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The Relationship between Affectivity and Self-efficacy for the Learning of Mathematical Contents

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ABSTRACT

The causal attributions and dimensions and the academic self-efficacy permeated by the affectivity are fundamental for the school achievement of the undergraduate student. In this study, we evaluated the relationship between affectivity and academic self-efficacy of 115 students (39 from the Computer Science course, 41 from the Civil Engineering course and 35 from the Electrical Engineering course of the Federal University of Mato Grosso). A questionnaire with 10 questions was made using the Likert scale, where the first two questions assessed the interference of the previous contents on the learning of mathematical contents, three evaluated the level of student's academic self-efficacy, the other two assessed some origins of the beliefs of the student's academic self-efficacy, the last question evaluated the relationship between effort and academic self-efficacy, and questions 4 and 5, the focus of this research, directly assessed the relationship between affectivity and academic self-efficacy. The results pointed to a protagonist role of affectivity in relation to academic self-efficacy and a confirmation that the effort continues to be the highlight for students' belief in academic self-efficacy.

Keywords: Affectivity. Self-efficacy. Mathematical Content Learning.

A Relação entre Afetividade e Autoeficácia Acadêmica para a Aprendizagem dos Conteúdos Matemáticos

RESUMO

As atribuições e dimensões causais e a autoeficácia acadêmica permeadas pela afetividade são fundamentais para a realização escolar do aluno de graduação. Neste estudo, avaliamos a relação entre a afetividade e a autoeficácia acadêmica de 115 alunos (39 do curso de Ciência da Computação, 41 do curso de Engenharia Civil e 35 do curso de Engenharia Elétrica da Universidade Federal de Mato Grosso). Foi aplicado um questionário com 10 questões utilizando-se a escala de Likert, onde as duas primeiras questões avaliavam a interferência dos conteúdos prévios sobre a aprendizagem de conteúdos matemáticos, três avaliavam o nível de autoeficácia acadêmica do aluno, outras duas avaliavam algumas origens das crenças de autoeficácia acadêmica do aluno participante, a última questão avaliou a relação do esforço com a autoeficácia acadêmica e as questões 4 e 5, focos desta pesquisa, avaliavam diretamente a relação entre a afetividade e a

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autoeficácia acadêmica. Os resultados apontaram para um papel de protagonista da afetividade em relação à autoeficácia acadêmica e uma confirmação de que o esforço continua sendo o destaque para a crença de autoeficácia acadêmica dos alunos.
Palavras-chave: Afetividade. Autoeficácia. Aprendizagem dos Conteúdos Matemáticos.

INTRODUCTION

This article aims to point out the importance of affectivity in the self-efficacy of students learning mathematical contents. This study could be done with students at any level of studies, however, we chose to observe students in Computer Science, Civil Engineering and Electrical Engineering courses. This choice was motivated by the facts that these courses have a high concentration of subjects with mathematical content and that all the mathematical concepts taught in elementary, middle and high school are prerequisites for the mathematical content in the above courses.

According to Souza and Brito (2008), the physiological and affective states have a more limited effect over self-efficacy, as it constitutes a situational factor, and Bandura (1986) states that the most important factor in the development of self-efficacy beliefs are previous experiences, achievements and performances. He believes the main source of information on a person's capacities is their own experience. Nowadays, these two statements have possibly suffered variations. Taking as reference Wallon's theory of the Psychogenesis of the Complete Person and Weiner's (1985) studies on causal attributions and dimensions, as well as those of Bandura (1997) on self-efficacy, we propose to indicate that the relation between affectivity and self-efficacy is stronger than what was previously thought.

At present, Brazil is facing one of the worst crises in the educational system. The universities are full of students selected through the ENEM[1] exam system. They arrive with major setbacks in reading, comprehension, reasoning, and, even elementary mathematic operations. For Rama (2017), one of the main reasons for this is the deficiency in earlier education. Since 2005, when the Basic Education Development Index (Índice de Desenvolvimento da Educação Básica – Ideb) was created, the grade of the high school level education in Brazil has never been above 3.7 on the scale of 1 to 10. The low achievement in reading and comprehension of texts and in mathematics weighs considerably on this result. Specifically concerning reading in higher education, Tourinho (2011) states that students anywhere in Brazil enter higher education with significant difficulties both in language in general as well as in reading practice. Bortoli (2011) mentions that the mistakes made by the majority of higher education students, in the process of solving mathematical problems, are mostly related to not interpreting correctly the concepts studied in Elementary or Middle School. In this research we could observe that previously learned concepts have a very important role in student's

[1] Exame Nacional do Ensino Médio: Standardized Brazilian National Exam, which evaluates high school students in Brazil. The results are used as qualification for acceptance at universities.

self-efficacy belief, but this was not enough to consider affectivity a mere supporting element in this belief.

