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# Approach to the anxiety and coping perceived of mathematics during the pandemic in higher level students in an environment rich in symbols

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Although the curricula recognize the attitudinal component as a crucial competence for students to develop, the reality is that the integration of this objective with the extensive conceptual content that must be covered needs to be emphasized even more. If this integration is neglected, it may lead to anxiety during the learning process. In the present study, we conducted semi-structured interviews with students to explore their motivations for studying mathematics and the various strategies they employed to cope during the pandemic. These interviews not only revealed the complexity of this integration but also highlighted a context that could be linked to the specific social environment in which the students are immersed.

KEYWORDS

**anxiety, coping, pandemic, symbols, motivation**

## Introduction

The pandemic has created a new agenda for mathematics education (Engelbrecht and Borba, 2024). Inevitably, questions will be raised about the role of psycho-emotional factors in learning math, especially when faced with situations such as the lockdown caused by the SARS epidemic, when the education sector was forced to use an entirely virtual teaching model. Isolation led to a decline in mental health as the pandemic dragged on (Souhib et al., 2024). Students were forced to participate in the virtual modality and with all the obstacles that distance learning represents, e.g., the lack of a good Internet connection, an adequate space to study, even, students who do not have a computer at home (Ewell et al., 2022). The consequences of the confinement are still not fully dimensioned in terms of distress in students' emotional health and exacerbation of pre-existing problems (Herrera Albornoz et al., 2024).

For this study, we felt it was important to understand how students cope with their emotions when solving math problems. What are their favorite learning strategies during the pandemic and how they feel about some of the math symbols used in class that are very familiar to them due to where they live? The above is reformulated with the following research question:

What are the affective components that allow the coping of the anxiety caused by the resolution of mathematical problems in the first courses of the higher level? How does the social environment in which students grow up help them develop a favorable outlook on learning?

Based on these research questions, we believe that it is necessary to listen to the voice of the students in order to know how they faced the possible frustration that comes with solving mathematical problems, especially during the pandemic, and to know how the teachers approached the subject of mathematics.

The didactics of mathematics, seen as a specific professional discipline, cannot be analyzed as a field of study in which mathematical, psychological, pedagogical and practical aspects of teaching can be thought separately (Wittmann, 2021). For a long time, research in mathematics focused exclusively on analyzing the cognitive factors involved in learning. When the role of affective factors began to be addressed, emphasis was placed on positive or negative attitudes toward the discipline. Positive learning experience in mathematics such enjoyable and creative content can cope with anxiety (Casinillo et al., 2022). Now, as the emotional aspect is revisited, an important distinction will be made between beliefs, attitudes, and emotions (Schukajlow et al., 2023). One of the proposals for this study is that students begin to understand the meaning of learning calculus through images or symbols that are present in their daily lives, particularly traditional images.

In the classes conducted with the students who participated in the study, we employed learning strategies based on the symbols present in their social environment. We believe these strategies could be highly effective in applying calculus to Isthmian society, particularly in exploring the specific competencies identified by Cirillo and Hummer (2021) that take into account the context, in Martell et al. (2024) words "everyday episodic experiences that foster spatial thinking." In the Isthmus of Tehuantepec, Oaxaca, Mexico, featuring numerous figures that could be applied (see Figure 1).

Anxiety is a latent factor in the classroom that has been examined from various perspectives and is not solely attributable to the student. Research indicates that a student's subjective valuation of mathematics is linked to a reduction in anxiety experienced during problem-solving and contributes to a more positive perception of the subject (Li et al., 2021). Math anxiety is characterized by feelings of panic and helplessness when individuals are asked to solve mathematical tasks or problems (Rozgonjuk et al., 2020).

