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Undergraduate students' emotions around a linear algebra oral practice test

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ABSTRACT

Educational research has reported different benefits related to the use of practice tests. In the case of the teaching and learning of mathematics, evidence has been found that the use of practice tests is associated with an improved performance in standardized tests. However, it is less known about the emotions that students experience during such practice tests. This paper reports on a study on the use of practice test in mathematics instruction at the undergraduate level, which focuses on exploring students' emotions during a practice test for linear algebra. 78 students answered a questionnaire one day after having participated in an oral practice test on linear algebra. The results suggest that before the practice test nervousness was predominant among students, but this emotion decreases as the activity progresses.

Keywords: emotions in mathematics learning, practice test, undergraduate students

INTRODUCTION

A practice test is a type of assessment or exam that is taken to prepare for an actual exam. It allows the individual to familiarize themselves with the format and types of questions and identify areas where they need improvement before taking the test. Practice tests have positive impacts on learning, according to research. Their utilization has been demonstrated to enhance recall and significantly boost long-term memory retention (Roediger & Karpicke, 2006), and that the use of practice tests is more beneficial for learning than restudying (Adesope et al., 2017). In the case of the teaching and learning of mathematics, evidence has been found that the use of practice tests that require students to practice the application of problem-solving principles, procedures and numeracy skills, is associated with an improved performance in standardized tests (Avvisati & Borgonovi, 2020; Thai et al., 2021). However, although some of the academic advantages of practice tests are known, it is less known about the emotions that undergraduate students experience during such practice tests. For instance, Leeming (2002) reports a teaching experience in which students in a psychology class had a short exam at the start of every class. The students who participated in this teaching experience not only performed better on a retention test compared to their peers who did not take these practice tests; the participating students also rate the course as more enjoyable and beneficial than other courses that do not use this approach. A relevant open question in this context would be what the emotions are experienced by university mathematics students when participating in practice tests. Knowing the emotions that students experience would allow us to explore the feasibility of implementing this type of study approach in undergraduate mathematics teaching but considering the students' perspectives.

In this article we report a study that focuses on the prior open question. In particular, the study is guided by the following research question: *What are the characteristics of the emotions expressed by undergraduate students who participate in an oral practice test in linear algebra?* This work brings to the fore the emotions experienced by undergraduate students when they engage in a practice test. To place this study in the research landscape, in the next section we offer a conceptual review anchored in research on affect in mathematics education, which will allow us to address the research question.

AN OVERVIEW OF ACADEMIC EMOTIONS

For a long time, the significance of the affective dimensions of mathematics education was overlooked. However, for at least 30 years the field of mathematics education has been developing studies focused on students' and teachers' emotions, attitudes and beliefs about mathematics, its teaching and learning. Some of those studies address how these affective elements influence

the students' disposition to participate in the learning process and how they affect their academic performance (Gómez-Chacón, 2000; Hannula, 2020). These affective elements refer to the emotional and attitudinal aspects of learning the subject, such as students' motivation, engagement, self-esteem, and attitudes toward mathematics. These dimensions play a critical role in students' learning experiences and can impact their achievement and success in mathematics. Students with positive attitudes and high motivation towards mathematics are more likely to persist in facing challenges and be engaged in the learning process. On the other hand, negative affective experiences can lead to students feeling frustrated, disengaged, and demotivated, which can negatively impact their learning outcomes. Thus, it is crucial to consider and address the affective dimensions in mathematics education to support students' learning.

McLeod (1989) suggests that beliefs, attitudes, and emotions can vary in both intensity and stability. Although beliefs and attitudes can be relatively stable, emotions tend to change rapidly. Gómez-Chacón (2000) claims that emotional reactions in problem-solving are usually intense but of relatively short duration. For example, when solving a mathematical problem, emotions can oscillate between the positive (e.g., when the student feels there is progress in solving the problem) and the negative (e.g., when the student experiences a blockage in their solution process). Gómez-Chacón (2000) suggests that people who are aware of their emotions can learn to control their reactions towards a mathematics problem to prevent them from interfering with their problem-solving performance. For example, accepting that there may be difficulties in the solution process but avoid letting frustration led you to abandoning the task.

