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# Factors that promote positive attitudes towards mathematics in higher education students

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**Abstract.** The purpose of this review article is to explain the importance of understanding attitudes towards teaching and learning mathematics in higher education students. For that, we start from the premise that attitudes are related to performance towards learning mathematics, bearing in mind that what directly influences their success are the feelings of possessing competencies to understand their contents and not the feelings of difficulty towards them. In essence, at first, we describe the different attitudes towards mathematics. Next, we examine how attitudes influence math learning and finally identify the factors that foster positive attitudes toward math. From this, we suggest teaching practices that can be carried out to foster positive attitudes towards mathematics and propose new lines of research in this field.

## 1. Introduction

Academic performance towards mathematics has been constituted in recent years as one of the continuous challenges in most educational institutions, not only because mathematics is recognized as an essential subject of curricular meshes, but also by the fact of contributing to human development, especially in its cognitive spheres and for the functions it possesses during adulthood. Due to this importance, in Western societies, there are concerns about the fact that there is a large percentage of students, which reflect difficulties in understanding and applying the knowledge of mathematics [1-5].

Faced with this situation, it is necessary to understand this issue, since it is somewhat paradoxical, in the sense that, on the one hand, mathematical knowledge is essential for modern societies because of the technological development that we live without precedents, and on the other hand, due to the fact that it is one of the most complex knowledge to understand for students. In the area of mathematics, factors that converge to promote school failure with respect to this knowledge are concentrated [1-5].

In the Colombian context, the performance towards mathematics has not changed. In this area, 15-year-old Colombian apprentices are at an average of less than three years (118 points) in relation to their other peer countries of the Organization for Economic Cooperation and Development (OECD). This organization, through the PISA test, has determined that Colombian students have serious delays compared to neighboring nations such as Chile, Mexico and Costa Rica. To counter this, during the 2014-2014 period, the OECD benefited 2345372 primary school apprentices and more than 90000 teachers, in 4300 schools and institutes distributed in 832 municipalities. However, despite making these efforts, the results have not become encouraging [2].

The foregoing indicates that Colombia needs to continue strengthening the mathematical competences of its students, and even more so, if the shortcomings are reported from school. If these



aspects are not addressed in a timely manner, it is possible that these learners will be hindered by the possibilities of learning mathematical knowledge in higher education. When, they perceive that this knowledge is complex and difficult to understand, they end up in the majority of the times to generate feelings of anxiety, tension, helplessness and restlessness, thus generating the creation of negative attitudes towards this discipline [2].

Consequently, in recent years, the need to increase the amount of studies and research associated with the attitudinal dimensions of the individual has been reflected, taking into account the accumulation of beliefs, affects and behaviors that the learner builds in relation to mathematics. Therefore, attitudinal dimensions constitute a key point of analysis to identify how negative beliefs and affections towards this science can become a major obstacle to learning mathematics [3].

For this reason, this research advances in the consolidation of understanding the importance of considering the individual's attitudinal dimension (beliefs, affections and behaviors) about learning and teaching mathematics. We chose this theme because the attitudinal dimension towards mathematics is taking a greater role nowadays since emotions, affections and thoughts can influence the learning performance of these areas [3].

In addition, because it is thought in a stereotyped way that the failure towards the academic performance of mathematics is due to not having sufficient cognitive skills or "lack of intelligence". However, with this paper we intend to identify how attitudinal factors can influence their performance. From the "Centro de Apoyo a las Matemáticas y la Física (CAMFI)" of the "Universidad Simón Bolívar, Colombia", we are interested in knowing other strategies that facilitate the learning of this area. For these reasons, we intend to investigate what factors promote the positive disposition towards their learning.

Therefore, we will be describing how attitudes influence the learning of mathematics. Then, we will mention the positive attitudes that are associated with successful performance towards mathematics and finally we will be suggesting a series of teaching practices that help foster the attitudes identified.

## 2. Method

The development of this article used as research method the bibliographic review of different academic articles. This method consists in preparing a text, based on the synthesis of different readings during the documentary research phase, followed by conclusions or a discussion [4]. With this method, we seek to systematize a variety of ideas by other authors, to allow the creation of other useful, original and practical text. Therefore, we propose to reference each of the objectives based on recognized authors, in order to offer scientific validity to the above.

## 3. Attitudes and performance in mathematics. What is your relationship?

First of all, what are attitudes? In general, attitudes can be understood as "evaluations" of various aspects of the world. Thanks to these evaluations, we can know certain patterns in people's cognitions, affections and behaviors, to act towards some aspect of their environment. Generally, attitudes are characterized by illustrating the tendency of the subject to feel, think or act, either positively or negatively towards an object [6-8].

As you can see, attitudes can influence the learning of mathematics, since it allows to determine a position regarding the teaching of its contents. Generally, this position is established because the affections, cognitions and performance are cyclic, that is, on the one hand, the experience that the apprentice has regarding the learning of mathematics can cause different reactions and influence in a consistent way in the formation of beliefs. On the other hand, the beliefs that are built based on these reactions have direct consequences on their behaviors, which can be manifested in learning situations and in their willingness to significantly address the issues [12-14].