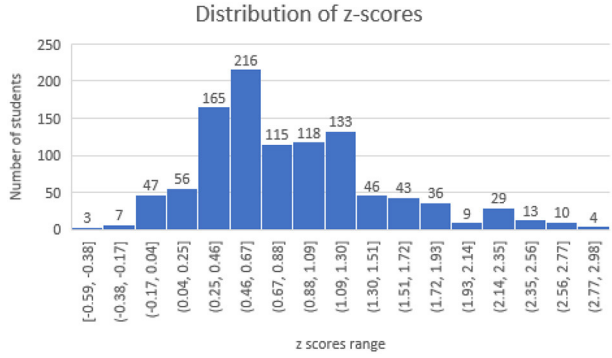


FIGURE 1
Distribution of z-scores.

Math anxiety associated with biological, educational, cognitive, and neural aspects driven primarily by fear and a sense of inability to solve mathematical problems (Kul et al., 2024). For students suffering from math anxiety, they often perceive math problem solving as a threatening stimulus that can evoke disengagement of attention or motivation (Daches Cohen and Rubinsten, 2022). It can even be regarded as a genuine phobia due to the tension and fear it provokes (González-Gómez et al., 2024). Math anxiety develops in students based on how mathematics is presented to them, rather than solely as a function of the content's difficulty (Samuel and Warner, 2021). Although it has been established that mathematical anxiety is associated with a decrease in overall motivation toward mathematics, the discussion about the types of mathematical motivation is still going on (Li D. et al., 2023).

We considered that it was important to approach the students' perception and understand from their voice how they dealt with the anxiety of learning mathematics at a distance, without the face-to-face support of their teacher and peers. In addition, the scientific literature has addressed qualitative studies on mathematics anxiety but we found a need to reinforce studies on how students cope with anxiety, especially in an indigenous region rich in symbols around them.

This paper proposes to examine the psychoemotional component within its social context, specifically the Isthmian and Oaxacan environments, which are rich in familiar symbols. The equations presented in textbooks acquire new meanings by incorporating images from these environments, thereby connecting two distinct registers of representation: from analytical symbols to visual imagery (Moyer-Packenham et al., 2022). Math anxiety has been shown to be closely related to spatial skills, i.e., symbolic and situational mathematics can help decrease learning anxiety-y (Li T. et al., 2023).

## Method

One of the initial references for this study pertains to the method of capturing students' discourse. In this context, Belo-Tomic et al. (2021) propose an interpretative phenomenological approach to comprehend the experiences and meanings that students attribute to their lives. Similarly, Larracilla et al. (2019) emphasize the significance of reexamining mathematics through its symbolic nature, recognizing that it is embedded within a cultural context where perceptions have been formed since childhood.

The qualitative research paradigm is rooted in phenomenology and allows a direct exploration of the student's learning experience, that is, what they can feel and perceive about their formal and non-formal learning experience (Yee, 2019).

### Questionnaire participants

The sample consisted of 1,045 students, of whom 45.95% were female and 54.05% male. The mean age was $M = 20.42$ (SD = 2.1).

For the application of the questionnaires, the teachers of the academy were contacted. The objectives of the study were explained to them, the link was sent to them via e-mail and they were told to explain to their students that the answers were not obligatory.

## Instruments

### Semi-structured interview

Through semi-structured interviews, we investigated how participants apply what they learned in mathematics classes to their daily lives. Additionally, we explored whether learning mathematics induces anxiety and, if so, what strategies they employ to cope with it. The sample of students who participated in the interview consisted of students who took the online course during the pandemic. Through the online advisories conducted with students who showed the greatest interest. We explained to them the intention of the study and asked for their willing for interview. Due to the confinement, interviews were conducted by Google Meet.

## Operationalization

| Category | Subcategory | Concept |
|---|---|---|
| Relationship of paid work to mathematical perception. | Mathematical performance and family economics. | Expressions of students' beliefs about the nature of mathematical activity, about themselves, and about their role as learners in classroom interaction (Chacón, 2000). |
| Mathematical symbology found in the environment. | Perception of figures in the environment. | Mathematical language and symbols simplify communication, reducing the need for verbose expressions, so that it can eliminate ambiguities and strengthen arguments |
| Emotions provoked by the resolution of mathematical problems and the way to face them. | Math anxiety | Feelings of tension and anxiety that interfere with number manipulation and mathematical problem solving (Eccius-Wellmann and Lara-Barragán, 2016). |

Mathematics anxiety profile (Eccius-Wellmann and Lara-Barragán, 2016).