In the next section we will discuss some of the present propositions in published studies, first on affectivity and then on self-efficacy. We will then present our research methodology and the results we obtained, followed by a discussion about the findings. We conclude with our thoughts and indications on how affectivity has an exceptionally strong relation with self-efficacy.

AFFECTIVITY

Research is not needed to find that many educators have met students with mental blocks in their learning process and did not know how to solve this problem. These blocks were possibly caused by a mistaken instruction choice or the choice of an expression that was not understood, or still, for not realizing that the lack of an environment full of affectivity was causing this block. Many times, the cause of a block can be attributed to the lack of necessary previous knowledge or lack of student effort.

Studies such as Tassoni's (2000), point to the fact that:

> All learning is impregnated with affectivity, as it occurs in social interactions, in a binding process. Thinking specifically of learning in the school, the web that is woven between students, teachers, school content, books, writing, etc., does not happen purely in the cognitive field. There is an affective base, permeating these relations. (Tassoni, 2000, p.3-4, our translation)

Thus, it is not possible to imagine any action by a subject without the influence of the interaction with the medium in which s/he is, that is, without the influence of the events that are taking place around him/her, taking into account the affective events. As Plinio (mimeo) very well pointed out, among these events, the attitudes and the reactions of their peers' about them, are, without a shadow of doubt, the most important. Therefore, it can be expected that in a school environment, regardless of the level, any actions and reactions of the teacher towards the student that show affectivity, will favor his/her self-esteem. After elementary school, it seems as if a veil is put up between the teacher and the student in a way that the teacher cannot see the students' affective reactions. In higher education, the issue is worsened, as many professors totally ignore the fact that the pupils are still persons being formed in respect to their emotions, dreams and expectations in relation to their future role in society. The professor's great merit here is to perceive that his or her fundamental role is to find a balance between the affective and the cognitive in the student, for, according to Leite and Tassoni (2006), affectivity is present at all times or stages of the pedagogical work developed by the teacher. The paradox of this process (the recognition of affectivity as an essential part in the teacher's work) at all levels, lies in the fact that, to the teacher, it should be obvious to observe

that the results of his/her work would be extremely positive when a choice was made to establish a friendly relationship with the students, without losing respect and authority and, likewise, the work would be very heavy when the option was to distance oneself from the students. However, in practice, we can observe that it is not as obvious as we think. Possibly, several factors interfere in this apparently easy observation. Thus, we totally agree with Veras and Ferreira (2010) when they state that it is essential that the Professor in higher education also be involved in this process, considering affectivity as part of the development, aiming at the full overall educational development of the university students and at a positive learning experience.

The basis of the development process in Wallon's psychogenetic theory is the interrelation between the child and the environment, in a certain aspect, and the interrelation between the cognitive, affective and motor dimensions in another. These interrelations guarantee that the biological and the social aspects do not develop isolated from each other. When we refer to the social, we are including the cultural dimension. To ratify this statement, Dantas (2016) highlights that social mediation is at the base of development. It is the characteristic of a being that Wallon describes as "genetically social," radically dependent on other beings to survive and to build itself as a being of the same species. In another respect, affectivity develops alongside cognition. In Wallon's theory, it is clear that this process develops from infancy into maturity, justifying the expression *complete person.* Thus, affectivity, cognition, and motor activities interact among each other. As Mahoney (2008) explains:

> The motor, the affective, the cognitive, the person, although each one of these aspects has a different structural and functional identity, they are so integrated that each constitutes a part of the others. Their separation is necessary only for the description of the process. One of the consequences of this interpretation is that any human activity always interferes with all of them. Any motor activity has affective and cognitive resonance; all affective dispositions have motor and cognitive resonance; all mental operations have affective and motor resonance. And all these resonances have an impact on the fourth set: the person, who, while maintaining this integration, is the result of it. (Mahoney, 2008 as cited in Ferreira & Acioly-Régnier, 2010, p.30)

