PRACTICES AND BELIEFS OF PRIMARY SCHOOL TEACHERS IN THE IMPLEMENTATION OF MATHEMATICS EDUCATION IN STEAM ENVIRONMENTS.

[1]EDWIN JOSUE MANOSALVA AMAYA, [2]DORIXY DE ARMAS DUARTE, [3]ANYI PAOLA RODRIGUEZ MENDOZA, [4]FERNANDO RAÚL GUZMÁN ÁLVAREZ

Acceptance date: June 23, 2023; Publication date : July 20, 2023

Summary.

The article presents eight research-based mathematics teaching practices, outlined by the National Council of Teachers of Mathematics (NCTM) in "From Principles to Actions: Ensuring Mathematical Success for All" (2014). These practices focus on strengthening the teaching and learning of mathematics and encompass aspects such as setting goals, promoting reasoning, using mathematical representations, and obtaining evidence of students' thinking.

The article then explores the influence of teachers' beliefs on teaching practices. It describes how beliefs act as cognitive and affective filters, influencing the interpretation of knowledge and experience. The definition of beliefs is adopted as sustained psychological interpretations of the world that are held to be true. In addition, belief systems, which organize beliefs around specific ideas or objects, are discussed.

The text suggests that teachers' beliefs, deeply rooted and influenced by cultural factors, play a crucial role in their teaching practices. The complex relationship between beliefs and practices is highlighted, with some research suggesting that beliefs influence instructional decisions, while others indicate that practice can affect beliefs.

It delves into the beliefs of teachers in the context of mathematics teaching, highlighting two main orientations: constructivist orientation and transmission orientation. Teachers with constructivist beliefs hold that students should construct their own knowledge, while those with transmission beliefs see teaching as the transmission of knowledge. Teachers' beliefs about the nature of mathematics and students' mathematical thinking are also explored, showing how these beliefs impact instructional practices.

Keywords *: Teaching Practices, Teacher Beliefs and Mathematics*

INTRODUCTION

Many elementary school teachers have beliefs about teaching and learning mathematics and enacting practices that are not aligned with the effort in the field of mathematics education (Stigler & Hibert, 2009). A large number of teachers will have to change their deep-seated beliefs about teaching and learning mathematics (Ellis & Berry, 2005). Given the role that teachers' beliefs about the nature of mathematics and the teaching of mathematics, and the learning game play in their selection and enactment of instructional practices, it is essential to understand the influence that different school environments can have on developing and changing teachers' beliefs and practices. In this state of the question, a common thread will be given in the theme of the beliefs of the teaching practice in the basic sciences "Mathematics" which has been abandoned and of little concurrence in the present research; hence, the practices and beliefs promulgated about teaching and learning in the hands of elementary mathematics teachers situated in a STEAM (Science, Technology, Engineering, Arts, Mathematics).

The little research that has been done on the subject has shown that teachers' beliefs about the nature and teaching and learning of mathematics play a vital role in educational effectiveness and decision-making, including the practices to enact (Ernest, 1989; Ball, 1991; Richardson, 1996; Fennema & Franke, 1992; Pajares, 1992; Thompson, 1992). The movement in mathematics, education advocates for student-centered instructional practices that prioritize inquiry, problem-solving, comprehension, and discourse. For Mathematics Teachers [NCTM], 2000; CNTM, 2014; Ma, 2010;

Peressini, Borko, Knuth, & Willis, 2004). The beliefs that teachers have about the teaching and learning of mathematics should influence the instructional strategies they select and enact. (Beswick 2012) suggests that beliefs related to aspects of the particular context in which a teacher works, may also mediate other beliefs that are more influential in terms of shaping their practice in that context. In this state of the art it is possible to identify the beliefs and promulgate practices related to the teaching and learning of mathematics carried out by mathematics teachers located in a STEAM (Science, Technology, Engineering, Arts, Mathematics) environment. Therefore, with this state of the art it will be possible to gain an understanding of how primary mathematics teachers located in a STEAM school or environment, view the teaching and learning of mathematics in an environment that supports practices oriented through the prioritization of science, technology, engineering, arts and mathematics in a real-world, problem-based, transdisciplinary approach to learning from the application of mathematics.

Teachers' beliefs and practices.

Teachers' beliefs about teaching and learning in mathematics influence the instructional strategies they select and implement (Ross, 2002; Polly, McGee, 2013). Beliefs that reflect the vision of teaching and learning outlined in The National Council of Teachers of Mathematics (NCTM) and the Principles and Standards for School Mathematics (2000). They are considered by many teachers, educators and researchers to be the ones who most support reforms oriented to instructional practices (Francis, 2015). These reforming teachers believe that students should build their own knowledge and that instruction should focus on understanding and problem-solving, be driven by the development of students' capacity ideas, and provide students with opportunities to socially construct knowledge through a community of learners (Peterson et al., 1989). In addition, teachers with this view believe that all students can and should learn mathematics with comprehension.