The Mathematics Anxiety Profile Questionnaire, designed and validated by Eccius-Wellmann and Lara-Barragán (2016), was administered in this study. It comprises three dimensions: attitudes, emotions, and beliefs. The questionnaire was validated using a sample of 417 students from administrative sciences and engineering programs, achieving an internal consistency index (Cronbach's Alpha) of 0.91. Respondents select from five response options: (1) Almost never, (2) Sometimes, (3) About half the time, (4) Frequently, and (5) Almost always.

The data obtained from the questionnaire were analyzed through a Confirmatory Factor Analysis (CFA) using AMOS version 26 software using maximum likelihood (ML) to analyze the goodness of-fit-index. To determine whether it was feasible to use the CFA, we performed Kaiser-Meyer test KMO = 0.912 and the Bartlett's test of sphericity $p \leq 0.001$. Gamma index (GFI = 0.900), (CFI = 0.922), (RMSEA = 0.071), (TLI = 0.909), NNFI = 0.90. The standardized root-mean-square residual (RMSR = 0.036) chi-square obtained was 206.310 with degrees of freedom 116 ($p \leq 0.001$).

# Results

## Qualitative results

It is important to recognize student motivation as a valuable resource for persevering in mathematics courses. In their own words:

> I understand that more challenging tasks lie ahead; this is just a small preview of what is to come. Each subject serves as a foundation for the next, and if I do not grasp the material thoroughly, I will struggle with future topics. This realization motivates me to persevere, even in the face of fear [A2SI21].
>
> Yes, I work here in Juchitán. There are times when I work as a motorcycle taxi driver. For example, my dad works at a purification plant, and there are days when I cover for him. My mom works in a lumber shop, and I see that mathematics is essential for giving change and calculating the amount of wood that will be used. You have to be very precise; otherwise, there would be a lot of waste.
>
> Is it important to consider how, or in what ways, a student participates economically with their family? In particular, when asked whether they believed that achieving strong mathematical performance contributed to the family economy, they acknowledged that it did, albeit for different reasons.
>
> I believe that mathematics can enhance our ability to optimize various aspects of life, such as setting goals, establishing a business, and making projections and calculations regarding potential profits [A2SI21]. Mathematics can indeed be helpful; for instance, when I need to manage my finances, wrap items for shipment, or handle orders. Additionally, my father, who works in the wind energy sector, often has to create budgets, which proves to be very useful. I have participated in these activities with him and have observed how calculations are applied [A1SI21].
>
> I agree because it aids in the distribution of expenses, including what you will spend on administration and in reducing costs [E2SI21].

If you own a business, it is essential to address problems effectively, provide accurate change, and manage accounts efficiently. I believe these skills are vital for success in the business world.

The interviewer asked the students whether mathematics is equivalent to arithmetic, and if so, what the purpose of learning calculus is. Most of the interviewees agreed that the geometric shapes in their environment resembled those studied in class.

> In both pictures and paintings, I have observed shapes commonly found in mathematics. The regional huipiles display similar patterns; for instance, some huipiles feature circles and figures that appear remarkably precise. Interestingly, these designs are often created by individuals who are not professional artists, yet they execute them with great skill due to their experience [K1SI21].

Sometimes, solving mathematical problems can induce anxiety and even fear. It is essential to understand the strategies that students use to overcome these emotions, enabling teachers to improve their activities and seek resources that prevent students from facing challenges in isolation.

Solving problems does not excite me; instead, it causes stress, and at times, I struggle to grasp the concepts on the first attempt. This inability to solve exercises can leave me feeling inadequate. Additionally, teachers often progress quickly, focusing primarily on students who comprehend the material rapidly.