The emotional experiences that emerge in connection with mathematics instruction are varied and depend on a number of factors. For example, Schukajlow et al. (2017) point out that the type of mathematical problem that is posed as well as its level of difficulty influence students' motivation and emotions when trying to solve it. In this sense, we think it is important to explore undergraduate students' emotions in a linear algebra course since the inherent level of formalism of linear algebra has been identified as a learning obstacle for students (e.g., Dorier, 1998), which could trigger a wide range of emotions in students (Martínez-Sierra & García-González, 2016), especially when introducing a practice test in a game format.

What Are Emotions and How Can They Be Characterized?–A Framework

Emotions are multifaceted phenomena that arise in reaction to a stimulus. They involve psychological and affective aspects, but also cognitive components, motivations and their manifestations.

It is possible to characterize emotions based on their *valence* (Pekrun et al., 2017). Watson and Tellegen (1985) use the terms positive and negative to refer to the valence of an emotion. The underlying issue here is to establish a scale that allows distinguishing a wide range of emotions. This is, how to classify reactions that can range from enjoyment to anxiety, or from joy to anger. In addition to valence, the *intensity* with which emotions are manifested can also vary. Barrett and Russell (1999) define the concept of *activation* to refer to such intensity. The authors point out that this concept refers to the level of energy manifested when experiencing an emotion, so it can be expressed in a range that goes from drowsiness to hyperactivity or frenetic excitement. Deactivation serves to put the organism at rest, whereas activation prepares the subject for a quick reaction (Pekrun et al., 2017).

In the school context all kinds of emotions emerge emotions of positive or negative valence and with different levels of activation. Behnagh (2019) refers to two types of emotions in the academic context: social emotions and epistemic emotions. Social emotions are related to the interactions with other subjects, for instance feeling empathy or envy for other people. Epistemic emotions are focused on the cognitive processes that occur during learning activities. Epistemic emotions represent a category of emotions that arise when acquiring knowledge about the environment or about oneself (Pekrun et al., 2017).

Pekrun (2006) defines achievement emotions as those that are directly related to activities that lead to some kind of achievement and points out that these emotions can be superimposed or combined with some social emotions. According to Pekrun, achievement emotions can be classified into two types: those related to the activity and those related to the outcome. Among the emotions related to the activity we can mention the boredom or the amusement that students may experience during a learning activity. Joy or frustration at passing or failing an exam are examples of outcome-related achievement emotions.

Regarding the differences between epistemic emotions and achievement emotions, Pekrun et al. (2017), point out:

> Epistemic emotions differ from achievement emotions by their object focus. Knowledge and the generation of knowledge are the objects for epistemic emotions; in achievement emotions, success and failure are the objects. Some emotions are epistemic by nature, such as confusion, whereas others can belong to various categories of emotion, depending on the object focus of attention. Specifically, during cognitive activities, some emotions can be experienced as epistemic emotions or as achievement emotions. A student's frustration at not deriving a correct solution to a mathematics problem would be considered an epistemic emotion if the focus is on the cognitive incongruity resulting from the unsolved problem. However, if the focus is on personal failure and the inability to solve the problem, then the student's frustration would be considered an achievement emotion (p. 10).

The discussion in this section provides three-dimensional framework for characterizing emotions: valence, intensity, and the object on which the emotion is focused. These dimensions are used to answer the research question declared in the introduction of this article.

METHOD

This section elaborates on the research method implemented in the study. It begins by describing the study participants and the activity implemented. Subsequently, the procedure for data recording and analysis is explained.

