The Folk Music of the Caribbean Coast in Teaching the Relationships between the Sides of a Right Triangle

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Abstracts

This article aims to describe a teaching-learning process for understanding the relationships between the sides of a right triangle through a mnemonic based on traditional vallenato folk music, using the theoretical approach of Socioepistemology. This approach connects the philosophy of cultural experiences with learning, employing music as a tool to facilitate the memorization of mathematical concepts. The methodology, which is qualitative and based on the participatory action paradigm, included planning, action, observation, and reflection to design, implement, and evaluate the musical mnemonic. Information was gathered through field journals, interviews, recordings, questionnaires, and pre- and post-intervention tests. The results showed that using musical mnemonics not only improved students' engagement and concentration in learning mathematics but also reinforced their cultural identity through vallenato music.

Keywords: music, triangle.

1. Introduction

This research focuses on applying a musical mnemonic as a cultural practice to enhance the teaching-learning process of trigonometric ratios, drawing on the theoretical framework of Socioepistemology. This theory integrates philosophical and cultural elements into education, leveraging common experiences in students' contexts. In this case, vallenato music, deeply rooted in the identity of the municipality of Urumita, La Guajira-Colombia, is used as a motivational resource that aids in the memorization and understanding of abstract mathematical concepts. Mathematics education, particularly trigonometry, often represents a challenge in educational settings, especially at the secondary level. Mnemonic tools have proven effective in improving memory and the learning of complex content by associating it with familiar elements for students. Mnemonics are defined as a method of mental association to facilitate the recall of

specific information (Royal Spanish Academy, 2009). This qualitative research, oriented within the participatory action research paradigm, seeks to describe, implement, and assess the effect of musical mnemonics on learning trigonometric ratios, following the phases of planning, action, observation, and reflection, with a group of tenth-grade students from a school in southern Guajira.

The review of previous research on mnemonics applied to mathematics highlights studies that have shown its positive impact on learning. For instance, Carrillo (2006) investigated the use of mnemonic resources in teaching basic trigonometric functions, approaching mnemonics as a rarely documented school resource that can nonetheless be key in the mathematical learning process. Other studies, such as those by Moyano (2016), explored music as an educational tool for the sine function, emphasizing music's emotional influence on students' cognitive readiness. Purnell-Webb and Speelman (2008) also demonstrated that rhythmic patterns help recall learned texts when the rhythm is familiar. In the context of physics education, Berrio (2019), Gordillo et al (2017) found that using visual mnemonics facilitates the understanding of complex concepts, such as classical mechanics, in high school students. Matos-Vasquez et al. (2019) observed that music applied to mathematical activities in early childhood education positively impacts learning, supporting the idea that music can be an effective tool at different educational levels.

Regarding the teaching of trigonometric ratios, various studies have identified challenges in understanding trigonometric concepts and proposed innovative educational approaches. Jácome and Montiel (2007) documented students' difficulties in handling trigonometric ratios and functions, suggesting teaching based on proportions rather than traditional right triangles. Fiallo (2010) emphasized the use of dynamic geometry for learning trigonometric demonstrations, allowing students to discover properties without direct teacher intervention. Montiel and Buendía (2011) proposed an epistemology of social practices that considers trigonometric ratios and functions as educational tools adaptable to different cultural contexts. Rueda (2012) recommended using manipulatives like the Circular Trigonometric Geoboard to contextualize trigonometric ratios in an experimental setting. Zabala (2015), Gordillo, W., & Pino-Fan, L. (2016). explored the development of heuristics in teaching trigonometry, while Scholz and Montiel (2015) proposed a problem-based instructional sequence that breaks away from the traditional right triangle approach.

This research proposal seeks to integrate knowledge gained from these studies and develop an innovative teaching strategy that utilizes vallenato music as a mnemonic tool to easily remember trigonometric ratios. This resource allows students to connect mathematical learning with a significant cultural practice, thus improving their engagement, interest, and concentration in math classes. The methodology used in this research includes direct observation, semi-structured interviews, questionnaires, and pre- and post-intervention tests. Expected results include increased student willingness to learn trigonometry, improved academic performance, and strengthened cultural identity. This research also contributes to the field of mathematics

education, demonstrating the importance of considering cultural and emotional factors in designing educational strategies.