> When I encounter a problem, such as during the first unit when the teacher allowed me to practice solving for the sine of x, I initially found it challenging because mathematics is not my strong suit. However, as I gained clarity, I attempted the exercises again. I watched instructional videos, and upon returning to the exercises, they became less difficult, allowing me to solve them successfully. Nevertheless, when I face something particularly complicated, I tend to become upset or frustrated, which causes me to withdraw and lose my desire to learn more [K1SI21].

They understand that participation and correction are essential; however, the reality is that nearly all of them hesitate to take the risk. Just as they may feel anxious about their inability to solve a mathematical problem, they experience a similar sense of satisfaction when they succeed in doing so.

> When I solve it, I feel a sense of satisfaction. I feel good because I have successfully tackled a mathematical problem [A2SI21].
>
> In my case, I was excited to solve a math problem. It made me feel very happy because I was learning, and the exercises were going well. The truth is that I was very enthusiastic; previously, calculus was not my strong suit, and last semester, it was the same, especially since the last topic we covered was really engaging [A1SI21].

In the realm of further inquiry, it is striking to note that the attitudes deemed necessary for approaching a mathematical problem often include patience and analytical skills as essential requirements for problem-solving.

I believe that the ability to analyze requires patience.

> A slight sense of anguish arises from my struggles with mathematics. I experience a mix of anxiety and despair; however, I also view it as a challenge. It does not paralyze me; rather, it motivates me to confront the challenge head-on [E2SI21].

To have confidence means to have faith in oneself and the ability to solve problems. If I tell myself, not going to be able to do it, be able to do it. Maintaining a positive attitude is essential; if I continue to doubt my capabilities, I will hinder my own success.

> You must maintain an optimistic attitude, as mathematics demands significant concentration and patience [K1SI21].

More thought is required about what to make the student aware of, that the process of arriving at the correct answer is possible only if the necessary time and space is provided to do so. The feeling of frustration for not answering quickly and adequately can be tempered as the interview shows:

> At the beginning I felt it was a little complicated, but I feel it is very important to be aware of the work that has to be handed in and the activities that have to be done, because you are aware and if you are connected 1 day and not the next, you lose this notion, to be attentive to the indications and look for tutorials on other platforms, usually like YouTube, on the topics that are being seen [A2SI21].
>
> To face it, when I went to class, I simply paid attention and did not stop watching the procedures of the exercises, even though I was stressed because I did not understand, it did not enter my head and that was what made me pay attention and if you could not in class, look in other sources how you can solve the problem [J1SI21].

We inquired about the main difficulties they faced during this type of mathematics learning at home:

> Generally speaking, initially, we did not have internet access; we had to hire it, and at times, it would fail constantly [E1SI21].

The distractions at home often made it difficult for me to focus in class. Sometimes, I felt tired and unmotivated, which only added to the challenges I faced.

> When I had doubts about how to solve the exercises or which formulas to use, I often found them complicated. However, I always made an effort to ask for help or search the internet. From there, I was able to gather ideas and find solutions to the problems [K1SI21].
>
> But if orality is so effective in the social environment, audiovisual media are not only complementary; they can also be largely compatible with written media. When I struggled with some aspects of Taylor's series, I had to rely on videos from another platform and sometimes on notes shared by my classmates. We would compare these in our group, but typically, they were YouTube videos or exercises provided as examples to help us solve the problems [A1SI21].

When I entered the classroom and encountered a concept I did not understand, I would ask questions. If my doubts remained unresolved, I would turn to YouTube to search for videos on the

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topic I was studying. I also sought examples online to clarify the specific areas where I had questions.

> I almost always tried to watch videos on YouTube. Sometimes, I looked for similar examples in the math books I have. When I could not find anything, I turned to a classmate for an explanation [R1SI21].

## Quantitative results

The questionnaire yielded a Cronbach's Alpha Internal Consistency Index of 0.90.

A tendency toward total disagreement can be seen in the responses. This provides evidence that for the sample of engineering students, mathematics generates anxiety, despite the fact that their academic training is mainly focused on mathematical thinking. However, if we analyze the question "I usually give up on a math problem that seems too difficult or too long," the answers are somewhat balanced. This would lead us to think about strengthening perseverance in students, to support them in not giving up a problem until they find the solution in order to reinforce the feeling of achievement (Table 1).

