27], with statistical information referring to the year 2018, the total number of establishments in the state of Veracruz was 278,230. Of these, 46.7% correspond to the commercial sector, 41.6% to the service sector, 10.5% to manufacturing and 1.2% to the rest of economic activities. Regarding its size, of the total number of establishments by employed personnel, 96.10% are micro companies (0 to 10 workers), 3.81% are small and medium-sized (11 to 250) and 0.09% (more than 251) are large companies [27]. The research seeks to study specifically the business population of 12 municipalities, representative of each region of the state of Veracruz: a) in the northern region, Banderilla, Xalapa, Poza Rica de Hidalgo; b) in the central area, Córdoba, Orizaba; c) in the southern region, Boca del Río, Puerto de Veracruz, Lerdo de Tejada, San Andrés Tuxtla, Acayucan, Minatitlán, Coatzacoalcos [27]. These municipalities add up to a total of 235,240 establishments from all sectors. The classification of companies based on their size was made according to information from the Ministry of Economy [28].

It is a non-probabilistic sample, companies that agreed to participate in the study were selected. The sample was built under the criteria of convenience, accessibility and proximity of the businessmen to the researcher. To carry out the survey, owners, directors or those responsible for the finance area of the companies were first invited through an email or phone calls requesting authorization to send the survey by email, LinkedIn or WhatsApp.

The survey was carried out in the September 2020 to May 2021 period. 291 surveys of medium and large companies were answered, of which 36 were discarded owing to lack of correspondence in their classification with the number of workers, achieving a total of 255 acceptable surveys. The information was collected over a period of 8 months.

Prior to collecting the information, a pilot test was carried out with 30 micro, small and medium-sized companies from the manufacturing, commercial and service sectors. From the pilot test it was determined to exclude micro and small companies because they did not have a finance department. The Cronbach's Alpha of the instrument calculated from this pilot test was 0.917, which indicates a very acceptable internal consistency of the test.

A questionnaire on mathematical thinking skills by [29] was used, consisting of 15 items on a 5-point Likert scale (from 1 totally disagree to 5 totally agree), grouped into three dimensions of five indicators each: remember, know and apply. Prior to these 15 items, questions were included to find out the characteristics of the company (sector, size and years of activity).

To respond to the proposed hypothesis, an exploratory factorial analysis was used, which was carried out with the Factor 10 software, since the variables values did not follow a normal behavior, hence the calculation was made using the Polychoric correlations [30].

4. Results

Of the companies that participated in the study, it is observed that 53.7% of the companies are medium-sized and 46.3% are large. The largest percentage (34.1%) corresponds to large companies oriented to the service sector. Table 1 shows the profile of the participating companies.

Table 1. Profile of participating companies

Type	Sector			Total
	Services	Commercial	Industrial	
Medium	24.7	20	9	53.7
Large	34.1	3.9	8.2	46.3
Total	58.8	23.9	17.3	100

Antiqueness	Percentage
<= 10	46.7
11 – 25	30.2
26 – 40	10.2
41 – 55	4.7
56 – 70	4.7
71 – 85	3.1
86+	0.4

Table 2 shows that all the results of the polychoric correlation analysis are greater than 0.5 and less than 1, and that the result of the Bartlett sphericity test and the KMO (>.80), which is significant ($p<0.05$), indicating that the variables are suitable for factor analysis. In addition, the extracted factors that explain 56% of the variance of the test scores support this decision.

Table 2. Polychoric correlation matrix

Variable	1	2	3	4	5	6	7	
V1	1							
V2	0.672	1						
V3	0.5	0.685	1					
V4	0.562	0.688	0.679	1				
V5	0.489	0.629	0.629	0.705	1			
V6	0.469	0.614	0.616	0.666	0.669	1		
V7	0.508	0.638	0.588	0.721	0.721	0.762	1	
Variable	8	9	10	11	12	13	14	15
V8	1							
V9	0.643	1						
V10	0.554	0.693	1					
V11	0.594	0.702	0.67	1				
V12	0.603	0.655	0.643	0.656	1			
V13	0.544	0.642	0.664	0.662	0.683	1		
V14	0.559	0.586	0.575	0.608	0.675	0.59	1	
V15	0.616	0.634	0.645	0.631	0.721	0.613	0.702	1
Matrix determinant				3.78E-06				
Barlett statistical (*g.l* 10.5)				3052.8				
P value				0.000010)				
Kaiser-Meyer-Olkin Test (KMO)				0.95819				