Understanding teachers' beliefs is an important step toward understanding teachers' instructional practices (Wilkins, 2008; Thompson, 1992; Pajares, 1992; Nespor, 1987). Mathematics teachers' beliefs reflect personal theories about the nature of mathematics and the teaching and learning of mathematics, which influence decision-making and choice of instructional practices (Pajares, 1992). Specifically, mathematics teachers' beliefs have an impact on their classroom practice, on the ways in which they perceive teaching, learning, and assessment, and on the ways in which they perceive students' potential, abilities, dispositions, and abilities (Barkatsas & Malone, 2005).

There is a complicated relationship between math teachers' beliefs and instructional practices in which causalities become difficult to explain. Some studies have found that beliefs influence instructional decisions, while others have found that practice influences beliefs (Buzeika, 1996). Although the complexity of the relationship between conceptions and practice defies simplicity of cause and much of the contrast in teachers' instructional emphasis can be explained by differences in their prevailing views of mathematics (Thompson, 1984). In fact, beliefs are the best indicators of the decisions individuals will make (Pajares, 1992).

STEAM instructional approaches and practices.

STEAM is an evolving movement in the education community, this movement was born out of the emphasis of recent years on the development of science, technology, engineering, and math (STEM) curricula and programs to drive innovation and secure the national economy. STEAM reflects a more balanced approach that integrates the arts and humanities into the sciences. Yackman (2007) explains the complex relationships between the elements of STEAM by asserting that we live in a world where science cannot be understood without technology, and that most of your engineering research and development is expressed, that you cannot create without an understanding of the arts and mathematics, and that education should more naturally reflect the world about which you teach (Yackman, 1999). 2007).

STEAM attempts to meet this challenge by adopting a transdisciplinary approach to learning that focuses on problem-solving, approaches that go beyond disciplines, using the collective experience of different disciplines to solve authentic problems (Quigley & Herró, 2016). The goal of this approach is to prepare students to solve the world's pressing problems through innovation, creativity, critical thinking, effective communication, collaboration, and ultimately new knowledge (Quigley & Herró,

2016). STEAM instructional approaches prioritize problem-solving, authentic assignments, inquiry, process skills, student choice, and technology integration. The problem is that STEAM-based instructional approaches provide a context for learning, present multiple lines of inquiry, and situate learning in the real world with its situations, which provide a stage for process skills such as creativity and collaboration. Authentic assignments tap into students' interests by addressing real-world, one-off, and local issues. Research-rich experiences are driven by students' curiosity, wonder, interest, and passion and require students to find their own paths through the problem. In addition, student choice encourages multiple ways to solve a problem and provides opportunities for students to choose the path to take when solving the problem. Finally, the integration of technology enhances students' ability to learn through engagement and the development of functional skills for the present century. Nonetheless, given the mutual goals of STEAM and elementary teaching practices in mathematics education, the recent emphasis on STEAM instructional practices may be a vehicle for achieving the goals of a movement reforming mathematics education.
A huge number of primary school teachers have beliefs about the teaching and learning of mathematics and promulgate practices that are not aligned with recommendations for national and international reform efforts in the field of mathematics education (Stigler & Hiebert, 2009; Polly et al., 2013). While the standards-based reform movement began in the 1980s, there has been only minimal change at the classroom level in critical areas affecting children (Herrera & Owens, 2001). For standards to reform or to achieve significant success, many teachers will need to modify their deeply held beliefs about teaching and learning mathematics (Ellis & Baya, 2005). In addition, the influence of a STEAM environment, teachers' beliefs and practices are not well understood. On the other hand, STEAM and the math reform movement share overlaps and complementary goals: achieving success and that will likely have a positive effect on learners' education.
Given the role that teachers' beliefs about the nature, teaching, and learning of mathematics play in their selection and representation of instructional practices, it is critical to understand the influence that different school environments can have on the development and change of beliefs and practices. education, and in topics that in the latest research have generated and resolved questions such as the following:

- What are the beliefs about teaching and learning mathematics held by primary school teachers in STEAM schools or settings?
- How does teaching in STEAM schools influence teachers' enactment of practices and beliefs about mathematics teaching and learning?

In light of the current momentum of STEAM schools, this state of affairs would be based on an instructional approach and its influence on the practices promulgated by teachers and beliefs about the teaching and learning of mathematics are needed. This study would contribute to a better understanding of how a STEAM approach would be situated in schools and how it would influence the practices and beliefs promulgated by teachers about the teaching and learning of mathematics. In addition, the findings would contribute to the growing field of STEAM Education, investigating the influence that teaching has in a STEAM setting and on the promulgated practices and beliefs of elementary school teachers about the teaching and learning of mathematics.
This research would also go on to inform teacher educators in mathematics and STEAM, program and curriculum designers, and researchers can use the findings of this study to inform their practice and as a springboard for further research on the influence of STEAM configuration on teachers' beliefs and practices. Designers of STEAM programs and curricula could consider the influence of STEAM instructional practices on the beliefs and practices promulgated in mathematics and, therefore, student learning that can use the findings to inform and refine their professional training programs. Finally, this review situates teacher learning in a STEAM school, and given the infancy of the STEAM movement, this area is virtually intact in the current literature. This study will contribute to filling gaps in future research by revealing a better understanding of how teaching in a STEAM environment influences teachers' promulgated practices and beliefs about mathematics teaching and learning.

