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Effect of learning centered on emotional management on the appreciation towards mathematics in university students

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ABSTRACT

Emotions are related to the motivation to learn, being necessary the development of courses designed to improve the appreciation for mathematics. The study determined the effect of a learning program focused on the management of emotions on the appreciation of mathematics in students of a private university in northeastern Peru. A quasi-experimental design study was planned in which 108 students of the first cycle of psychology, initial and elementary education careers who were taking the subject of logical thinking during the first academic semester of 2019 participated. Data were collected through a pre- and post-intervention survey, using a questionnaire consisting of 39 items evaluated by experts and with a Cronbach's coefficient of 0.95 and were analyzed using descriptive statistics and paired samples t-test. The program consisted of 15 learning sessions that included pedagogical strategies to activate students' thoughts of interest in mathematics. After the application of the program, the level of appreciation in each of the groups increased significantly from pretest to posttest ($p<0.000$). The intervention positively influenced students' appreciation in mathematics. Thus, emotional management can be an effective strategy to improve attitudes in higher education, and this approach can be replicated in other educational levels and disciplines.

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1. INTRODUCTION

It is estimated that in European, American, and Australian countries, 20% of the student population lacks mathematical skills, because it is considered a difficult [1] and boring subject with little utility [2]. These perceptions are usually the result of beliefs obtained at school or family [1], influenced by negative emotions towards mathematics [3] and the strict and authoritarian way in which the teacher teaches the subject [4], bringing as consequences an increase in absenteeism, dropping out of school and changing careers in higher education [5]. However, research in mathematics education has focused on cognitive factors, while affective factors (students' self-beliefs, attitudes and emotions in mathematics) are ignored [6].

Emotion is defined as a complex feeling that results in physical and psychological changes that affect thinking and behavior and have significant influence on learning [7]. Emotions that are related to knowledge acquisition are defined as epistemic emotions, whereas emotions that are related to academic success or failure are defined as achievement or academic emotions [8]. Epistemic emotions can be both

positive (joy, happiness, excitement, curiosity, and interest) and negative (frustration, irritation, and dissatisfaction) and achievement emotions can also be positive (relief, pride, joy, optimism, enjoyment, and relaxation) and negative (embarrassment, despair, anger, and anxiety) [9]. Positive emotions activate in students learning towards knowledge acquisition, whereas negative emotions are detrimental to academic performance [8]. In that sense, emotions are important in mathematics education, as students experience high levels of both negative and positive emotions [10].

However, it is necessary to design effective educational practices that foster positive emotions towards mathematics. Several studies show that using real-life scenarios in mathematics teaching can improve students' appreciation of the subject [11]–[13]. In this aspect, Alsina [11] proposes the activation of positive emotions through an adequate management of mathematics teaching in everyday life, where the student sees the usefulness of using mathematics to explain what is happening in their environment. While the theories of emotional intelligence [14] and multiple intelligences [15], offer theoretical frameworks to design new models or pedagogical approaches in mathematics education to personalize cognitive and emotional learning processes. On the one hand, Gardner and Hatch [16] in his theory of multiple intelligences argued that there is not only one type of intelligence, but that there are eight intelligences: linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal and naturalistic. On the other hand, Goleman [17] proposed the theory of emotional intelligence arguing that we have to effectively manage our emotions. In this sense, he recognizes five domains covering personal competencies (self-awareness, self-regulation, and self-motivation) and social competencies (social awareness or empathy and social skills) [7], which should be evidenced in the development of classes. It should be noted that both types of theories are related when referring to interpersonal and intrapersonal intelligence [17], also associated with school success [15]. Similarly, learning strategies can promote students' positive emotions and reduce negative emotions [18]. Therefore, the didactic theory of Zayas [19] is useful to work in a complementary or synergistic way the cognitive and affective dimensions of learning in higher education. Most studies have used the different theories and methods of teaching and learning individually or in combination when appropriate, to promote positive learning experiences in mathematics. However, there are limited studies that focus on integrating theories of intelligence along with concrete learning approaches to enhance mathematics appreciation at the college level, highlighting the need for research such as the present one aimed at filling this gap in students' mathematical learning.