Mathematics for engineering students is not their strong point, they do not consider themselves good, they consider that they cannot obtain good results. In general, they do not show confidence in their own mathematical problem-solving skills (Table 2).

Responses regarding mathematical anxiety show a balanced distribution. It can also be observed that spending time on solving a mathematical problem does not necessarily lead to frustration. This aspect could have been approached differently, focusing on the frustration that arises from an inability to solve a mathematical problem. Furthermore, the question people enthusiastic about mathematics? Does not significantly enhance our understanding of students' anxiety toward the subject.

Likewise, based on the scores obtained from the questionnaire, we created a table to categorize the levels of anxiety experienced by the students corresponding to their respective scores (Table 3).

TABLE 1 Response to the items corresponding to dimension 1, attitudes.

| | | | | | |
|---|---|---|---|---|---|
| I value what I gain from the effort to understand mathematics. | 25.5% | 57.5% | 14.9% | 2.2% | 0% |
| When I study mathematics, I try to link new ideas with the knowledge I already have. | 17.7% | 41.6% | 18% | 14.3% | 8.4% |
| It is difficult for me to ask for help when I do not understand some math problems. | 25.8% | 32.6% | 17.1% | 15.5% | 9.0% |
| When solving math problems any obstacle makes me give up. | 11.5% | 24.2% | 29.8% | 23.0% | 11.5% |
| Mathematics is a subject I like to study | 31.1% | 35.1% | 17.7% | 11.1% | 5.0% |
| I am attracted to improve my cognitive skills in order to understand mathematics. | 3.4% | 15.8% | 26.2% | 24.8% | 29.8% |
| I tend to give up on a math problem that seems too difficult or too long. too difficult or too long | 10.6% | 27.3% | 22.0% | 32.6% | 7.5% |
| I tend to give up on a math problem that seems too difficult or too long. too difficult or too long | 11.5% | 28.6% | 28.00% | 24.5% | 7.4% |
| I can be fully concentrated when solving math problems. | 9.6% | 20.8% | 28.6% | 29.5% | 11.5% |
| If something seems difficult to me I prefer to ask for the answer rather than solve it on my own | 11.8% | 22.4% | 29.5% | 26.1% | 10.2% |

# Discussion

The primary objective of the study was to identify (1) the main motivations for students to study mathematics and (2) the strategies they employ to cope with the anxiety that learning mathematics induces. The research emphasized the relationship between students' contributions to the family economy as a motivation for learning mathematics and their perceptions of what it means to learn mathematics as a second language.

Motivation plays a crucial role in the learning process and is a key factor in predicting and understanding student performance (Higgins et al., 2019). In this context, a student's attitude toward mathematics can be significantly influenced by their family environment (Quaye and Pomeroy, 2022). When students are immersed in an environment rich in geometric shapes, such as those found in huipiles and Isthmian handicrafts, they may develop an appreciation for mathematical curves and functions, which can then be integrated into classroom learning. Huipiles not only feature geometric designs; they also embody elements of identity, affirmation, and social acceptance, making them deeply symbolic. This strategy reinforces the notion that students increase the perceived value of mathematics and enjoy the learning process.

With regard to economic motivation, part-time paid work for students may lead to a decline in academic performance or, in a worse scenario, result in dropping out of school. However, it can be argued that balancing work and study fosters the development of valuable skills and abilities, provided that class attendance and study time are not compromised (Hovdhaugen, 2015). Engaging in paid work during the student phase can serve as a source of practical experience and contribute to curricular training (Planas-Coll and Enciso-Ávila, 2014). Additionally, it can promote a deeper engagement with learning, allowing students to gain a greater understanding and contextualization of the material (Cuevas-de-la-Garza and de-Ibarrola, 2013). For instance, Tawdrous et al. (2024) found that students demonstrated an improving attitude toward mathematical skills and asked teachers more questions and requested practical examples.