Limitations of the research application approach

The research environment such as this review imposes several limitations; Placing the study in a STEAM elementary school limits the generalizability of the results to STEAM settings with students in grades 1-5. (There are few institutions in the country with this approach) The number of teachers willing to participate also limits studies like this (the percentage of teachers who may be competent in this approach is very low). It is also possible that the role of the researcher(s) as an instructional coach in the school may have dissuaded some teachers from participating. In addition, when taken individually, components of the methodology are weak arguments (i.e., surveys that rely on self-reported data). however, together all the elements form a powerful empirical evidence base to investigate how teaching in a STEAM setting influences the practices and beliefs promulgated by teachers about the teaching of mathematics.

Next, the dynamic relationships between primary school teachers' beliefs about nature and teaching and learning, education reform efforts, and mathematics teachers' instructional practices. They lead us to the following review, providing a roadmap of the existing literature in the field related to research in studies of this type of research or state of the art.

Studies of this type should be framed within situated learning theory (Brown, Collins, & Duguid, 1989; Lave and Wenger, 1991). Situated learning theory adopts the assumption that learning experiences cannot be separated from the situated elements in which they occur (Lave, 1988), commonly known as communities of practice. Such communities are made up of the community's unique ways of thinking, being, and doing (Wenger & Snyder, 2000). The focus of this research is based on the belief that teacher learning is situated in particular contexts. Knowledge constructs, therefore, are studied as cognitive exercises that occurred within an inseparable social situation (Wenger & Snyder, 2000). Situated learning theory will help me understand the changes in teachers' beliefs and instructional practices that occurred while teaching math in a STEAM context.

To understand the current reform movement, it is important to first explore the history of mathematics education reform. Early twentieth-century mathematics teaching and learning were profoundly influenced by Thorndike's stimulus-response link theory (Thorndike, 1923). Thorndike theorized that mathematics is best learned through exercise and practice and mathematics is viewed as a hierarchy of mental habits or connections (Thorndike, 1923). His use of scientific evidence was to support his claim that mathematics is best learned through exercise and practice directed a large portion of mathematics and the community takes a long time to accept this view (Ellis & Berry, 2005). The Progressive Movement of the 1920s was a reaction against the highly structured and rote instructional practices that were born out of Thorndike's theories, Influenced by (Dewey, J. 1899), early progressive educators believed that learning occurs best when it is connected to students' experiences and interests, the initial phase of the progressive movement had little impact on schooling, because many educators perceived it as radical (Ellis & Berry, 2005). The social efficiency movement, an offshoot of early progressive movements, had a more profound impact on mathematics education. The social efficiency movement questioned the importance of high school math for all students. The study of advanced mathematics, proponents argued, was best suited for those who had a future need for the subject. By the 1940s, the combined effects of Thorndike's structured "scientific" teaching methods and the movement's classification of students of social efficacy based on future-based needs resulted in a follow-up in mathematics education where the majority of students were placed in vocational, consumer, and industrial mathematics courses.

The new mathematical movement of the 1960s and 1970s was born out of a sense of national crisis that arose from the launch of Sputnik. These concerns and dissatisfaction with the lack of rigor in high school math preparation led to the inclusion of K-12 math education as a funding area and set the stage for new math (Herrera & Owens, 2001). There was a national concern that the U.S. needed more technical and mathematical skills to propel advancement in the developing technological era. This national concern led the National Council of Teachers of Mathematics (NCTM), the world's largest mathematics education organization, to appoint the Postwar Commission plans The Commission's goal was to make recommendations on mathematics curriculum to establish the United States as a world leader and to continue the technological development that had begun during the war crisis (Herrera & Owens, 2001). The Soviet Union's first satellite, Sputnik, launched into space heightened the sense of urgency and catapulted the new mathematical movement that had already begun. More rigorous math, and curriculum was seen as a necessity to maintain national security; Thus, the new mathematical movement emphasized deductive reasoning, set theory, rigorous proof, and abstraction. Many opponents of the new mathematical movement argued that the mathematical concepts and structures were excessively rigorous and complex (Dickey, E.M. 2010). In addition, the implementation of the new mathematics curriculum was uneven and was not accompanied by the professional development and materials needed to teach well: Eventually, there was a widespread feeling that the new mathematics had failed and it was necessary to go back to basics (Herrera & Owens, 2001).