CAUSAL ATTRIBUTIONS AND DIMENSIONS

There are many studies on the relation between people's beliefs and their daily attitudes. Many causes are attributed to this, however, we will attain to the causal attributes for the success or failure in school. Without a doubt, Weiner's (1985) workplaces him among the researchers that contributed the most for the understanding of causal attributions for scholastic success or failure. He developed the attribution theory that has as its highlight a three-dimensional structure for causes. They are: the internality, the stability, and controllability. For Martini and Del Prette (2002), based on the dimensions

of causality, it can be said that capacity, effort, humor, and health, among others, are considered causes internal to the subject, while the teacher's influence, the task and the family are external causes.

Our focus here is on the teacher's influence, rather than other elements on the vast list of possible causes for students' success or failure. We will concentrate on the teacher's influence as one of the most important causes for the students' results, more precisely, on an affective interaction having been established between the teacher and the student. According to Beck, Magalhães, Lourenço and Pontes (2004), causal attribution influences interpersonal relations, interfering in the student's learning performance. For Weiner (1985), self-esteem, self-concept, and expectations are great determiners of performance, and are influenced by causal attributions. Bar-Tal (1978) cited by Faria, (1998), states that causal attributions are interferences that the subjects build, concerning the causes that influence the results of their achievement in a certain context.

Finally, it must be clear that, according to Neves and Faria (2007), the formation of attributional styles depends on the motivational and personality characteristics of each individual and also on the specific real situations and the type of results obtained, from which each subject can create their own attributional style. In spite of this statement, the authors admit that four style-types can be defined: *ego-defensive attributional style, counter-defensive* or self-*derogatory style, global externality style,* and *internality of the norm style.* It is not our interest to go into detail about the four types as the authors do in their article, however, according to them, each of these styles has different affective, cognitive and behavioral consequences that are responsible for building expectations of success that, as we have mentioned, directly influence achievement. Considering affective consequences, we would like to mention that the affective environment that involves these causal attribution processes are, in fact, important in forming students' self-efficacy beliefs.

SELF-EFFICACY

According to Bandura (1997, p.3) self-efficacy is the belief in one's own capacity of organizing and carrying out the necessary courses of action to produce certain achievements. This concept is closely related to students' performance in Mathematics. According to Barros (1996), it has been found that mathematical self-efficacy has been related to causality attributions for success and failure in this school subject.

Without delving into the concept of self-efficacy, for we will not touch on all the aspects involved in the formation of the belief of self-efficacy, we will highlight some researchers' findings that show approximations between affectivity and self-efficacy in the processes of teaching and learning of Mathematics. We single out, for example, Bandura (1986), for whom self-efficacy brings about several results by means of affective processes related to the individual's emotional reactions, stress, and reactions experienced in situations that are considered difficult or threatening; Souza and Brito (2008), who observed that, according to the socio-cognitive model, self-efficacy plays

a role in determining behavior and thought; Bandura (1977), who mentioned that some factors play a role in the source of the development of these beliefs, among which, social persuasion and the physiological and affective states; and Linnenbrink and Pintrich (2003), who state that academic self-efficacy is associated to more positive affective reactions. We highlight here the words of Neves and Faria (2007) followed by those of Rodrigues and Barrera (2007):

> Positive academic self-efficacy seems to be a promoter of more adaptive achievement standards, more efficient learning strategies, and even, more positive emotions, suggesting that the school, as an environment of individual development, should try to offer means and opportunity for the students to create expectations of more positive academic self-efficacy, contributing to the students' success in school and to their global well-being. (Neves and Faria, 2007, p 637, our translation)

> The physiological indicators related to the emotional states can also be a source of development of beliefs of self-efficacy. Feelings such as anxiety, fear or discouragement can make the student feel incapable of performing a certain task. On the other hand, a good mood and optimism can make the student believe and trust in his or her abilities. (Rodrigues and Barrera, 2007, p.4, our translation)

With a certain dose of reality about beliefs on students' self-efficacy, we mention the words of Bzuneck (2001):

> […] only after the assurance that the students have retained the knowledge, abilities and capacities, as well as having positive expectations of results, and that these results will be valued by them, will the beliefs in self-efficacy have the power to motivate them, for it is due to them that the choice, the direction and the persistence in learning behaviors will happen. (Buzneck (2001) as cited in Rodrigues and Barrera, 2007, p.4, our translation)

Based on the studies presented here, we can infer that the causal attributions and dimensions act on academic self-efficacy, which, in turn, acts on school achievement. We must also consider that the causal attributions and dimensions act directly on school achievement. Our objective is to show that in these causal attributions, affectivity has been more influential in students' self-efficacy than was presumed. Especially in academic self-efficacy.