Study Participants

The participants in the research study were science students at a Mexican public university. At the time of developing the research they were enrolled in the second semester of the core curriculum for science students, where they should take a course on linear algebra. All students were invited to participate in the study by their linear algebra teacher (the first author of this article). It was made clear to them that their participation would be anonymous and voluntary, and it would not affect their grades. Thus, a total of 60 male students and 18 female students participated in the study.

Description of the Implemented Activity

As part of the activities of the linear algebra course, a practice test that would be useful to review content prior to the study of fields and vector spaces was proposed. This is, content related to systems of linear equations, matrix theory, and calculation and properties of determinants. An oral practice test was chosen to favor group interaction and learning through the contributions of classmates, but also to try to identify the difficulties of the students. This activity had been implemented in previous courses, noting that although it appears to produce positive outcomes for students' learning, it appears to be an activity that demands affective involvement from the students. For this reason, it was decided to resume this practice test as a teaching practice to be analyzed from the perspective of the students regarding the emotions experienced by them before, during and after their participation in the practice test.

To implement the practice test, the teacher of the group prepared a questionnaire of approximately 70 questions and arranged the questions individually in a slide show presentation that would be projected to the entire group. To promote the dynamism of the activity, the questions referred to quick-response theoretical issues; for example, defining a concept, stating a property, or correcting the statement of a theorem. Some examples of the questions are shown below:

- Define an idempotent matrix.
- Let A be a 2×1 matrix and B be a 1×2 matrix. Is the product AB commutative? Explain.
- True or false? Every square matrix corresponds to an inverse matrix of the same order. Argue your answer.
- What is the value of the determinant of a matrix that has two equal rows? Why?

It is important to notice here that the questions were in the order in which the topics were studied during the course, so if students paid attention, the answer to one question could be the key to answering the next one. To try to keep the group's attention, the student who had to answer each question was chosen randomly from a deck of cards–where each card represented a student. Also, the selected card was returned to the deck, so there was not a minimum or maximum number of times a student had to participate. The questions and answers were raised in an open and loud way so that they could be heard by all the students. Students had the opportunity to raise their hands and answer those questions that their classmates had not answered correctly.

Data Collection and Data Analysis

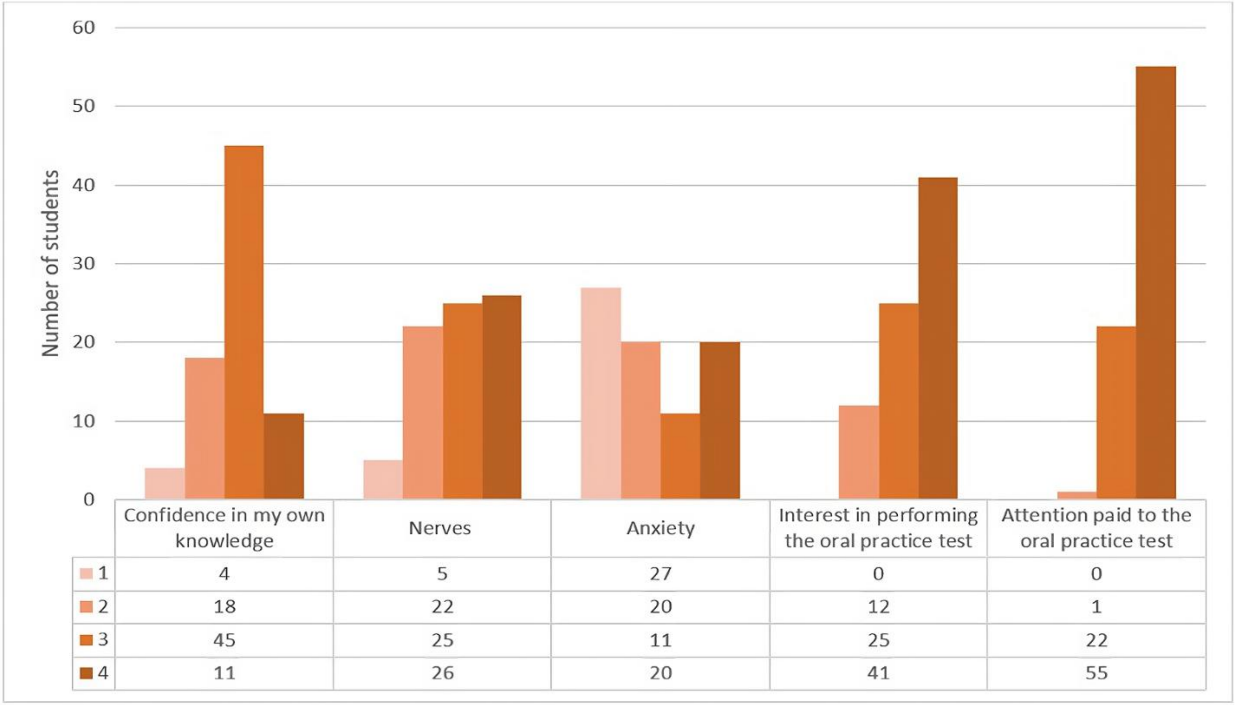
To find out how students felt about the oral practice test, a survey with seven items was designed and implemented. To validate the consistency and alignment of the instrument with the aim of the research, four researchers in mathematics education were invited to review and comment on the instrument. Based on the individual observations of the researchers, each of the seven indicators was adapted. They are described in the following section. The instrument inquiries about the emotions the students experienced before, during and after the activity. For instance, how confident, nervous, or interested they felt by participating in the oral practice test. The practice test was applied in one session and, in the following class, the students who agreed to participate in the study were asked to answer the instrument anonymously and honestly.