The factor loadings indicate the correlation between each variable and the corresponding factor, hence a variable with a higher factor loading will be more representative of the factor. Taking this into account, an analysis of the factor loading matrix helps to identify how the manifest variables are grouped to form each of the resulting factors of the model, and even to label them. Once it is known which manifest variables "load" in factor 1, it is deduced what type of theoretical construct is represented by said factor.

Table 3 shows the matrix of factor loadings. The first 5 (V1 to V5) are reagents from the area of remembering mathematical knowledge, while the reagents (V6 to V10) correspond to the area of mathematical understanding, finally the reagents (V11 to V15) are related to the mathematical application. Table 3 shows the factorial solution.

Table 3. Communalities and variance factor

Variable	F1	communalities	Variable	F1	communalities
V1	0.608	0.369	V9	0.802	0.644
V2	0.758	0.575	V10	0.832	0.693
V3	0.742	0.551	V11	0.805	0.648
V4	0.822	0.675	V12	0.821	0.675
V5	0.821	0.674	V13	0.772	0.596
V6	0.826	0.682	V14	0.74	0.548
V7	0.856	0.733	V15	0.808	0.654
V8	0.692	0.479			
Total variance (%)					63.792

Results show that there is only one factor made up of the 15 variables. The variable with the highest factorial weight states that the understanding of practical problems in financial mathematics improves the quality of financial operations carried out by financial employees (V7). Furthermore, the variable with the lowest value is the one that establishes that mental calculations of the four basic arithmetic operations will help finance employees in quick and accurate calculation (V1). In addition, communalities are presented. The communalities of a variable is the proportion of its variance that can be explained by the factorial model obtained. Variable one is the worst explained since it is only capable of reproducing 36.9% of its original variability. The variable that best explains is variable seven. Likewise, Table 3 shows the total explained variance (63.79), this value is appropriate since it is greater than 50%.

5. Conclusions

The purpose of the study focused on analyzing the demand of the Veracruz business sector for employees with mathematical skills that can be applied to financial decision-making. Regarding the first dimension, it is concluded that entrepreneurs require their employees to know and remember mathematical operations so they can be fast and precise in their calculations and be able to relate variables.

The analysis of second dimension showed that entrepreneurs require their employees to have a better understanding about the practical application of mathematics. They assume that it can help them to improve financial operations, financial decision-making and better understand of calculations in computer applications.

As for the third dimension, the analysis allows us to conclude that entrepreneurs demand that their employees are able to perform financial calculations that allow them to solve complicated financial problems, such as calculations of investment plans, future price discounts, which help reduce operational risks, and to improve the monitoring of information. The variables that had less weight for the employers were (V1) and (V8). The (V1) refers to the way in which the mental calculations of the four basic arithmetic operations help the employee of the finance area of the company to be fast and precise and (V8) to the communication improvement with clients when the employee understands mathematical calculations. The results obtained in this research allow us to conclude that employers require that their employees know, understand and know how to apply mathematical skills in the finance area of their company: use math to solve basic financial

budgeting problems, understand math calculations to solve financial interest calculation problems, and apply math skills to solve complicated financial problems such as the effect of inflation and making investment plans. These results are consistent with [26] and [23]. They identified the math ability as one of the top ten skills managers and business leaders have to have.

The knowledge, understanding and application of practical problems in financial mathematics offer employees in the finance area of a company a logical framework to determine the relationships between financial variables. Additionally, they improve the quality of operations and the understanding of computer applications. These results are consistent with those of [20] who showed that the mathematical discipline has links with technology knowledge. Currently, companies need the employee to have interdisciplinary knowledge [23].

One limitation of this study is the number of companies that did not participate, because the survey was carried out during the pandemic, a very complicated period for companies in which their attention was focused on solving the financial and operational problems derived from lockdown. Many companies did not respond to the invitation to participate in the study.

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