The backlash over the new mathematical movement led to a return to basics in the 1970s. The back-to-basics era emphasized algebraic computation and manipulation and gave little priority to problem-solving. Teaching mathematics during the back-to-basics era was characterized by the National Science Foundation's case studies: In all the math classes reviewed, the sequence of activities was the same. First, the answers for the previous day's task were given. The more difficult the problems, the more they were solved by the teacher or the students on the board, A brief explanation, sometimes none, was given of the new material and the problems assigned for the next day; The rest of the class worked on homework while the teacher moved around the room answering questions. The most notable thing about math classes was the repetition of this routine. (Welch, 1978, cited in NCTM, 1991) Once again, mathematics education in the back-to-basics era was met with a sense of national crisis stimulated by a perception of being left behind in the world in technological and economic positions (Herrera & Owens, 2001).

The publication of A Nation at Risk (1983) awakened the general public to a sense of crisis (Herrera & Owens, 2001). The report's strong rhetoric aroused a sense of urgency: If an unfriendly foreign power had tried to impose the mediocre educational performance that exists today, we might well see it as an act of war (NCEE, 1983). As a leader in mathematics education, the NCTM was once again asked to form a committee to develop recommendations for school mathematics. Consequently, NCTM published an agenda for Action: Recommendations for School Mathematics in the 1980s. The booklet explained eight recommendations for school mathematics related to teaching, learning, technology, and professionalism and proposed making problem-solving the focus of school mathematics (Wilson, 2003; Dickey, E.M. 2010). The NCTM responded to the call to action sparked by the publication of A Nation at Risk (1983) by taking an advocate role and publishing the School Mathematics Assessment Curriculum and Standards in 1989. The release of this publication ignited the standards movement in all school subjects.

The publication of the initial standards was followed by the publication of the Curriculum and Assessment Standards for School Mathematics (1991) and the Standards Assessment Plan for School Mathematics (1995). These draft standards influenced national policy and served as a guide in nearly every state for adopting policies and curriculum for mathematics education (Macleod, 2003; Dickey, 2010). In 2000, NCTM then released the Principles and Standards for School Mathematics (2000), a refinement of the original standards, the standards continue to challenge conventional instructional practices by promoting changes in content and pedagogy. The central focus of the content of the standards is on the concept as opposed to the merely procedural. In addition, the pedagogy described in the standards is based on constructivism that sees the student as a participant in the construction of knowledge and changes the role of the teacher from giver of knowledge to orchestrator of discourse in the classroom and facilitator of learning experiences (Herrera & Owens, 2001). More recently, the NCTM published Principles to Actions: Securing Mathematical Successes for Everything (2014). This publication builds on NCTM's previous work with standards for providing five essential elements of school mathematics programs and eight research-based mathematics teaching practices (NCTM, 2014).

Eight Mathematics Teaching Practices.

In NCTM's Principles to Actions: Ensuring Math Success for All (2014) presenting eight research-based teaching practices that are informed by research and support math learning for all students. Mathematics Teaching Practices provide a framework for strengthening mathematics teaching and learning" (NCTM, 2014). These practices represent a core set of high-leverage practices and essential teaching skills needed to promote deep learning of mathematics (NCTM, 2014).

- Mathematics Teaching Practices:
- Set math goals to focus learning.
- Implement tasks that promote reasoning and problem-solving.
- Use and connect mathematical representations.
- Facilitate meaningful mathematical discourse.
- Post questions with purpose.
- Develop procedural fluency based on conceptual understanding.
- To support the productive struggle in the learning of mathematics.
- Obtain and use evidence of student thinking.

Beliefs - Belief Systems

Since beliefs act as cognitive and affective filters through which knowledge and experience are interpreted (Handal & Herrington, 2003, p. 59) teachers' beliefs are a significant factor in the development of an understanding of teaching and learning mathematics (Green, 1971). While many researchers have studied beliefs, there is no explicit agreement on the universal definition of beliefs (Philipp, 2007). Thompson (1992) described beliefs as a subset of conceptions. While she seemed to use the two terms interchangeably, she described conceptions as a more general mental structure that encompasses beliefs, meanings, concepts, propositions, rules, mental images, preferences, and the like. Rokeach (1968) described beliefs as having a component (knowledge), an affective component (arousing emotion), and a behavioral component that is activated when action is required. For this study, Philipp's (2007) definition of beliefs as psychologically held interpretations, premises, or propositions about the world that are thought to be true was adopted.

Belief systems can serve as a metaphor to describe the way one views and organizes oneself as a group through beliefs, usually around a particular idea or object (Philipp, 2007, p. 259). Green (1971) described three dimensions of belief systems: (1) Some beliefs are primary while others are derived from the exercise of life itself. Therefore, Primary beliefs develop from direct experience and are more influential than derived beliefs. In addition, a belief is never kept in total isolation from other beliefs and some serve as the basis for others; (2) Beliefs can be central (strongly held) and peripheral (less strong and more susceptible to change); (3) Beliefs held in groups that are normally isolated from other groups. These groups allow individuals to avoid confrontations between belief structures, conceptions, and behaviors; Primary and core beliefs are difficult to change, particularly when they are grouped and contextualized into relatively independent groups (Grootenboer, 2008) However, Thompson (1992) argues that belief structures are susceptible to change in light of experience and consideration of how they hold up in relation to one another is useful when studying beliefs.