The analyzed questions are of three types. First, there are three open questions in which the emotions reported by the students were identified and coded using the predefined categories that were introduced in the conceptual overview of this article (i.e., valence and intensity). Second, there is one Likert-type question with five aspects to assess, which were analyzed by determining their frequencies and calculating medians. Third, there is a multiple-choice question focused on finding out in which version of a practice test (implemented orally or in writing) they think that they would experience higher levels of confidence, nervousness, anxiety, interest, and attention. Finally, to assess the general opinion about the activity, the participants were asked to write a maximum of three adjectives to describe the activity and to write a brief opinion about this practice test modality.

In the open questions, students were asked to rate how they felt before, during and after participating in the oral practice test. The emotions expressed in students' answers were classified with respect to their *valence* and *intensity*. Regarding the valence, a code was established to classify student responses as: positive (green color), negative (red color), or neutral (yellow) emotions. Regarding intensity, it was agreed that each of the emotions expressed would be identified as active (A) or deactivated (D). Once the participants' responses were transcribed, the researchers independently coded the responses. When performing the classification some answers were identified that included a positive and a negative emotion simultaneously, for this reason, it was agreed to use blue color to identify this kind of answer. Following this agreement, a second individual coding was performed. Subsequently, the coincidences in the classification were compared and the differences were discussed to establish a consensus.

RESULTS

In this section, we present the results related to how the students felt when participating in the oral practice test.



	Confidence in my own knowledge	Nerves	Anxiety	Interest in performing the oral practice test	Attention paid to the oral practice test
1	4	5	27	0	0
2	18	22	20	12	1
3	45	25	11	25	22
4	11	26	20	41	55

Figure 1. Frequencies for five indicators through which students rated their experience of participating in an oral practice test (Source: Authors' own elaboration)

What are the Characteristics of the Emotions Expressed by the Students After Participating in the Oral Practice Test?

To characterize the emotions expressed by the students, they were asked to rate their experience of participating in this oral practice test on a scale of 1 to 4, where 1 represents a very low level, 2 represents a low level, 3 represents a high level, and 4 represents a very high level. Five aspects were considered: confidence in their own knowledge, nerves, anxiety, interest in performing the practice test, and attention paid to the activity. **Figure 1** shows the frequencies for each indicator. In addition to this, assuming they had the opportunity to do this activity in written form as a traditional practice test and not orally, participants were asked to indicate in which of the two activities (written or oral practice test) they would experience higher levels of confidence, nervousness, anxiety, interest, and attention. The answers to this question are presented after **Figure 1**.