Therefore, in this study we seek to determine the effect of a learning program focused on emotional management on the level of appreciation toward mathematics in college students and pose the following question: what is the effect of a learning program focused on emotion management on appreciation toward mathematics in college students? We test a program that offers an integrated learning framework based on the theories of emotional intelligence and multiple intelligences, didactic approaches to education and learning experiences at the university level, which provide a broader coverage of the cognitive and non-cognitive aspects of learning applicable to the context of mathematics education among students in the first cycles of psychology, initial and primary education at a private university in northeastern Peru. With this study we seek to contribute to the improvement of teaching practice by proposing and examining the effectiveness of a theoretical teaching model to promote a positive effect on the attitude of students towards mathematics to improve their academic performance.

2. METHOD

2.1. Program design

Since a model implies the adaptation of a general theory to a specific context, this study built a program that is based on the didactic theory-teaching-learning process of Zayas [19], the emotional intelligence theory of Goleman [17], the multiple intelligences theory of Gardner and Hatch [16] and the university educational experiences of Alsina [11], which attempts to bring together the cognitive and affective dimensions of learning, often considered separately. The program integrates didactic strategies such as collaborative work, social networks, mobile mathematics applications and multimedia presentations. In addition, it focuses on crucial emotional aspects such as motivation, self-regulation, social skills and cognitive flexibility.

In the specific field of mathematics teaching, a methodology focused on teaching with love and joy is promoted, incorporating emotional rewards such as positive gestures and actions by the teacher, in which his role is to act as a facilitator and extrinsic motivator, fostering a positive and stimulating educational environment. Therefore, this program aims to develop mathematical competencies for practical and working life, activating positive emotions in student learning and future professional and does not privilege one over the other, but insists that both are fundamental. The mathematics teaching program based on emotion management is shown in Figure 1.