Goldin et al. (2009) found that there is no universal pattern for beliefs and that they are highly subjective and vary across different carriers (Goldin et al., 2009). Pajares (1992) agrees that beliefs are deeply personal, rather than universal, and are not affected by persuasion. It then offers fundamental assumptions for researchers to adopt when studying teachers' educational beliefs. For this study, the following assumptions were adopted regarding teachers' educational beliefs:

- Beliefs are formed early, they tend to perpetuate themselves and persevere in the face of contradictions presented by reason, time, schooling or experience.
- Beliefs are influenced by cultural factors and develop over time.
- Beliefs help people understand the world and themselves.
- Beliefs act as a filter that affects the way one sees the world.
- Beliefs are prioritized based on their connections or relationships to other beliefs.
- The earlier a belief is formed, the harder it is to change it.
- Beliefs strongly influence behavior.
- Beliefs must be inferred.
- Beliefs are not all-or-nothing entities, they can be held with varying degrees of intensity.

Influence of Teachers' Beliefs on Training Practices.

Understanding teachers' beliefs is an important step toward understanding teacher instructional or training practices (Wilkins, 2008; Thompson, 1992; Pajares, 1992; Nespor, 1987). Research has shown that teachers' beliefs about the nature, teaching, and learning of mathematics play an important role in teachers' effectiveness and educational decision-making, including the practices they enact (Ernest, 1989; Ball, 1991; Richardson, 1996; Fennema & Franke, 1992; Pajares, 1992; Thompson, 1992). Because behavior is primarily instinctive and intuitive, not reflective and rational (Thompson, 1984), the development of teaching practices is significantly affective and belief-driven. (Grootenboer, 2008). Thompson (1984) described how teaching practices might develop: Teachers develop patterns of behavior that are characteristic of their instructional practices. In some cases, these patterns may be manifestations of consciously held notions, beliefs, and preferences that act as driving forces in shaping teacher behavior; In other cases, the driving forces may be unconsciously held beliefs or intuitions that may have evolved from the teacher's experience.

In other words, mathematics teachers' beliefs reflect personal theories about the nature and teaching and learning of mathematics that influence their decision-making in instruction (Pajares, 1992). Specifically, mathematics teachers' beliefs have an impact on their classroom practice, on the ways in which they perceive teaching, learning, and assessment, and on the ways in which they perceive students' potential, abilities, dispositions, and abilities (Barkatsas & Malone, 2005). Raymond (1997) concluded that teachers' beliefs about mathematical content are more closely related to their instructional practices than the beliefs they have about mathematics teaching and learning. In addition, teachers' beliefs about the nature, teaching, and learning of mathematics are not specific to mathematics teaching, such as beliefs about their students and the social and emotional makeup of their classes. These beliefs play an important role in teachers' decision-making and are likely to take precedence over beliefs that are specific to the teaching and learning of mathematics (Thompson, 1984).

There is a complicated relationship between math teachers' beliefs and instructional practices in which causality is difficult to explain. Some studies have found that beliefs influence instructional decisions, while others have found that practice influences beliefs (Buzeika, 1996). Although the complexity of the relationship between conceptions and practice defies simplicity of cause and much of the contrast in teachers' instructional emphasis can be explained by differences in their prevailing views of mathematics (Thompson, 1984). In fact, beliefs are the best indicators of the decisions that individuals will make and will make in the present and future. (Pajares, 1992).

Beliefs immersed in teachers.

All teachers have beliefs, regardless of how they define and label themselves, about their work, their students, their subject, and their roles and responsibilities, but a variety of conceptions of educational beliefs have not yet appeared in the literature (Pajares, 1992). Teachers' mathematical beliefs consist of the belief systems held by teachers about the teaching and learning of mathematics (Handal, 2003). These views represent implicit assumptions about curriculum, schooling, students, teaching and learning, and knowledge (Handal & Herrington, 2003). Schoenfeld (1985) suggests that the beliefs of mathematics teachers can be seen as an individual's perspective on how one engages in mathematical tasks. Philipp (2007) identified a spectrum of mathematics teachers' beliefs that is consistent with the constructivist/traditional framework of classifying instructional practice. More specifically, Thompson, Thompson, and Boyd (1994) describe teachers' orientations toward teaching mathematics by characterizing the nature of mathematical discourse that is exemplified by its enactment of mathematics practices. Thompson, & Boyd, 1994). Calculus-oriented teachers focus on the problem to be solved, prioritize responding to and maintaining expectations for students' explanations that are superficial and incomplete (Thompson, Thompson, & Boyd, 1994). Thompson, Thompson, and Boyd (1994) continue: A teacher with a calculative orientation is one whose actions are driven by a fundamental image of mathematics as the application of calculations and procedures to derive numerical results.