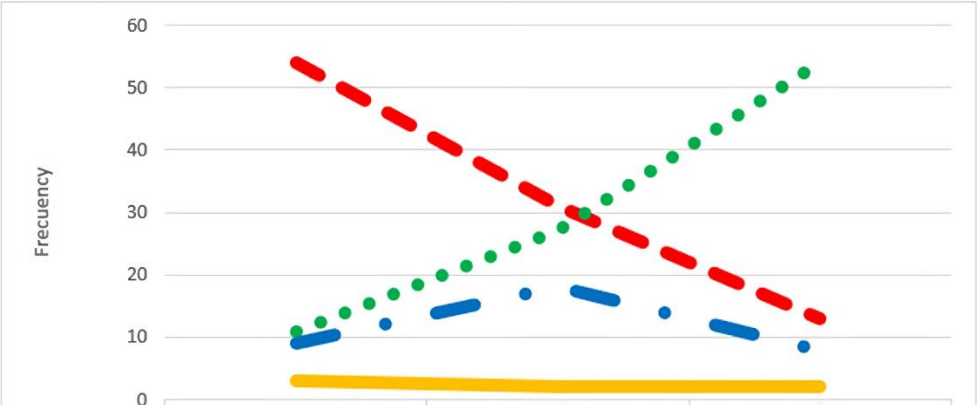
Regarding confidence in their knowledge, a median and a mode of three were identified on the scale of 1 to 4, with 45 participants selecting level 3. When asked if their confidence levels would increase when carrying out the activity in written form, 14 students answered yes and 19 indicated that in the oral practice they would feel more confident. However, 45 students indicated that there would be no difference. Thus, it seems that the confidence that they declare to experience is not associated with the format of the activity.

The median associated to the level of nervousness was 3, with only five students selecting level 1. Levels 2, 3, and 4 were selected by 22, 25, and 26 participants, respectively. 18 participants indicated that the nervousness would have been greater in a written exam, 33 indicated that there would be no difference, and 27 considered that the oral test generates more nerves. In the case of anxiety, the median is 2 and the mode is 1 with 27 students selecting this level. Like the previous case, 35 participants indicated that there would be no difference in this indicator when performing the activity orally or in writing. 21 indicated that the oral practice test generates more anxiety and, on the other hand, 22 attribute this characteristic to the written exam. In these two aspects, no significant differences are observed that allow a conclusion in this regard.

Regarding the interest in carrying out the activity and the attention paid to it, none of the students chose level 1. In the first case, 12 students chose level 2 and in the second case only one student selected this level to describe their experience. The median and mode identified for interest was 4, with 41 students choosing this level. In addition to this, 50 participants indicated that their interest in participating in this activity is greater than their interest in doing it in written form. Meanwhile, 21 indicated that there would be no difference, and only seven mentioned that they would be more interested in a written assessment.

The indicator referring to the attention paid to the oral practice test was the one that received the highest evaluation, since 55 students selected level 4. However, 43 indicated that the level of attention would remain the same in a written exam, while 28 indicated that the attention is greater in this oral activity and the remaining seven considered that they would be more attentive in a traditional practice test.

In addition to the above, students were asked to rate how they felt before, during and after participating in the oral test. The emotions expressed in students' answers were classified with respect to their *valence* and *intensity*. Regarding the *valence*, it was considered positive, negative or neutral. To classify the emotions expressed in students' answers the colors green, red and yellow were used respectively. However, when performing the classification some answers were identified that included a positive and a negative emotion simultaneously, for instance feeling nervous and enthusiastic at the same time; as previously mentioned, we



	Before	During	After
Red	54	31	13
Yellow	3	2	2
Green	11	27	54
Blue	9	18	8

Figure 2. Participants' emotional valence before, during, and after the oral practice test (Source: Authors' own elaboration)

used blue to identify this kind of answer. There were 234 responses provided by 78 participants, and only two of them could not be classified as they did not accurately answer the question posed.