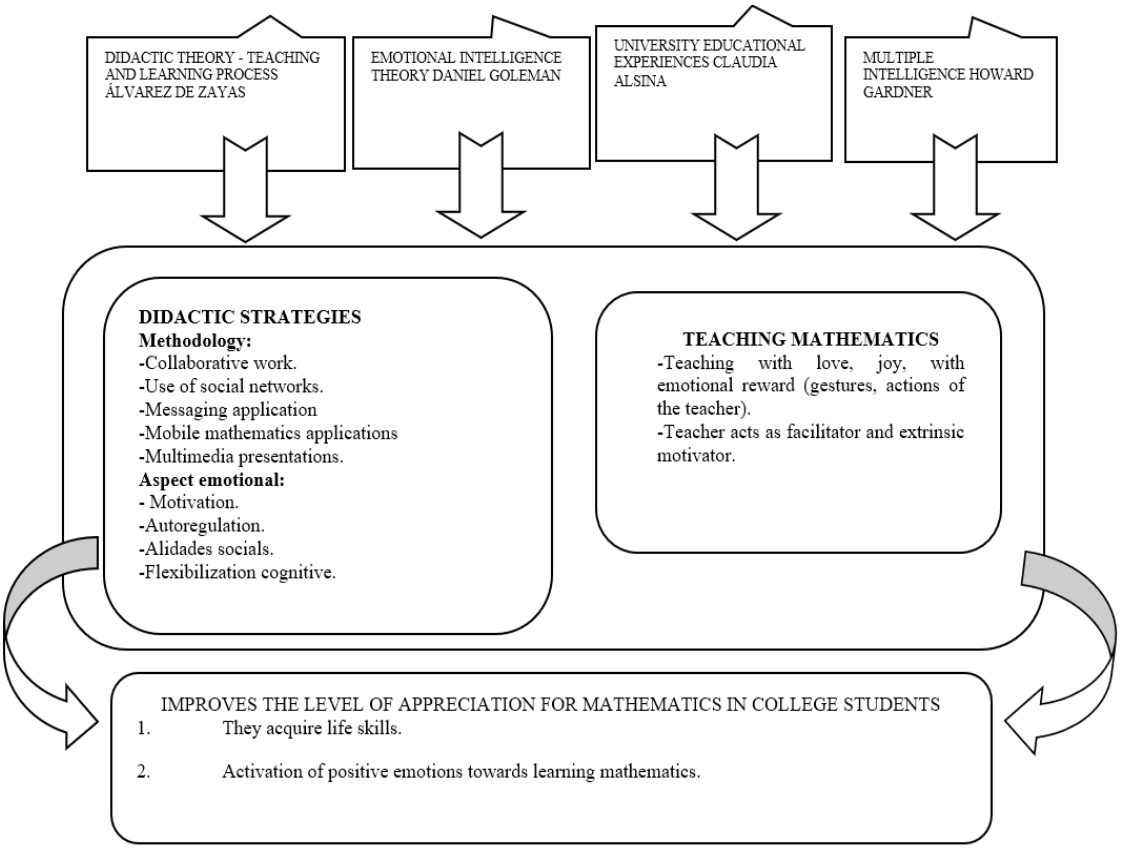

Figure 1. Graphical synthesis of the mathematics teaching program

2.2. Study design and participants

Quasi-experimental single-group study, based on convenience sampling, in 108 students enrolled in the course of logical thinking in the first academic semester of 2019, according to the current curriculum of professional schools, distributed in initial education which consisted of two sections: A (22) and B (33), elementary education (24) and psychology (29) in a private university in the Lambayeque region of Peru. All students with regular attendance were included, which was verified through the control sheet provided by the teacher of the subject. Participants who failed to attend were excluded from the study.

2.3. Instrument

The instrument for measuring the variable appreciation of mathematics was developed by the researchers. This instrument consists of a Likert-type questionnaire with 39 items grouped into two dimensions: teacher and subject. Content validity was assessed by three experts with postgraduate professional training of master's or doctoral degree, who evaluated each item based on the objectives, dimensions of the variable, wording, clarity, coherence and measurement scale. The questionnaire obtained a high reliability through the Cronbach's alpha coefficient with a value of 0.95.

2.4. Methodology applied in the proposal

After having the endorsement of three experts, the program was implemented in the logical thinking curricular experience corresponding to the first cycle of studies, with the purpose of improving the students' level of appreciation of mathematics. The students of all groups were taught during 15 two-hour learning sessions in their respective classrooms over a 4-month interval, taught by a teacher in charge of the subject. A total of 12 topics related to fundamentals of mathematical thinking, mental operations order of information, logic, proportionality, rule of three, percent, graph reading, linear function and quadratic function, taken from the course syllabus of the study programs, were developed.

The methodology applied in each session was peculiar and innovative, focused on didactic resources that allow students to acquire new learning, as well as to identify and understand their emotions in order to adequately manage their reactions in a specific context. The application of collaborative work in the

classroom was the didactic strategy that allowed the active and constant participation of the student, the interaction with the members of the work team helped greatly to socialize the emotions generated by the learning of mathematics in addition to acquiring commitment to their learning. Each learning session had its own strategy where the teacher, taking into account the thematic content to be developed, creates the appropriate environment and selects the most appropriate didactic resource. Among the didactic resources used were mathematical applications on mobile devices (GeoGebra), social networks (Facebook), messaging (WhatsApp), multimedia material (slides), among others.

Emotional management was carried out through strategies based on theoretical models of emotional intelligence and educational experiences. The teacher sought to generate positive emotions towards the teaching of mathematics by creating emotional skills through direct treatment (calling the student by name), creating a healthy climate, constant motivation through verbal encouragement, clarification or resolution of doubts, collaborative work that generates empathy and respect among students. The program was developed taking into account cognitive and emotional aspects based on the development of practical activities, collaborative work and the use of technology.