METHODOLOGY

Participants

In this study we had the participation of 115 voluntary students from several different semesters in the Computer Science, Civil Engineering, and Electrical Engineering at the Federal University of Mato Grosso/UFMT. From the Computer Science course, 39 students participated, 41 participants were students in the Civil Engineering course and 35 were studying Electrical Engineering. These courses were chosen for the significant amount of mathematical content in the syllabi of the courses. Among the participating students, 89 are still studying this mathematical content, the other 26 have finished all those requirements.

Instrument

According to the presuppositions of qualitative research, this investigation consisted in the gathering of information by means of a research questionnaire in which Likert's scale was used. The questionnaire was the following:

1) Learning difficulties occur in subjects with mathematical content due to the lack of previous content.

   Totally disagree Disagree Indifferent Agree Totally agree

2) Self-efficacy in psychology designates a person's conviction of being capable of doing a specific task. The lack of previous content interferes in a student's self-efficacy in learning mathematical content.

   Totally disagree Disagree Indifferent Agree Totally agree

3) The success of colleagues in activities proposed for the group interferes in the student's self-efficacy to learn mathematical content.

   Totally disagree Disagree Indifferent Agree Totally agree

4) Encouragement from the teacher interferes in the student's self-efficacy to learn mathematical content.

   Totally disagree Disagree Indifferent Agree Totally agree

5) Affectivity or lack of it on the teacher's part in relation to the class interferes in the student's self-efficacy to learn mathematical content.

   Totally disagree Disagree Indifferent Agree Totally agree

6) The logical structure of Mathematics favors the student's self-efficacy to learn mathematical content.

   Totally disagree Disagree Indifferent Agree Totally agree

7) The student's trust in his/her capacity is related to his/her self-efficacy in learning mathematical content.

Totally disagree Disagree Indifferent Agree Totally agree

8) The student's perseverance in his/her activities is related to his/her self-efficacy in learning mathematical content.

Totally disagree Disagree Indifferent Agree Totally agree

9) The student sees difficulties as challenges in his/her activities in learning mathematical content.

Totally disagree Disagree Indifferent Agree Totally agree

10) The student's effort interferes in his/her self-efficacy in learning mathematical content.

Totally disagree Disagree Indifferent Agree Totally agree

Data Collection Procedure

An email was sent to the Coordinators of the Computer Science, Civil Engineering, and Electrical Engineering courses at the Federal University of Mato Grosso, asking for their collaboration by disclosing, to the students of their courses, the research questionnaire, made available on the link https://goo.gl/forms.FUyxd5PWZjVldWvX2, and clarifying that no student was obligated to respond and also that no one who did so would have their name disclosed in this research. We asked that those who wished to participate answer each question according to their real understanding of the topic being investigated. It goes without saying that all three course coordinators were very helpful.

Treatment of Data

The first two questions aimed at observing the importance of previous content for learning, both directly and indirectly, through the influence of the student's self-efficacy. We consider questions 4 and 5 crucial for this research, for they will effectively show if affectivity influences the student's self-efficacy. It can be through an indirect demonstration, as in question 4, by incentives, or as in question 5, through care, dedication, attention, etc., on the part of the teacher. Questions 7, 8, and 9 aim at analyzing the degree of self-efficacy the students participating in the research have, if it is high or low. The objective of questions 3 and 6 is to observe some of the origins of the participant students' self-efficacy beliefs, and question 10 focuses on giving information for the analysis of the influence of effort on self-efficacy.

In the analysis of each of the questions, the results "totally disagree" and "disagree" will be grouped together as will the results "agree" and "totally agree". All in terms of percentage.