2. Theoretical Framework

2.1 The Socioepistemological Theory of Mathematics Education

The Socioepistemological Theory of Mathematics Education, developed mainly by Cantoral and collaborators (Cantoral et al., 2014), argues that learning mathematics should be understood as a social and contextualized process. This theory acknowledges the legitimacy of different forms of knowledge, including popular, technical, and academic knowledge, and focuses on how these forms of knowledge are socially constructed and institutionally disseminated.

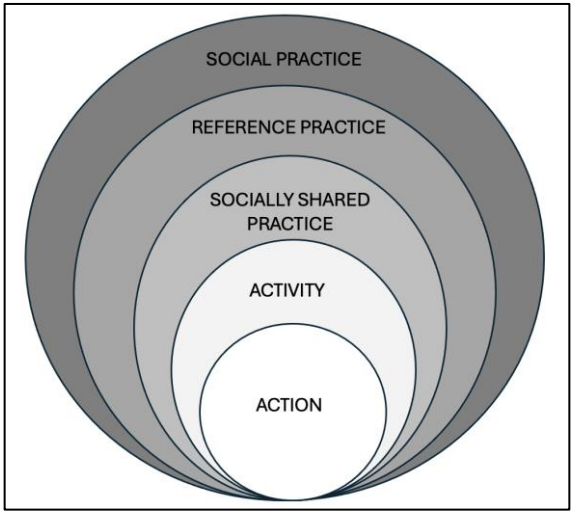

Figure 1: Conceptual Representation of Socioepistemological Theory(adapted from Cantoral et al., 2014)

Fundamental Principles of Socioepistemology

- Contextualized Rationality: This principle suggests that how people understand and apply knowledge depends on the context. Mathematics becomes a cultural practice in which students build knowledge related to their environment and previous experiences (Crespo, 2007).

- Epistemological Relativism: This principle holds that knowledge does not possess universal truth. In socioepistemology, knowledge is interpreted according to frames of reference that can vary based on culture and social practices.

- Progressive Resignification: Inspired by Piaget's genetic theory, this principle describes how meanings are reconstructed in new contexts, fostering understanding that adjusts and enriches as concepts are applied in different situations.

- Normative Principle of Social Practice: This principle establishes that social practice is the basis of knowledge construction, where it is not the individual who defines practices, but rather society determines what individuals should learn and ho

2.2 Mnemonics in Mathematics Learning

Mnemonics are defined as the art of improving memory through associations (Carrillo, 2006). In mathematics, this technique facilitates recalling complex concepts and procedures by linking them with symbols, words, or melodies. Mnemonics are particularly useful in subjects like trigonometry, where students often struggle to remember relationships between the elements of a right triangle.

2.2.1. Classification of Mnemonics

Mnemonics can be classified into visual and verbal types:

- Visual Mnemonics: Use images or symbols to help retain information.

- Verbal Mnemonics: Rely on words, phrases, rhymes, or songs to remember concepts.

Some common examples of mnemonics in mathematics include Cramer's rule and the use of rhymes or songs to remember the value of pi or the steps in a mathematical procedure.

Music has been used in education as a mnemonic tool across various disciplines, thanks to its ability to create an emotional connection and facilitate information retention (Piñeros, 2016, Pino-Fan et al., 2017). In this context, vallenato music presents itself as a powerful tool for teaching trigonometric ratios in a community where this genre is an essential part of its cultural identity.

2.2.2. Vallenato Folk Music in Education

Vallenato music, originating from the northern region of Colombia, is a cultural tradition with strong roots in La Guajira. Incorporating it into mathematical learning allows students to associate complex concepts with a familiar and meaningful context, thus facilitating their understanding.

There are several effects of music on mathematical learning; studies show that music improves students' motivation and disposition toward learning abstract concepts. Music, as a mnemonic element, enables students to associate mathematical theory with an emotional component, enhancing the retention and understanding of concepts.

Trigonometry is one of the most abstract areas of mathematics and represents a significant challenge for high school students. However, using mnemonics, concepts like trigonometric ratios can become more accessible and appealing to students.