Pre- and post-tests were conducted on all groups. The post-test was administered to all groups after they were taught the course using emotion management to determine the effectiveness of the program. The pretest and posttest questions were similar.

2.5. Statistical analysis

Statistical analysis and processing of the data was performed using the SPSS version 25 statistical package. The normality of the data was tested using the Shapiro-Wilk test, revealing that the data were normally distributed. Frequency statistics, percentages, averages and standard deviations were found. Hypothesis testing was performed using the student's t-statistic for related samples with a p-value<0.05.

2.6. Ethical aspects

The intervention was carried out once approval to conduct the study was obtained from the university. Participation was invited by written informed consent, after informing the objective of the study. In addition, participants were informed that no identifiable data would be collected and that their participation was completely voluntary.

3. RESULTS AND DISCUSSION

3.1. Results

Descriptive statistics for demographic variables are provided in Table 1. The mean age of the participants was 19.06 years (range 16-44) and the 16-23-year age group predominated (93.5%). Females constituted 78.7% of the participants. The percentages in Table 2 show some interesting data. Some trends identified when exploring the frequency of responses to the questionnaire included the choice of career to avoid these subject difficulties in remembering recent lectures, perceived lack of teacher motivation, limited participation in practical exercises, and frequent need for help with home activities. Details of the questionnaire are included in Table 2.

Table 1. Sociodemographic characteristics of the study sample (n=108)

Features		N (%)
Gender	Male	23 (21.3)
	Female	85 (78.7)
Age	16-23	101 (93.5)
	24-30	4 (3.7)
	31-37	2 (1.9)
	38-44	1 (0.9)

The variable level of appreciation for mathematics was measured at the beginning and end of the 2019 I class period. In the initial evaluation it was observed that the indifferent level is the one that predominates in all groups and the final evaluation indicated a favorable level. These results are shown in Table 3.

The results of the student groups are compared in Table 4. Table 4 demonstrates a significant difference between students' mathematics appreciation scores before and after the intervention ($p=0.000<0.05$). These results support the hypothesis that a learning program focused on emotional management improves appreciation toward mathematics in college students and ensure the significance of the proposed approach.