Thompson, Thompson, and Boyd (1994) illustrate the contrast between the two orientations by explaining: Conceptually oriented teachers; They focus students' attention away from thoughtless application of procedures and toward a rich conception of situations, ideas, and relationships between ideas. These teachers strive for conceptual coherence, both in their pedagogical actions and in the students. As a result, conceptually oriented teachers tend to focus on aspects of situations that, properly understood, make sense of numerical values and suggest numerical operations, and conceptually oriented teachers often ask questions that move students to view their arithmetic in a non-calculus context.

For these types of states of affairs, teachers' beliefs and practices are described and classified in terms of constructivist/reformist or transmission/traditional orientation, and may guide discussions on reform-oriented practices using the Teaching the Eight Mathematical Practices, discussed earlier in this framework (NCTM, 2014). In addition, it will be possible to characterize the practices of specific mathematics teachers (Practice #4) as exemplifying a conceptual orientation (reform) or a computational orientation (traditional).

Constructivist-oriented beliefs

Teachers who hold constructivism-oriented beliefs hold that the student should construct his or her own knowledge and that instruction should focus on understanding and problem-solving, be driven by the development of students' capacity ideas, and provide students with opportunities to socially construct knowledge through a community of learners (Peterson et al., 1989). These teachers treat math tasks as opportunities to make sense, not to follow rules (Battista, 1994).

Beliefs channeled to transmission.

Transmission-oriented teachers' beliefs hold that teaching is a process of transmitting knowledge and dispensing information in which students are at the receiving end of knowledge, their teaching approaches are often rote and detached from human experience; Teachers who teach transmission-oriented classes, beliefs are prone to reduce mathematical tasks to step-by-step computational tasks, procedures that they can then teach their students to perform, see the inability to quickly find a solution to a task as failure, focusing on the correct procedures, train students to perform the desired procedure, and judge them based on their consistency with the desired procedure (Battista, 1994).

The range of mathematical beliefs of teachers is very wide (Handal, 2003). In this state of the art, we have chosen to highlight the teachers' beliefs that are most relevant to the study in question; Teachers' beliefs about the nature of mathematics, students' mathematical thinking, student and teacher roles, what will be considered evidence of mathematical understanding, instructional planning, and curriculum will be reviewed.

Beliefs about the nature of mathematics.

Brown and Cooney (1982) argued that a teacher's inclination to teach a certain way, to use or not to use knowledge learned from a variety of experiences is in fact affected by what he believes to be mathematics; Some reforms, to oriented beliefs, view mathematics as a dynamic body of knowledge, while teachers with transmission-oriented beliefs see mathematics as static. Karp K.S. (1991) found that teachers with negative attitudes toward mathematics enacted instructional practices that are more rule-based and teacher-directed, while teachers with more positive attitudes enacted practices that focused on understanding, exploring, and discovering mathematical relationships.

Beliefs about students' mathematical thinking.

Fennema, Carpenter, Franke, Jacobs, and Empson (1996) investigated mathematics teachers' beliefs and instructional practices as they learned about student thinking, classifying teachers' beliefs into four levels:

- Level A: Teachers believe that students learn best when they are told how to do math.
- Level B: Teachers are beginning to question the need to show children how to do math and have contradictory beliefs.
- Level C: Teachers believe that children learn math while solving many problems and discussing solutions.
- Level D: Teachers accept the idea that children can solve problems without direct instruction and that math instruction should be based on children's abilities.

Teachers who studied children's mathematical thinking while learning mathematics developed more sophisticated, reform-oriented beliefs about mathematics, teaching, and learning than those who did not study children's thinking. (Philipp, 2007). Teachers who have traditional knowledge oriented to the transmission of beliefs believe that students develop mathematical understanding by receiving clear, understandable, and correct information about mathematical procedures and by having the opportunity to consolidate, automate, and generalize the information they have received by practicing the demonstrated procedures (Goldsmith & Schifter, 1997).

Final thoughts.

Since beliefs serve as filters through which new ideas are perceived, it is essential for teachers to be challenged to reflect on their beliefs. Teachers need systematic guidance in developing skills for critical reflection and self-evaluation, posing an important dilemma for teacher educators to consider: If beliefs are lenses through which humans see the world, then beliefs filter what we see; However, what we see also affects our beliefs, creating a dilemma: How do math teachers change beliefs by providing practice-based evidence if teachers can't see what they don't believe?

The essential ingredient in solving this conundrum is reflection on practice. When practising teachers have opportunities to reflect on the innovative, reform-oriented curricula they are using, on the mathematical thinking of their own students, or on other aspects of their practices, their beliefs and practices change. The need for reflection is evident in the findings that differences in teachers' beliefs appeared to be directly related to differences in their reflexivity, Reflexivity in teaching can be attributed to the integration of conceptions and consistency between professed viewpoints and practical instruction. When beliefs are formed through reflection teachers gain possible insights into the possible sources of their students' difficulties and misconceptions, thus becoming aware of the subtleties inherent in the content; When teachers are not reflective, their beliefs appear to be manifestations of unconsciously held views or expressions of commitment to abstract ideas that can be considered part of a general ideology of teaching. It is especially important to question the beliefs of teachers who feel they have succeeded in learning mathematics from more traditional methods so that they reflect on the effectiveness of these methods for all children of the present and technology just around the corner.