Trigonometric ratios (sine, cosine, tangent, among others) are fundamental in studying trigonometry. Students tend to forget these relationships due to their abstract nature and lack of connection to everyday life.

Incorporating vallenato music into teaching trigonometric ratios allows students to relate formulas to familiar melodies. This approach promotes more intuitive and less mechanical learning, making it easier to understand and recall trigonometric relationships. For this reason, a song with a vallenato rhythm was composed and taught to students to aid in their memorization.

Vallenato Rhythm: Paseo

To calculate trigonometric ratios,
First identify various elements
Of the right triangle (repeat)

The hypotenuse I place in front of the right angle
Then I differentiate the names of the sides (repeat)

The opposite side of an acute angle is the one opposite

To the mentioned angle
The adjacent side is the other side
Along with the hypotenuse, it forms the angle (repeat)

The hypotenuse I place in front of the right angle
Then I differentiate the names of the sides (repeat)

Figure 6: Example of a Vallenato Song Used as a Mnemonic for Trigonometric Ratios.

3. Discussion

The analysis of the results obtained from implementing vallenato music as a mnemonic resource in teaching trigonometric ratios showed highly positive results in comprehension, retention, and disposition towards mathematical learning among tenth-grade students at the Agricultural Technical Educational Institution of Urumita. This methodological approach proved effective

not only in terms of academic performance but also influenced students' attitudes towards mathematics by integrating elements of their cultural identity into learning, facilitating a stronger connection with the content.

To measure the effectiveness of this intervention, questionnaires and performance tests were employed both before and after the implementation of the musical mnemonic, to observe changes in understanding and memory of trigonometric ratios (sine, cosine, and tangent). The quantitative results indicated a significant improvement in student performance after the intervention. In the initial questionnaires, most students showed difficulties in remembering and applying trigonometric relationships without support from materials or visual formulas, achieving an average score of 50% correct answers in the pre-tests. However, in the post-intervention tests, average scores increased considerably, reaching an average of 80% correct answers, which indicates that the use of vallenato music as a mnemonic tool had a direct impact on students' short- and long-term memory. This increase in retention is attributed to students' familiarity with vallenato rhythms, which facilitated the association of abstract concepts with recognizable rhythmic structures and melodies, allowing them to more easily recall the formulas and applications of trigonometric ratios.

The qualitative data, obtained through observations, semi-structured interviews, and field journals, complemented these quantitative findings by revealing changes in students' perceptions and attitudes toward mathematics. In post-intervention interviews, many students stated that integrating vallenato music into learning made mathematical concepts seem less intimidating and more accessible. Familiarity with the melodies and rhythm of this music, deeply rooted in their culture, allowed them to develop a renewed interest in trigonometry. This interest was particularly evident in students' comments, as they expressed that music allowed them to visualize trigonometric ratios not only as isolated concepts but as part of a cultural practice that was meaningful to them. Observations recorded in field journals also reflected that student showed a more participative attitude in class, interacting with greater confidence and willingness to solve mathematical problems. This change in attitude suggests that vallenato music not only acted as a mnemonic tool but also as a motivating element that increased students' commitment to learning mathematics.

In terms of pedagogical implications, the intervention also highlighted how the use of cultural resources in the classroom can foster inclusion and a sense of belonging among students. By incorporating an element of their local culture, students not only improved in academic performance but also strengthened their cultural identity, generating greater respect and appreciation for the relevance of mathematics in their daily lives. This is evident in the reflections of several students, who commented that by associating formulas with vallenato music, they not only remembered the concepts more easily but also began to perceive mathematics as a less abstract discipline, more connected to their daily reality.

Apart from the improvements in performance and disposition towards mathematics, the analysis of the results showed that using musical mnemonics promoted collaborative learning. During group activities, students showed enthusiasm in creating songs or rhythmic adaptations that facilitated memorizing trigonometric formulas. This participatory approach not only strengthened individual learning but also fostered a cooperative learning environment where students felt motivated to help their classmates remember and apply mathematical concepts through music. In this sense, the use of vallenato music as a pedagogical resource also contributed to improving social cohesion and a sense of community in the classroom, allowing students to collaborate in creating a learning experience that reflected their own cultural values.