Table 2. Appreciation toward mathematics according to surveyed students

Items	Never (%)	Almost never (%)	Sometimes (%)	Almost always (%)	Always (%)
1. You like mathematics.	13 (12)	24 (22.2)	48 (44.4)	21 (14.9)	2 (1.9)
2. When pursuing a career, you choose mathematics as a career option.	30 (27.8)	35 (32.4)	34 (31.5)	8 (7.4)	1 (0.9)
3. Mathematics awakens positive emotions in you.	15 (13.9)	19 (17.6)	52 (48.1)	18 (16.7)	4 (3.7)
4. The study of mathematics is necessary.	1 (0.9)	7 (6.5)	12 (11.1)	25 (23.1)	63 (58.3)
5. You study mathematics out of interest.	15 (13.9)	21 (19.4)	45 (41.7)	18 (16.7)	9 (8.3)
6. You are honest when developing a math test.	1 (0.9)	6 (5.6)	27 (25)	29 (26.9)	45 (41.7)
7. You remember the math class you took the days before.	10 (9.3)	10 (9.3)	50 (46.3)	25 (23.1)	13 (12)
8. The teacher motivates the math class.	3 (2.8)	11 (10.2)	26 (24.1)	29 (26.9)	39 (36.1)
9. The teacher employs different teaching strategies.	5 (4.6)	9 (8.3)	23 (21.3)	29 (26.9)	42 (38.9)
10. You go out to the board to solve a math problem.	8 (7.4)	21 (19.4)	60 (55.6)	13 (12)	6 (5.6)
11. You do math homework without help.	9 (8.3)	19 (17.6)	52 (48.1)	24 (22.2)	4 (3.7)
12. You stay in the classroom for the entire math class.	1 (0.9)	3 (2.8)	4 (3.7)	24 (22.2)	76 (70.4)
13. You spend time studying mathematics.	11 (10.2)	17 (15.7)	57 (52.8)	20 (18.5)	3 (2.8)
14. You feel confident when doing a math exercise	7 (6.5)	24 (22.2)	51 (47.2)	20 (18.5)	6 (5.6)
15. You enjoy mathematics.	17 (15.7)	25 (23.1)	50 (46.3)	11 (10.2)	5 (4.6)
16. Math classes are different every day.	1 (0.9)	10 (9.3)	29 (26.9)	37 (34.3)	31 (28.7)
17. The teacher makes the class enjoyable.	8 (7.4)	10 (9.3)	35 (32.4)	31 (28.7)	24 (22.2)
18. The teacher dominates the class.	0 (-)	5 (4.6)	13 (12)	27 (25)	63 (58.3)
19. The teacher shares work material.	0 (-)	2 (1.9)	26 (24.1)	33 (30.6)	47 (43.5)
20. Everything you study in mathematics applies to your reality.	2 (1.9)	11 (10.2)	39 (36.1)	31 (28.7)	25 (23.1)
21. You are on time for math class.	0 (-)	3 (2.8)	16 (14.8)	33 (30.6)	56 (51.9)
22. You stay in math class all the time.	0 (-)	3 (2.8)	8 (7.4)	19 (17.6)	78 (72.2)
23. The teacher attends class properly dressed.	0 (-)	0 (-)	7 (6.5)	18 (16.7)	83 (76.9)
24. The teacher answers your questions in math class.	0 (-)	3 (2.8)	15 (13.9)	34 (31.5)	56 (51.9)
25. The teacher conducts the class without any mishaps.	0 (-)	5 (4.6)	20 (18.5)	34 (31.5)	49 (45.4)
26. The teacher uses mathematical software.	24 (22.2)	17 (15.7)	24 (22.2)	17 (15.7)	26 (24.1)
27. You have applied what you have learned to reality.	4 (3.7)	14 (13)	47 (43.5)	28 (25.9)	15 (13.9)
28. The teacher inspires confidence in you.	1 (0.9)	4 (3.7)	28 (25.9)	34 (31.5)	41 (38)
29. The teacher has cared about you.	3 (2.8)	6 (5.6)	29 (26.9)	30 (27.8)	40 (37)
30. The teacher has mentioned you in the classroom.	9 (8.3)	9 (8.3)	48 (44.4)	22 (20.4)	20 (18.5)
31. You think you can do better in math.	1 (0.9)	6 (5.6)	23 (21.3)	37 (34.3)	41 (38)
32. You solve math exercises in groups.	1 (0.9)	6 (5.6)	40 (37)	42 (38.9)	19 (17.6)
33. You think you will pass math.	4 (3.7)	8 (7.4)	41 (38)	35 (32.4)	20 (18.5)
34. Your parents have had an easy time learning math.	3 (8.3)	18 (16.7)	37 (34.3)	29 (26.9)	21 (19.4)
35. Math classes seem to end early.	11 (10.2)	25 (23.1)	48 (44.4)	14 (13)	10 (9.3)
36. The teacher is organized.	2 (1.9)	3 (8.3)	17 (15.7)	28 (38)	58 (53.7)
37. The teacher is punctual.	0 (-)	4 (3.7)	15 (13.9)	20 (18.5)	69 (63.9)
38. Math tests inspire you.	11 (10.2)	28 (38)	44 (44.4)	18 (16.7)	7 (6.5)
39. You take time to review math.	11 (10.2)	22 (20.4)	52 (48.1)	19 (17.3)	4 (3.7)

Table 3. Level of appreciation towards mathematics before and after the application of the proposal

Category	Initial education A				Primary education				Initial education B				Psychology			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Unfavorable	1	4.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Indifferent	16	72.7	0	0.0	16	67.0	0	0.0	24	72.7	8	24.2	17	58.6	3	10.3
Favorable	5	22.7	22	100.0	8	33.0	24	100.0	9	27.3	25	75.8	12	41.4	26	89.7
Total	22	100	22	100.0	24	100.0	24	100.0	33	100.0	33	100.0	29	100.0	29	100.0