Figure 2 shows the frequency of emotions with respect to their valence. As can be seen, before the test there is a tendency towards negative emotions (red line). However, this trend decreases as the activity progresses. Positive emotions (green line) increase during the activity and become more frequent after the practice test has ended. Although students also report experiencing negative emotions during the oral test, the frequency of this emotion seems to decrease as students express that during the activity they find themselves attentive, focused, amused, excited or confident.

As shown in **Figure 2**, a greater number of responses (18) were identified as blue during the activity than before (9) and after (8). Examples of these responses are: "nervous and amused", "at times relaxed and at other times with anxiety", "entertained, nervous and thoughtful", "satisfied because I realized that I already knew almost everything they had asked. Unfortunately, it was only when I was asked the first question that my nerves got the better of me". After the practice test, the most common responses emphasize feeling satisfied, entertained, happy, and relaxed. At this point the negative responses no longer refer to nervousness but rather focus on the results obtained; adjectives such as "disappointed", "frustrated", "dissatisfied" were expressed.

Overall, a decrease in negative emotions and an increase in positive emotions are observed as the oral practice test develops. However, to represent the individual evolution of emotions, color sequences associated with three moments of the activity (before, during, and after) were constructed. Based on their responses a color sequence was identified for each of the 78 participants. Discarding the students that provided a blank response, 76 sequences were obtained. There are 25 different sequences; the three most common are: red-green-green (16 participants), red-red-green (14 participants) and red-blue-green (nine participants). A similarity between these three sequences, which represent 50% of the participants, is that they all refer to negative emotions before the oral practice test and positive emotions after it.

Regarding the *intensity* of the emotion, the categories activated and deactivated were used. In this case, it was not possible to classify nine responses because they did not allow an activation level to be identified. However, of the remaining 225 responses, it was identified that 82% of the participants manifested active emotions both before and during the activity. Meanwhile, 63 of the responses indicated less intense emotions (i.e., deactivated emotions) at the end of the activity.

Additionally, students were asked to describe the activity with a maximum of three adjectives. A total of 217 adjectives were obtained to characterize the activity, the most mentioned word was "fun" with a total of 41 mentions, followed by "exciting", "entertaining", and "dynamic", with 23, 22, and 22 mentions, respectively. Although they are not adjectives, the word "nerves" appears 21 times, followed by the word "feedback" with 18 mentions. On the positive spectrum, more words were also identified to describe the activity as "innovative", "interactive", "useful", "effective", "interesting", and "creative". In the negative spectrum, a total of 19 words characterized the activity as triggering "stress", "tension" or "anxiety", and three people described it as "embarrassing".

Finally, students were requested to write an additional comment about the oral practice test if they wished. Some of students' comments are the following:

- Do it more often! And with more questions so that there is variety.
- It was a fun activity; it takes our breath away. Those seconds when the teacher is going to say who is next are extremely stressful, but then when you see the question you feel a great relief.
- I think you can realize that quite a few classmates have the same doubts than you, and they are confused with the same topics. That gives you food for thought and helps you to identify your weaknesses to work on them.
- It was a very fun activity and I even think it brought us closer together as a group.

- It seems to me a very efficient way to remember the topics studied, it also gives it a sense of play, which keeps you interested.
- The activity is more dynamic and forces you to pay more attention.
- It was a good review.
- The only problem I see is chance. The difficulty of the question you have to answer is very varied, so you may be "lucky" to get an "easy" question.
- Maybe most would benefit from this type of activity, but it caused me a lot of anxiety.
- I prefer that no one pay attention to what I say.

The students seem to acknowledge the activity as fun, exciting and effective to review mathematical content. They also report experiencing various emotions and nerves that decrease as the activity progress and they feel more confident in their knowledge. In general, the evaluation of the activity is positive; however, as they express it explicitly, it can be an unfavorable activity for introverted people or those who are afraid to respond in front of the group.