RESULTS AND DISCUSSION

For questions 1 and 2 the results were the following:

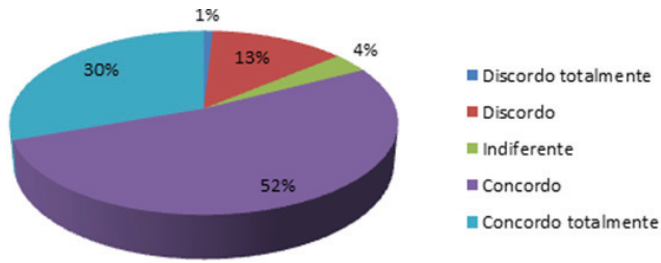

Figure 1. Learning difficulties occur in subjects with mathematical content due to the lack of previous content.

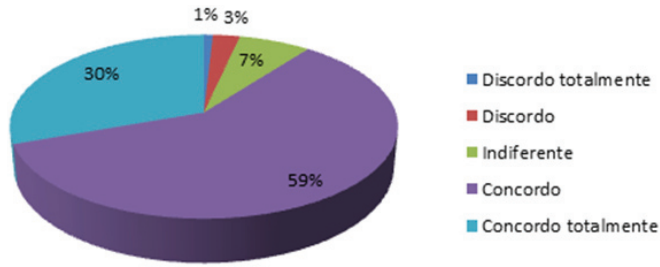

Figure 2. Self-efficacy in psychology designates a person's conviction of being capable of doing a specific task. The lack of previous content interferes in a student's self-efficacy in learning mathematical content.

Analyzing the results of the first two questions, that focus on previous content in the learning of mathematical content, we find a considerably high level of agreement that previous content is fundamentally important in learning mathematical content. When considering only the relation of previous content with learning mathematical content, an 82% rate of agreement was obtained to the statement that the lack of previous content interferes in the learning of new mathematical content, which is a very considerable rate. To further confirm this finding, a rate of 89% was the finding when the lack of previous content showed interference with the students' self-efficacy in learning these contents. It can be seen that, at first, the students felt that the absence of previous content directly interfered in learning content, however, when asked to consider the lack of previous content interfering in the learning of mathematical content via an interference in their self-efficacy, the rate increased 7 percent points. This shows that, contrary to the belief that learning and understanding mathematics is intimately linked to mastering previous

content. This is not a study focused on a search for a truth; we are merely presenting our findings.

For questions 4 and 5, these were the results:

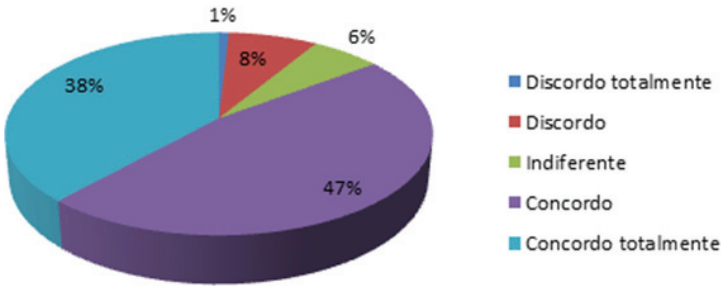

Figure 3. Encouragement from the teacher interferes in the student's self-efficacy to learn mathematical content.

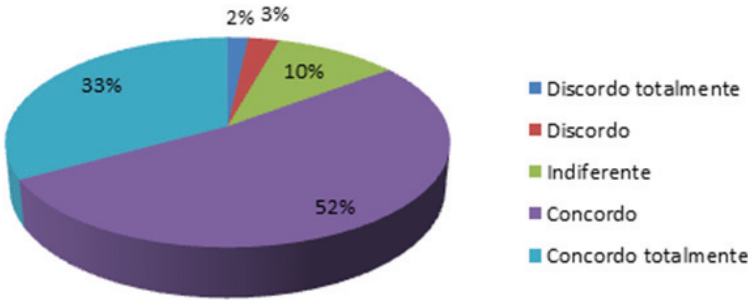

Figure 4. Affectivity or lack of it on the teacher's part in relation to the class interferes in the student's self-efficacy to learn mathematical content.