When, attitudes towards mathematics are characterized by generating negative affective reactions, such as boredom, suspense, fatalism, lack of optimism, demotivation or rejection, these tend to transform into beliefs such as "I do not serve this", "I do not see meaning to study mathematics", "why study mathematics if we are not going to use this knowledge"; these affect behavior through disposition, that

is, manifesting whether I like it or not, and forming perceptions associated with self-efficacy towards this science, which determines the degree of involvement of the learner with the assimilation of mathematical knowledge [15-17].

Now, based on the above, what attitudes promote a positive disposition towards mathematics? Next, we will be explaining this aspect.

#### 4. Positive attitudes and learning mathematics

García, Escalera, Mika, Santana and Guzmán, conducted an empirical study to determine the level of anxiety towards mathematics in university students. According to these authors, anxiety towards this discipline occurs due to anxiety towards the understanding of problems, numbers and mathematical operations, temporality towards their content and evaluation of their knowledge. According to these authors, factors such as evaluation, beliefs associated with the ability to understand the topics, the experiences that have caused their teaching, the conditions and circumstances where they are taught, and the emotions and reactions that cause their contents, are variable. that influence to encourage anxiety towards mathematics [18].

To demonstrate this, the authors conducted a quantitative investigation under a correlational orientation with 303 students. The objective of this study was to measure the scales that are associated with anxiety towards these contents. As an evaluation instrument, they used the Muñoz and Vázquez questionnaire formulated in 2017, to measure anxiety towards mathematics. According to their results, the aforementioned variables allow to help explain the factors that are associated with anxiety towards mathematics, since 81% of the variables studied contribute to generating anxiety and 19% of these do not help explain in their whole. The main variable that is associated with anxiety towards mathematics is the understanding of mathematical problems, since there are significant correlations of 0.5 with the other variables [18]. With the study of García and associates, it is possible to identify that the factors that promote positive attitudes towards mathematics are the beliefs of self-efficacy regarding the ability to understand their contents and have had positive experiences with the learning of mathematics [18].

Similarly, there have been other studies that have been interested in investigating the implications that attitudes have on learning mathematics and how they can generate anxiety towards them. In this sense, we find the research of Rojas, Escalera, Moreno and García, who studied the implications of trust, anxiety, attitudes and their usefulness towards mathematics. Under this orientation, the authors carried out a quantitative research of exploratory, non-experimental cross-section. The sample selected was 75 university students and used the evaluation attitude of Auzmendi statistical questionnaire formulated in 1992 [19].

According to the results of their study, the authors found that 90% of the variables studied are significant, which means that the variable of pleasure, confidence, anxiety and usefulness are those that are most associated with the formation of attitudes towards Mathematics, which in its configuration, allow us to understand the learner's affinity towards this type of content. The curious thing about this study is that the motivation did not have so many implications to foster adaptive attitudes towards mathematics, which suggests that it is necessary to detail the degree of satisfaction and pleasure that it generates in the learners and not so much how much effort, direction and persist to learn [19].

With the research of Rojas and associates we can identify that the factors that foster positive attitudes towards mathematics are to have confidence towards this knowledge, to identify the usefulness of mathematics in daily life and low levels of anxiety, that is, to have few catastrophic ideas about learning math [19]. Other research has been interested in knowing how much anxiety the resolution of mathematical exercises generates. Along these lines, we find the reflections of Monje, Castro and Pérez, who carried out a theoretical-reflection article called "Problem solving and mathematical anxiety: Deepening their relationship". According to his reflections, anxiety towards mathematics involves the analysis of the affective factor. To detail this affective complexity, it is necessary to examine the beliefs that the subject possesses towards the learning of mathematics, which is possible to do so if the beliefs associated with the nature of its contents, those of oneself as a student, the teaching of this and those of the social context where your learning occurs [20].

According to these authors, these beliefs (cognitive aspect), generate subjective reactions (affective aspect) that ends in the execution of behaviors (behavioral and observable aspect). In the case of the teaching of mathematics, these beliefs end up transforming into attitudes, that is, predispositions and evaluations towards mathematics, which determines their intentions and influence the degree of involvement towards mathematical contents. Therefore, the authors recommend studying the content of the attitudes that students have towards mathematics, because depending on their nature, you can identify the evaluations they apply to get involved and immerse themselves in their learning. This is possible to know through the beliefs and reactions they cause [20]. With the reflections of Monje, Pérez and Castro, it can be identified that the factors that foster positive attitudes towards mathematics are the beliefs that are held towards mathematics [20].

Along the same reflexive line, there have been other investigations that have been interested in knowing the causes and consequences of anxiety towards mathematics. In this case, we find the research of Palacios, Santiago and Ortega, who carried out the design of a model of structural equations to identify the factors that originate it. The authors conducted an explanatory quantitative investigation with a sample of 1.064 trainees from a primary and secondary school. As an instrument, the authors carried out a Likert-type scale, which measured metacognitive abilities towards mathematics, the emotional-emotional reactions that cause their teaching, attitudes towards schooling and the anxiety that causes their learning [21].