Furthermore, our results agree with Shahrill et al. (2024) in that students can become positively perceived toward videos and

TABLE 2 Respuesta de los ítems correspondiente a la dimensión 2 emociones.

| | | | | | |
|---|---|---|---|---|---|
| I can do well in mathematics | 19.8% | 39.8% | 20.2% | 18.0% | 2.2% |
| I am naturally good at mathematics | 15.2% | 31.1% | 17.7% | 19.9% | 16.1% |
| No matter how much I study, mathematics is always difficult for me. | 25.5% | 45.1% | 25.3% | 2.3% | 1.8% |
| I am confident in my mathematical abilities | 15.8% | 32.0% | 28.0% | 18.3% | 5.9% |
| Mathematics is my strong point | 17.4% | 31.5% | 22.0% | 22.0 | 7.1% |

TABLE 3 Response to the items corresponding to dimension 2 emotions.

| | | | | | |
|---|---|---|---|---|---|
| I can do well in mathematics | 19.9% | 39.8% | 20.2% | 18.0% | 2.1% |
| I am naturally good at mathematics | 15.2% | 31.1% | 17.7% | 19.9% | 16.1% |
| No matter how much I study, mathematics is always difficult for me. | 25.5% | 45.1% | 25.3% | 2.3% | 1.8% |
| I am confident in my mathematical abilities | 15.8% | 32.0% | 28.0% | 18.3% | 5.9% |
| Mathematics is my strong point | 17.4% | 31.4% | 22.0% | 22.0% | 7.1% |

online instruction when dealing with emergency situations such as COVID-19. In the same vein Kusmaryono and Basir (2024) developed a qualitative study to analyze students' perception and emotions when learning with video tools, their results showed that they felt motivated and happy.

Regarding symbolic learning and representation, Li T. et al. (2023) found that symbolic mathematics may correlate more with mathematical anxiety compared to other mathematical representations, e.g., verbal, and that, consequently, this representation allows capturing a greater attentional resource in students. In a culture where orality is predominant, memorization is essential. We refer to memorization as the conceptual mental representation stored in long-term memory (Ashcraft and Krause, 2007; Chevalère et al., 2022). Excessive procedures to cover the syllabus can reduce the effectiveness of memorization, jeopardizing the course objectives related to procedural knowledge acquisition and potentially increasing anxiety.

Having the patience and perseverance to watch a video procedure multiple times, rather than relying solely on a written document, is supported by the results obtained. By listening to the explanations, one can gain a deeper understanding of what is meant by "patience" in the context of continuing despite feelings of frustration. This understanding can enhance perseverance, foster self-efficacy, and ultimately increase dedication (Beltrán-Pellicer and Godino, 2020). Consequently, perseverance is recognized as a predictor of academic achievement (Kooken et al., 2021). Practice is a crucial element in any learning process; however, practicing a mathematical exercise multiple times holds particular significance due to the common belief that providing quick and accurate answers equates to intelligence. In conjunction with the exercises, teachers can implement learning strategies that incorporate symbols relevant to the students' context. These symbols play a vital role in mathematical cognition, enabling the expression of rules and general patterns across various phenomena (Khatin-Zadeh et al., 2024).

The quantitative results allowed us to contrast with the interviews in that the students expressed responses that reflected a low interest in mathematics and that it was difficult to ask their teachers for help. An important aspect to highlight is that the responses were balanced in terms of when they felt that solving a math problem was an obstacle. In this sense, it can be understood that, when facing fear toward a problem, they can always look for audiovisual resources that allow them to clarify their doubts.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Author contributions

EL-R: Writing – original draft, Writing – review & editing. ND-D-G: Conceptualization, Data curation, Formal analysis, Investigation, Writing – original draft. BG-J: Conceptualization, Data curation, Formal analysis, Methodology, Writing – review & editing. CV-S: Conceptualization, Formal analysis, Investigation, Writing – original draft. IG-M: Conceptualization, Formal analysis, Investigation, Supervision, Writing – original draft.

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