BIBLIOGRAPHIC REFERENCES.

[1] Barkatsas, A. T., & Malone, J. (2005). A typology of mathematics teachers' beliefs about mathematics teaching and learning and instructional practices. Journal of Research in Mathematics Education.

[2] Battista, M.T. (1994). Teachers' Beliefs and the Reform Movement in Mathematics Education. The Phi Delta Kappan - Berliner, & R. Calfee (Eds.), Handbook of Educational Psychology. New York: Macmillan.

[3] Beswick, K. (2012). Teachers' beliefs about school mathematics and mathematicians' mathematics and their relationship to practice. Educational Studies in Mathematics.

[4] Buzeika, A. (1996). Teachers' Beliefs and Practices: The Chicken or the Egg. Merga.

[5] Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. Educational Researcher.

[6] Brown, C. A., & Cooney, T. J. (1982). Research on Teacher Education: A Philosophical Orientation. Journal of Research and Development in Education.

[7] Carpenter, T. P., Fennema, E., Franke, M. L., Levi, L., & Empson, S. B. (1999). Math for Kids: Cognitively guided instruction. NH: Heinemann.

[8] Carpenter, T. P., Fennema, E., Peterson, P. L., Chiang, C. P., & Loef, M. (1989). Using Children's Mathematical Thinking Knowledge in Classroom Teaching: An Experimental Study. Journal of American Educational Research.

[9] National Commission for Excellence in Education. (1983). A Nation at Risk: The Imperative of Education Reform. Washington, D.C.: U.S. Government Press.

[10] National Council of Teachers of Mathematics. (1989). Curricular and Assessment Standards for School Mathematics. Reston, VA: Author.

[11] National Council of Teachers of Mathematics. (1991). Professional standards for teaching mathematics. Reston, VA: Author.

[12] National Council of Teachers of Mathematics. (1995). Standards for the evaluation of school mathematics. Reston, VA: Author.

[13] National Council of Teachers of Mathematics. (2000). Principles and standards for school mathematics. Reston, VA: Author.

[14] National Council of Teachers of Mathematics. (2014). From Principles to Actions: Ensuring Mathematical Success for All. Reston, VA: Author

[15] *Dewey, J. (1899). The School and Society, Second Edition (1915). Chicago: University of Chicago Press.*

[16] *Dickey, E.M. (2010). Encyclopedia of Educational Reform and Dissent. Thomas C. Hunt, James C. Carper, Thomas J. Lasley II, and C. Daniel Raisch (Eds.). Thousand Oaks, CA: Sage Publications.*

[17] *Ellis, MW, & Berry, R. Q. (2005). The Paradigm Shift in Mathematics Education: Explanations and Implications of Reforming Conceptions of Teaching and Learning. The Math Educator.*

[18] *Fennema, E., Carpenter, T. P., Franke, M. L., Levi, L., Jacobs, V. R., & Empson, S. B. (1996). A longitudinal study of learning to use children's thinking in teaching mathematics. Journal of Research in Mathematics Education.*

[19] *Fennema, E. & Franke, M. L. (1992). Teachers' knowledge and its impact. In Grouws, D.A. (Ed). (1992). Research Handbook on the Teaching and Learning of Mathematics: A Project of the National Council of Teachers of Mathematics., (pp. 147-164). New York, NY, England: Macmillan Publishing Co, Inc.*

[20] *Francis, D. I. C. (2015). Dispelling the notion of inconsistencies in teachers' mathematical beliefs and practices: a 3-year case study. Journal of Mathematics Teacher Training.*

[21] *Goldin, G., Rösken, B., & Törner, G. (2009). Beliefs: it is no longer a hidden variable in the teaching and learning processes of mathematics. Beliefs and attitudes in mathematics education: new research results.*

[22] *Green, TF (1971). Teaching activities. New York: McGraw-Hill.*

[23] *Grootenboer, P. (2008). Change of mathematical beliefs in future elementary school teachers. Journal of Mathematics Teacher Training.*

[24] *Goldsmith, L. T., & Schifter, D. (1997). Understanding Teachers in Transition: Characteristics of a Model for the Development of Mathematics Education. Teachers of Mathematics in Transition.*

[25] *Handal, B. (2003). Teachers' Mathematical Beliefs: A Review. The Mathematics Educator.*

[26] *Handal, B., & Herrington, A. (2003). Mathematics Teachers' Beliefs and Curriculum Reform. Journal of Research in Mathematics Education.*

[27] *Herrera, T. A. & Owens, D. T. (2001). The New Mathematics?: Two Reform Movements in Mathematics Education. Theory in practice.*