However, it is important to note that some students initially expressed difficulties in adapting the melody of vallenato music to mathematical concepts. In certain cases, it was observed that at the beginning of the intervention, some students experienced confusion while trying to memorize the formulas, as they were not used to using music as a mnemonic resource in mathematics. Nevertheless, as the process progressed and with constant practice in class, these students began to show notable improvement, adapting and recalling the concepts with ease. This suggests that the success of musical mnemonics also depends on a gradual adaptation process, where students need time and practice to become familiar with this educational strategy.

4. Conclusions

The results of this research show that integrating vallenato music as a mnemonic tool in teaching trigonometric ratios represents an innovative and highly effective pedagogical strategy. Music, being a deeply rooted cultural element in the region of La Guajira, becomes a significant educational resource that connects the learning of abstract mathematical concepts with a cultural practice close to the students' daily lives. This contextualized approach, grounded in the Socioepistemological Theory of Mathematics Education, allows mathematics learning to transcend the purely cognitive level and become a meaningful experience, where students can appropriate academic content through resources that are familiar and culturally relevant. By relating trigonometric concepts to the rhythmic structure and lyrics of vallenato songs, a connection is created between mathematical knowledge and the students' sociocultural context, facilitating better information retention and a deeper understanding of trigonometric relationships.

Furthermore, the intervention demonstrated that using cultural resources not only improves academic performance but also positively influences students' motivation, interest, and disposition towards learning mathematics. In this case, vallenato music not only acts as a mnemonic strategy that facilitates memorizing the formulas for sine, cosine, and tangent but also contributes to a more positive perception of mathematics. It is no longer seen as a distant or complex subject but as an area of knowledge that can be related to significant aspects of their

cultural identity. The familiarity with the vallenato musical genre allows students to develop a more relaxed and receptive attitude towards learning mathematics, finding in music an accessible and motivating tool that helps reduce the anxiety associated with memorizing and applying trigonometric formulas. This intervention, therefore, not only facilitates the acquisition of specific knowledge but also contributes to a transformation in how students relate to mathematics, fostering greater confidence in their abilities and a desire to participate actively in the learning process.

WORKS CITED

Berrio, J. (2019). Influence of visual mnemonics in learning classical mechanics. Bogotá: Universidad Nacional.

Carrillo, M. (2006). Use of mnemonic resources in teaching trigonometric functions. Mathematics Education Journal, 14(2), 112-127.

Fiallo, J. (2010). Dynamic geometry and learning of trigonometric demonstrations. Master's thesis, National Pedagogical University.

Gordillo, W., Pinzón, W. J., & Martínez, J. H. (2017). Concept maps: A technique for analyzing the notion of the derivative in a textbook. University Training, 10(2), 57-66.

Gordillo, W., & Pino-Fan, L. (2016). A proposal for reconstructing the holistic meaning of the antiderivative. BOLEMA, 30(55), 535-558.

Jácome, L., & Montiel, C. (2007). Difficulties in learning trigonometric ratios. Mathematics Education, 19(3), 231-248.

Matos-Vasquez, R., et al. (2019). Impact of music on learning mathematics in early childhood education. Studies in Education, 23(5), 44-56.

Montiel, C. (2013). Didactics of trigonometry: Approaches and perspectives. Mexico: UNAM.

Moyano, L. (2016). Use of music in learning the sine function. Education and Development, 10(1), 55-68.

Pino-Fan, L., Font, V., Gordillo, W., Larios, V., & Breda. (2017). Analysis of the meanings of the antiderivative used by first-year engineering students. International Journal of Science and Mathematics Education.

Purnell-Webb, P., & Speelman, C. (2008). The effectiveness of rhythmic mnemonic devices in text recall. Memory Studies, 2(1), 10-17.

Rueda, J. (2012). Teaching trigonometric ratios through manipulatives. Mathematics Education Journal, 11(4), 187-205.

Scholz, T., & Montiel, C. (2015). Resignification of trigonometry in school education. Educational Trigonometry, 15(2), 90-102.

Zabala, A. (2015). Heuristics in teaching trigonometry: A classroom experience. Mathematics Education, 21(1), 83-97.