Looking at the results of questions 4 and 5 we see exactly 85% of agreement in both. This rate is very considerable. In question 4 the interference of the teacher's encouragement in the student's self-efficacy in the learning of mathematical content is considered. The finding here can be related to the student's understanding that, by giving encouragement, the teacher is showing attention and interest in his/her success. This is a demonstration of the teacher's affection and care toward the student, that is, an affective environment is being established. In the fifth question, affectivity is being directly considered, and the rate of "totally agree" reached 52%, 4 percent points above the same option in question 4. There is no denying, as we mentioned before, that affectivity permeates all school environments, regardless of level. In higher education it has been proven to be determinant. It would appear to be natural to suppose that students would have their self-efficacy potentiated when placed in an affective filled environment conducted by and educator. In fact, however, if this were so natural, most of the Mathematics teachers would be making use of this strategy in their classes. No doubt, affection, comprehension, respect, encouragement, positivity, companionship, good humor, awareness of individual difficulties, and accessible

language all contribute to give the teacher's pedagogical practice a qualitative leap. Of course, solid knowledge and effective classroom management also represent enhancers of an environment conducive to the student's belief in self-efficacy.

For questions 7, 8, and 9 the findings were:

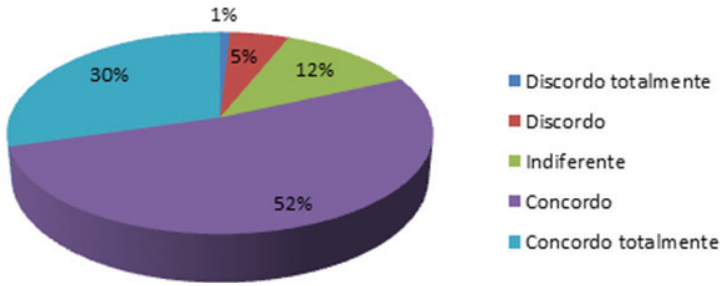

Figure 5. The student's trust in his/her capacity is related to his/her self-efficacy in learning mathematical content.

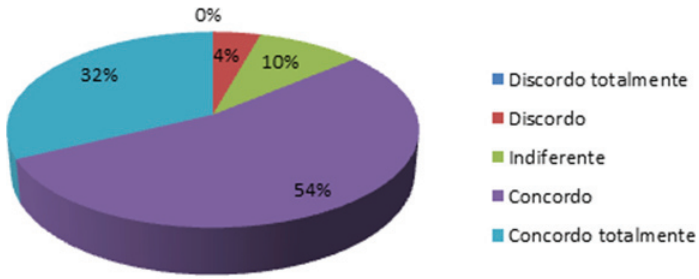

Figure 6. The student's perseverance in his/her activities is related to his/her self-efficacy in learning mathematical content.

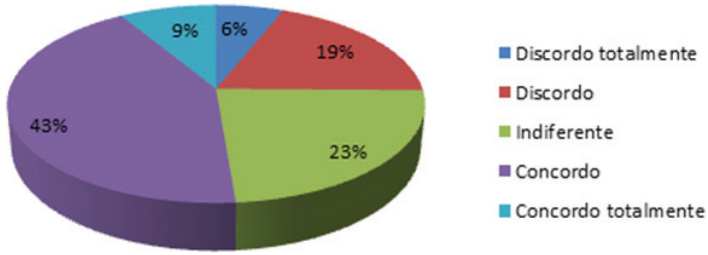

Figure 7. The student sees difficulties as challenges in his/her activities in learning mathematical content.

The results of questions 7, 8, and 9 clearly demonstrate a certain contradiction in respect to the levels of self-effectivity. While in 7 and 8 we see high self-effectivity, in 9 we find a slight demonstration low self-effectivity. It seems that the issue of previous content proficiency is causing this contradiction, as facing challenges refers us to verifying previous content, which seems not to exist. At this point, the teacher's interference,

demonstrating affection for the students, would make all the difference in correcting this course, changing low self-efficacy into high self-efficacy.

The results for questions 3 and 6 were:

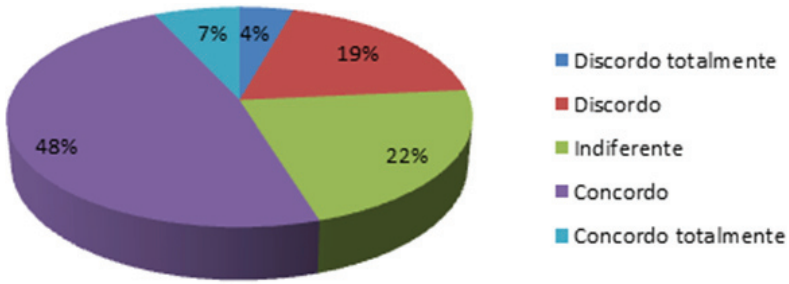

Figure 8. The success of colleagues in activities proposed for the group interferes in the student's self-efficacy to learn mathematical content.