Table 4. Student's t-test for paired samples before and after the application of the proposal

Groups	Before the intervention		After the procedure		Difference in averages	Standard deviation	IC 95%		t	gl	Sig. (Bilateral)
	Media	Standard deviation	Media	Standard deviation			Lower	Superior			
Initial A	130.27	18.19	167.82	12.95	-37.55	21.20	-46.95	-28.15	-8.31	21	0.000
Primary	131.29	17.23	160.79	11.55	-29.50	19.13	-37.58	-21.42	-7.56	23	0.000
Initial B	132.48	22.49	155.58	17.79	-23.09	21.42	-30.69	-15.49	-6.19	32	0.000
Psychology	138.14	16.83	162.97	14.98	-24.83	14.53	-30.36	-19.30	-9.20	28	0.000

3.2. Discussion

The main objective of this study was to analyze the effectiveness of a learning program focused on emotion management in improving the level of appreciation towards mathematics in university students. The results confirm the significant improvement in appreciation towards mathematics as a result of the intervention, demonstrating the effectiveness of the program, which is consistent with what previous studies

have suggested [14], [20]. Given that the results reflect a clear decrease in indifferent or negative appreciation towards mathematics with the intervention. This underscores the importance of emotional attention of the teacher on students, students on peers, and teacher on self. These results reveal the importance of proposing a mathematics teaching-learning model that considers affective factors as a fundamental part, with the main promoter being the teacher who has to manage the emotions of his students and his own [21]. It should be remembered that the affective dimension of competencies is part of the curriculum to be addressed in the teaching/learning processes of mathematics, so it is necessary not to neglect this non-cognitive component [22]. Therefore, for the construction of the program we have proposed the integration of theories referring to the teaching/learning process developed by Zayas [19], Gardner's theory of multiple intelligences [16], Goleman's emotional intelligence [17] and Alsina studies [11], which have not been explored in other studies and provide a robust conceptual frame work for integrating the cognitive and affective dimensions of learning often addressed separately.

Second, this study provided evidence on the level of appreciation towards mathematics of undergraduate students in the first academic cycles of a Peruvian university. Recognizing that most of the participants presented an indifferent level of appreciation towards mathematics, which was also found in other studies [3], [23]. Which is also unfavorable, since it discourages students to take first-year mathematics courses and that could be related to their previous learning experiences and teaching methodology.

A worrying aspect was that a considerable percentage of students indicated that they chose the career so that they would not have to study mathematics. These findings are consistent with the previous studies [24], [25]. It is important to note that this reflects the students' assessment of themselves regarding their inability to study mathematics, preferring careers with lower mathematical intensity, and highlights the need to intervene in the construction of academic self-esteeming this area.

We found that 38.8% of students do not find mathematics fun. This finding is consistent with the study of Schwartze *et al.* [26] who showed a high percentage of boredom in mathematics in students in Germany. It should be noted that boredom can hinder academic performance [22]. To combat this situation, Ilyas *et al.* [27] revealed that designing learning tools effectively by the teacher, creating a fun learning environment allows students to be more confident and creative in solving mathematical exercises. Despite this, in the present study more than half of the students (58.3%) referred that learning mathematics is necessary, which means that students area ware of the value of mathematics in vocational training, although they do not perceive the relevance of mathematics for their aspiring careers [28].