Considering the emotions expressed by the students regarding the practice test, and based on the results presented, the research question is answered next. Moreover, elements that allow deepening the conclusions derived from this study are established.

DISCUSSION

In this section, we draw on some of the results to argue in relation to the emotions experienced by the students when participating in an oral practice test as part of the activities of a linear algebra course.

We answer the research question, *"what are the characteristics of the emotions expressed by undergraduate students who participate in an oral practice test in linear algebra?"* by considering the most commonly expressed emotions but also referring to the valence and intensity of these academic emotions. In addition, we discuss the implications of the results in terms of achievement emotions–both those related to the activity and its outcomes.

The students' answers suggest that negative emotions are prevalent *before* the practice test. Mainly, nervousness tends to predominate. Other studies on the emotional experiences of undergraduate mathematics students in linear algebra courses have also reported that students taking this subject often experience negative emotions such as disappointment, fear, distress, and self-reproach emotions (e.g., Martínez-Sierra & García-González, 2016). However, the results of our study show that nervousness decreases as the activity progresses. The decrease in nervousness as the activity progresses could be related to the fact that students identify that they possess the knowledge to answer the questions that are posed. This, in turn, increases their self-confidence, reduces stress, and allows them to enjoy the oral practice test. This type of behavior in students has been reported previously. For instance, Aguilera-Hermida et al. (2021) identify that when students have a positive self-concept and trust their knowledge, the chances of improving their academic performance increase. Similarly, Bandura (2001) points out that self-confidence is a source of motivation and a behavior regulator.

The analyses of students' responses show that *during* the activity they experience a combination of positive and negative emotions (e.g., enjoyment and nervousness). The intensity of the emotions expressed by the students when asked about their feelings during the activity suggests that the oral test motivates them to be attentive at all times. This is a desirable situation for promoting mathematics learning because the time students spend focusing on a mathematical task (also known as on-task behavior; see for example Bragg, 2012) can bring them closer to achieving the goals pursued with the activity. Furthermore, Beserra et al. (2019) and Bragg (2012) suggest that an increase in on-task behavior can benefit students' mathematical learning.

According to Gómez-Chacón (2000), it is crucial to identify which elements of the curriculum favor the emergence, identification, and management of emotions when working on mathematical activities in order to help students gradually learn to control their emotional reactions so that they do not interfere negatively with their academic performance. This oral mathematical practice test triggered intense emotions of relatively short duration; nonetheless, despite the nervousness, the students expressed positive emotions related to the activity, such as joy and fun. One of the potentialities of this oral practice test is its ability to generate positive emotions in students, such as joy and fun. There is evidence that these emotions, although complex to foster among students, shape their positive attitudes toward learning mathematics, such as promoting tenacity and perseverance in the face of mathematical challenges (Kenan, 2018).

After the practice test, there was an increase in positive emotions and a decrease in intensity. The emotions expressed by the students are related to being relaxed, satisfied, or calm. This data suggests that oral practice tests could favor the regulation of emotions and make it clear to the students that, despite experiencing a temporary negative emotion, managing frustration and continuing with the task can bring academic achievements, as well as enjoyment, pride, and a perception of self-efficacy regarding their mathematical skills. These emotional experiences can also promote resilience in students towards mathematical challenges: as noted by Villavicencio and Bernardo (2016), positive emotions in mathematics learning are associated with more flexible cognitive strategies, greater interest in learning, and more commitment to tasks.

Regarding the object of the emotion, it was possible to identify emotions related to the activity. For instance, those students that refer to the perception that the practice test was fun. Emotions related to the outcome of the activity were also identified, like those linked to the students' rate of successes and errors. Based on the students' feedback regarding peer interaction,

collaborative learning, and oral participation, it appears that the dynamics of this practice test triggers not only epistemic emotions or those related to one's own knowledge, but also social emotions related to group participation.