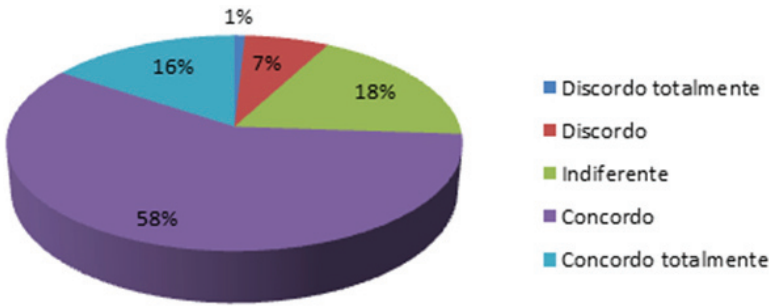

Figure 9. The logical structure of Mathematics favors the student's self-efficacy to learn mathematical content.

Questions 3 and 6 help us understand two sources of self-efficacy beliefs. In question 3, the 55% result points to the group's weak tendency in attributing the success of their peers' as the source of their beliefs in self-efficacy. In question 6, the 74% result shows the group's slightly stronger tendency to attribute the logical structure of Mathematics as the source of their belief in self-efficacy. We understand that these results were not sufficiently determinant to suggest that neither their peers' success nor the logical structure of Mathematics are actual sources of self-efficacy.

For question 10, the results were the following:

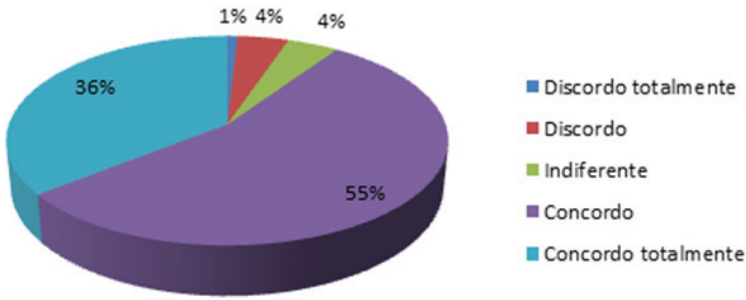

Figure 10. The student's effort interferes in his/her self-efficacy in learning mathematical content.

The result of the last question was striking for us, as 91% of the participant students agreed that their effort is the main interfering factor in their self-efficacy. This demonstrates what many other researchers have found. However, all the effort employed by the students in learning mathematical content can be worthless and turn into great frustration if they perceive that the environment surrounding them is promoting a belief that neither their peers' nor their teacher is interested in their success. We would like to suggest that the lack of affectivity in this learning process can be determinant in the degree of effort employed by the student.

FINAL CONSIDERATIONS

In this study we sought to highlight the role of affectivity acting as an enhancer of student's self-efficacy, independent of educational level, clarifying that, directly or indirectly, affectivity is imperative for the personal or intellectual development of the human being. We saw that the attributions and causal dimensions affect academic self-efficacy which, in turn, affect success in school. In this process, where affectivity is permeating all phases, we believe in total success in school. In search of a high self-effectiveness, affectivity is fundamental. It is as if each student were searching for a "state of flow" to reach his or her peak of personal and intellectual development. The teacher's choices during the period of interaction, from planning of content, choosing a methodology, deciding on an evaluation process, establishing a relationship with students, using adequate language for the explanation of content, communicating with students, etc., should always be accompanied by an attention to the establishment of an environment full of affectivity. It must not be forgotten that the human being is, by nature, moved by passions, emotions, the heart, etc. The student that feels cared for tends to become fully formed.

AUTHOR'S CONTRIBUTIONS STATEMENTS

J. R. D. S. conceived of the presented idea, developed the theoretical formalism, adapted the methodology to this context, prepared the questionnaire, collected the data, interpreted the results, performed the analysis and wrote the manuscript.

DATA AVAILABILITY STATEMENT

Data supporting the results of this study are available as 'supplemental files' on the Acta Scientiae website.

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