[28] *Karp, K.S. (1991). Elementary School Teachers' Attitudes Toward Mathematics: The Impact on Students' Autonomous Learning Skills. School of Science and Mathematics.*

[29] *Lavé, J. (1988). Cognition in Practice: Mind, Mathematics, and Culture in Everyday Life. Cambridge: Cambridge University Press.*

[30] *Lave, J., & Wenger, E. (1991). Situated Learning: Legitimate Peripheral Participation. Cambridge: Cambridge University Press.*

[31] *Macleod, D.B. (2003). From Consensus to Controversy: The History of NCTM Standards. In G. M. A. Stanic & J. Kilpatrick (Eds.), A History of School Mathematics. Reston, National Council of Teachers of Mathematics.*

[32] *McGee, J. R., Polly, D., & Wang, C. (2013). Guide teachers in the use of a standards-based mathematics curriculum: teacher perceptions and subsequent instructional practices following an intensive professional development program. School of Science and Mathematics.*

[33] *Nespor, J. (1987). The Role of Beliefs in Teaching Practice. Journal of Curricular Studies.*

[34] *Pajares, M. F. (1992). Teachers' Beliefs and Educational Research: Cleaning Up a Disordered Construct. Journal of Educational Research.*

[35] ***Peressini**, D., Borko, H., Romagnano, L., Knuth, E., & Willis, C. (2004). A Conceptual Framework for Learning to Teach Secondary Mathematics: A Situational Perspective. Educational Studies in Mathematics.*

[36] *Peterson, P. L., Fennema, E., Carpenter, T. P., & Loef, M. (1989). Beliefs of the teacher's pedagogical content in mathematics. Cognition and Instruction.*

[37] *Polly, D., McGee, J. R., Wang, C., Lamber, R. G., Pugalee, D. K., & Johnson, S. (2013). The association between teachers' beliefs, enacted practices, and student learning in mathematics. The Mathematics Educator, 22(2).*

[38] *Peterson, P. L., Fennema, E., Carpenter, T. P., & Loef, M. (1989). Beliefs of the teacher's pedagogical content in mathematics. Cognition and Instruction.*

[39] *Philipp, R.A. (2007). Mathematics Teachers. Beliefs and Affect'. In: F. K. Lester, Jr. (ed.): Second Research Handbook on the Teaching and Learning of Mathematics. Charlotte, NC: Information Age Publishing.*

[40] *Quigley, C. F., & Herro, D. (2016). Finding Joy in the Unknown: Implementing STEAM Teaching Practices in Middle School Science and Math Classrooms. Journal of Education Sciences and Technology.*

[41] *Raymond, A.M. (1997). Inconsistency between a beginning elementary school teacher's mathematical beliefs and teaching practice. Journal of Research in Mathematics Education.*

[42] *Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. Research Manual on Teacher Education.*

[43] *Ross, J. A., Hogaboam-Gray, A., & McDougall, D. (2002). Research on reform in mathematics education, 1993-2000. Alberta Journal of Educational Research.*

[44] *Rokeach, M. (1968). Beliefs, Attitudes, and Values: A Theory of Organization and Change.*

[45] *Schoenfeld, A. H. (1985). Meta-cognitive and epistemological issues in mathematical comprehension. Teaching and Learning Mathematical Problem Solving: Multiple Research Perspectives.*

[46] *Stigler, J. W., & Hiebert, J. (2009). The Teacher Gap: The World's Best Teacher Ideas for Improving Classroom Education. New York: Simon and Schuster, Inc. Stipek, D. J., Givvin, K. B., Salmon, J. M., & Mac Gyvers, V. L. (2001). Teachers' beliefs and practices related to the teaching of Mathematics. Teacher Education and Training.*

[47] *Thompson, A.G. (1984). The relationship of teachers' conceptions of mathematics and the teaching of mathematics to educational practice. Educational Studies in Mathematics, 15(2).*

[48] *Thompson, A. G. (1992). Teachers' Beliefs and Conceptions: A Synthesis of Research. Macmillan Publishing Co, Inc.*

[49] *Thompson, A. G., Thompson, P. W., Boyd, B. A., & Calculational, B. A. (1994). Computational and conceptual orientations in the teaching of mathematics. Professional Development for Mathematics Teachers: 1994 Yearbook. Reston, VA: National Council of Teachers of Mathematics.*

[50] *Thorndike, L.A. (1923). The psychology of arithmetic. New York: The Macmillan Company.*

[51] *Wenger, E. C., & Snyder, W. M. (2000). Communities of Practice: Organizational Boundaries. Harvard Business Review.*

[52] *Wilkins, J. L. (2008). The relationship between content knowledge, attitudes, beliefs, and practices of primary school teachers. Journal of Mathematics Teacher Training.*

[53] *Wilson, B. G., & Myers, K. M. (2000). Cognition placed in the theoretical and practical context. Theoretical Foundations of Learning Environments.*

[54] *Yackman, G. (2007). Education STE@M. Retrieved from http://steamedu.com*