According to the selected model and its statistical results, attitudes towards mathematics and anxiety are significantly correlated. Similarly, metacognitive strategies influence attitudes towards mathematics and schooling in general, that is, depending on the learning strategies that the subject has developed throughout their school life, they help to direct throughout life the way to function in the school environment. A curious fact: you can also find significant and stronger relationships between attitudes towards schooling and the rest of the detailed variables, which means that depending on the degree with which the student strives, find a sense to study and strive for learn, can predict anxiety levels [21].

Indeed, the research of Palacios and associates helps us identify that the factors that promote positive attitudes towards mathematics are positive attitudes towards schooling, positive study strategies and habits, and the emotional and emotional reactions that cause teaching and the learning of mathematics [21].

Finally, there has been other research interested in determining the student's profile with anxiety towards mathematics. Eccius and Lara conducted a study with 128 engineering students and 289 administration students to validate an instrument that allows characterizing the anxious profile towards mathematics. The research was quantitative descriptive and a Likert scale was used as a measuring instrument to measure aspects such as attitudes (acceptance, curiosity, assessment, rejection, disinterest, cognitive abilities), emotions (nervousness, worry, enthusiasm, indifference and frustration) and beliefs (about teaching and learning, about oneself as an apprentice, about the social context and about the nature of knowledge) [22].

According to the authors, these aspects are associated with the understanding of an anxious profile towards mathematics. The approach of these elements helps to determine indirectly the factors that foster positive attitudes towards mathematics, such as the degree of difficulty according to the learner's perception, the beliefs that he has regarding his abilities to understand it, the degree of persistence to cope with its complexities, its degrees of persistence and affinity towards them. In general, with these aspects it can be understood that attitudes, emotions and beliefs to mathematics help to understand the degrees of anxiety towards this type of content and consequently the type of mathematical attitudes that the learner possesses [22].

## **5. Teaching practices that promote positive attitudes towards mathematics**

One of the elements that influences the formation of positive attitudes in the apprentices, are the pedagogical attitudes, since they are predispositions or behavioral manifestations of the teachers, that somehow determine their intentions and guide them and drive them in their actions with respect to the

teaching-learning processes. The acts of the teacher need to be deliberate, conscious and participatory [23].

In addition, that pedagogical attitudes allow an integration of cognitive abilities to the behavioral and emotional development of the teacher, enhancing their skills towards the training of not only professionals, but also of people, creating favorable environments that in turn can stimulate interactions warm and positive human at the time the learning is consolidated. Therefore, teachers' attitudes are considered key factors that can facilitate the learning of mathematics. [23].

Therefore, it is pertinent for teachers to develop collaborative attitudes and practices, that is, where teamwork and the exchange of ideas promote collaborative learning, so that learners can feel social support when they are learning something new, in this case, mathematical knowledge [24].

Also, it is essential that teachers foster relational attitudes, where learners seek ways to benefit from the people around them, through the use of understanding, human sensitivity and commitment, as well as through the realization of collective contributions and the relationship of help to solve problems of daily life. In the case of the teachings of mathematics, this affects the perception of "having resources" to meet the demands of its contents [24].

In the same way, it is of utmost relevance that teachers develop attitudes with a professional and personal orientation, where mathematical contents are taught in a contextualized way and in relation to the solution of problems in the professional field of students. In the case of mathematics, if teachers teach their contents in a contextualized and practical way, students may find their teaching useful; aspect that strengthens motivation and the sense of learning their knowledges [25].

For this reason, the developments of these attitudes are pertinent, since if they are analyzed they look for the way that teachers can promote the integration of different knowledge, teamwork and collaborative for the construction of knowledge, the solution of real problems and the personal and individual development so that students and the teacher can learn to display all their potentials in the training processes.

## 6. Conclusions

The development of this article leads us to conclude that the learning of mathematics is not a purely cognitive matter or that it only depends on the intellectual abilities of the apprentice, there are other factors that influence his learning, such as attitudes towards it.

Attitudes can influence the learning of mathematics, because they have the ability to generate a position or evaluation against their teaching. This position or evaluation is influenced by the affective dimension, which generates emotional and motivational reactions to mathematical knowledge. Thanks to this, beliefs are formed, that is, the accumulation of ideas that support or argue the reasons why we develop a certain position for the purpose of the attitude, in this case, learn mathematics. These aspects can be examined in a concrete way through the behavioral dimension, which allows operationalizing the ideas that the subject has, thanks to the emotional reactions caused by the teaching of these contents.

Similarly, with the development of this article, we identify that the factors that promote positive attitudes towards mathematics are perceiving abilities towards mathematics, identifying the usefulness of mathematics for the future, the attitude of parents towards mathematics, beliefs towards mathematics, emotional and sentimental reactions that cause the teaching and learning of mathematics, pedagogical attitudes of the teacher, mathematical attitudes, positive attitudes towards schooling and strategies and positive study habits. With the development of this paper, we seek with this exploratory and analytical reflection, to have an "anchor point", to develop future empirical research in higher education. With this, we will seek to transfer to a descriptive phase that helps us characterize and understand the attitudes of students towards mathematics, in different contexts.

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