We found that 19.4% of the students had no interest in mathematics. This has been corroborated in another study [29], so it can be conjectured that students who are less interested in mathematics maybe more reluctant to put effort into learning it; although the present study did not examine this directly. Conversely, a student's greater interest in mathematics tends to predict higher levels of attention, engagement, persistence, and the use of learning strategies [28]. The reason for this is the lack of teacher motivation to get students interested in acquiring knowledge, which is confirmed by the survey results, of which only 24.1% of the respondents indicate that the teacher motivates their students in classes. It is important that students are motivated and participate in mathematics classes. Motivation can influence the effectiveness of learning and the desire to continue attending classes and doing homework [30]. Regarding this, Gómez-Chacón *et al.* [13] refers that for learning mathematics it is fundamental to develop activities related to reality, thus allowing the reinforcement of inquiry, awakening interest and motivation by activating positive attitudes in students, which allow increasing the capacity for enjoyment during mathematics learning. But, in addition, we cannot ignore the importance of teacher training on methodologies and pedagogical strategies to develop emotional support in the teaching of mathematics in such a way as to generate motivation and interest in students.

A large majority of students (48.1%) reported requiring help with homework assignments in college math courses. This can cause boredom with homework and learning. To address this problem, Nguyen *et al.* [31] propose to develop a tutoring system to strengthen mathematics problem-solving skills in students. Another significant finding was that, about 50% of the students' presented difficulties in recalling the class taken very recently, as has been found in existing research [32]. Students are considered to have successfully learned when they can recall and rephrase facts or use them to answer questions on tests. Therefore, students with in the sample have little understanding and mastery of mathematical concepts.

This was followed by the effects of study time on mathematics achievement. More specifically 20.4% of students in this study do not devote time to study mathematics, which was also found in other study [33]. This could influence a poor retention of the learned information and thus it is quickly forgotten.

On the other hand, the findings also indicated that a reduced percentage of students (10.2%) affirm that what they learn they apply in reality, although we could say that the perception is lower than we expected, it leaves no doubt that the contents seen in higher education are developed in a decontextualized way, without an application to everyday life. Specifically, mathematics is oriented to problem solving, therefore, teachers have to connect mathematics with everyday problems [32]. Therefore, we should consider the need to design activities that connect mathematics with everyday reality [11]–[13].

However, there is a relatively significant percentage of students (38%) who think they can improve in math. This interestingly links to the low percentage of students (11.1%) who have a negative thought that they will fail mathematics. Similar to other research [5], these findings suggest that relying on effort in mathematics explains the development of positive mathematical attitudes about achievement.

However, information on the effectiveness of the intervention is limited, since a comparison group was not included. In addition, it is suggested that the evaluation of the program be carried out by expanding the size and origin of the sample in order to obtain conclusions that can be generalized to the population. It is suggested that longitudinal studies be developed in order to measure the effectiveness of the program over time and in different educational contexts, so that it can be validated and also readjusted to the individual needs of the students. In addition, the use of this approach should be considered in other professional careers that present emotional challenges to students, such as science.

4. CONCLUSION

The study demonstrates the desirability of incorporating learning programs focused on the ability to manage the emotions of university students that can be integrated into mathematics courses, to be taught in the curriculum using a pedagogical approach of competencies. Therefore, they should be applied by teachers on the basis of the theories of both emotional intelligence and multiple intelligences as well as didactics and learning experiences at the university level. In this way, it is possible to contribute to create meaningful, comprehensive and sustainable learning environments, where mathematics is perceived as a relevant tool for both academic training and professional life.

The practical implications that can be drawn from this study are that university institutions should implement training workshops on emotion management, providing tools and strategies that contribute to the creation of a very favorable learning environment. It is also essential to incorporate different activities that connect mathematics to students' daily life contexts, which will allow them to appreciate the transcendence of this subject, fostering the significance of learning. Similarly, a continuous evaluation system should be implemented in which, in addition to academic performance, the emotional well-being and attitude of students towards mathematics should be considered. According to the results of this study, it is suggested that those responsible for the formulation of public policies in university education should consider the need to include emotional management as an essential and transversal element in all areas and disciplines of university education.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
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Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

The research related to human use has been complied with all the relevant national regulations and institutional policies in accordance with the tenets of the Helsinki Declaration and has been approved by the authors' institutional review committee.

DATA AVAILABILITY

The data that support the findings of this study are available on request from the corresponding author [NCSS].

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