The latter, as shown in the results, was favorable for most of the students, since they describe as exciting not knowing what the next question will be or who will have to answer it. Identifying this "environment of uncertainty" as an aspect of the activity that students enjoy coincides with recent observations about the characteristics of mathematics lessons that students perceive as captivating. Dietiker et al. (2023) argue that intriguing and surprising mathematics lessons tend to capture students' attention. Nevertheless, it is important to consider that this environment of uncertainty may not be enjoyed by all students, particularly introverted students who experience nerves and even anxiety when feeling exposed or having to respond in front of the whole group (Azizah & Suhendra, 2020).

Based on the answer to the research question, we draw general conclusions for this study, which are presented in the following section.

CONCLUSIONS

In conclusion, the results of this study suggest that undergraduate students experience a range of emotions during an oral practice test in linear algebra. While negative emotions such as nervousness are prevalent before the test, they tend to decrease as the activity progresses, likely due to an increase in self-confidence and identification of knowledge. The intensity of the emotions expressed by the students during the activity indicates that the oral test motivates them to be attentive and on-task, which is desirable for promoting mathematics learning. After the practice test, there is an increase in positive emotions related to being relaxed, satisfied, or calm, which suggests that oral practice tests can favor the regulation of emotions and promote resilience toward mathematical challenges. The results also suggest that the dynamics of this practice test trigger social emotions related to group participation, which are often exciting for students but may not be enjoyed by introverted students who experience nerves and anxiety when feeling exposed. Overall, the findings highlight the importance of identifying and managing emotions in mathematical activities and the potential of oral practice tests to generate positive emotions and promote tenacity and perseverance in students toward mathematical challenges.

What is the Contribution of This Study?

The study contributes to increasing the number of studies that have investigated the use of practice tests for mathematical teaching at the university level. In particular, regarding the emotions that students experience when faced with the implementation of this approach to the study of linear algebra. Also, this study helps broaden our knowledge about the level of acceptance that the oral practice tests have among undergraduate students. It contributes to understand how viable the wider implementation of this type of approach to the teaching of tertiary mathematics is.

Based on students' appraisal of their experience regarding trust, interest and attention given, we consider that the use of practice tests applied in groups can favor the dynamics of the class and have a positive impact on the learning process. Not only because it allows students to argue orally, but also because it favors the emergence of feedback and self-assessment of their knowledge.

Limitations of the Study

The study reported in this article has limitations that it is important to acknowledge. One of these is the potential biases that may have been introduced through the research design. For instance, the fact that the person who implemented the practice test and the questionnaire was also the students' mathematics teacher may have influenced the responses. A second potential bias could have been introduced because the participating students were mostly male. Future studies can avoid this potential bias by considering a more balanced gender distribution among the participating students. Finally, another potential bias may come from the fact that the students were asked to rate their emotions at three points in time (before, during, and after the practice test) all at once. Students may have tried to create a narrative of their emotions changing because by asking about three points in time, the survey implies that there could or should be a change. This potential bias can be avoided by distributing at different times the evaluation that the students make of their feelings in relation to the activity.

Future Research Routes

We consider it relevant to deepen the study of the emotions that derive from academic activities. In particular activities like this one, that could trigger emotions with high levels of activation. This kind of academic activities not only involve reviewing mathematical content, but also foster the interaction among classmates and, to a certain extent, the evaluation or appraisal of the teacher. Identifying and classifying the epistemic and social emotions that arise in the mathematics classroom could provide evidence to support the didactic choices that we make in undergraduate education. Likewise, future research could focus on determining whether the use of oral practice tests can promote the development of other mathematical competencies in university students.

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Ethical statement: At the university, where this study was carried out, there is not an ethics committee in charge of this type of ethical approval. However, we did obtain explicit permission from the students to participate in the study–on condition of anonymity.

Declaration of interest: No conflict of interest is declared by authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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