

Considerations about Ethnomathematics, the Culturally Relevant Pedagogy and Social Justice in Mathematical Education

Consideraciones sobre las Etnomatemáticas, la Pedagogía Culturalmente Relevante y la Justicia Social en la Educación Matemática

Considérations sur l'ethnomathématique, la pédagogie adaptée à la culture et la justice sociale dans l'enseignement des mathématiques

Considerações sobre a Etnomatemática, a Pedagogia Culturalmente Relevante e a Justiça Social na Educação Matemática

Milton Rosa¹

Universidade Federal de Ouro Preto (UFOP)

Doutorado em Educação

<https://orcid.org/0000-0002-5190-3862>

Daniel Clark Orey²

Universidade Federal de Ouro Preto (UFOP)

Doutorado em Educação

<https://orcid.org/0000-0002-8567-034X>

Abstract

One of the challenges internationally faced by education systems is related to the growing number of students from linguistically and culturally diverse origins, a fact that calls the attention of teachers and researchers. Because these fields are connected to traditional education systems, there is a growing urgency to solve such inability to effectively reach all students. With respect to the social justice context, it is necessary assessing the embodiment of mathematics' cultural perspective in the classroom, as well as creating the very basis for the ethnomathematics approaches and for pedagogy in mathematics discipline matrices, since it aims at developing this knowledge production. This approach focuses on promoting social justice and on the quality of students' educational experience. Thus, this sociocultural diversity has growing in educational research, since it is an area that seeks to connect the daily experiences of students with the teaching and learning process aimed at making education systems humanized. In the context of social justice, it is necessary to examine how mathematics is found in all cultures and, at the same time, to base it on ethnomathematical and culturally relevant pedagogies that can assume, in mathematical curricula, the various linguistic and

¹ milton.rosa@ufop.edu.br

² oreydc@ufop.edu.br

cultural forms of knowledge. Thus, the main objective of this approach is the integral promotion of student daily experiences in the school mathematics curriculum.

Keywords: Culturally Relevant Pedagogy, Ethnomathematics, Mathematics Education, Pedagogical Action, Social Justice.

Resumen

Uno de los desafíos que enfrentan los sistemas educativos a nivel internacional está relacionado con el creciente número de estudiantes de orígenes lingüística y culturalmente diversos, hecho que llama la atención de docentes e investigadores. Debido a que estos campos están conectados a los sistemas educativos tradicionales, existe una urgencia creciente por solucionar dicha incapacidad para llegar de manera efectiva a todos los estudiantes. Con respecto al contexto de justicia social, es necesario evaluar la utilización de la perspectiva cultural de las matemáticas en el aula, así como crear las bases teóricas para los enfoques de las etnomatemáticas y para los componentes curriculares pedagógicos de las matemáticas, ya que tiene como objetivo desarrollar esta producción de conocimiento. Este enfoque se centra en promover la justicia social y en la calidad de la experiencia educativa de los estudiantes. Así, esta diversidad sociocultural ha crecido en relevancia educativa, ya que es un área que busca conectar las experiencias cotidianas de los estudiantes con el proceso de enseñanza y aprendizaje encaminado a humanizar los sistemas educativos. En el contexto de la justicia social, es necesario examinar cómo se encuentran las matemáticas en todas las culturas y, al mismo tiempo, basarlas en pedagogías etnomatemáticas y culturalmente pertinentes que puedan asumir, en los currículos matemáticos, las diversas formas lingüísticas y culturales de conocimiento. Así, el objetivo de este enfoque es la promoción integral de las experiencias cotidianas de los estudiantes en el currículo escolar de matemáticas.

Palabras clave: Pedagogía Culturalmente Relevante, Etnomatemáticas, Educación Matemática, Acción Pedagógica, Justicia Social.

Résumé

L'un des défis auxquels sont confrontés les systèmes éducatifs à l'échelle internationale est lié au nombre croissant d'étudiants issus de milieux linguistiques et culturels divers, un fait qui attire l'attention des enseignants et des chercheurs. Étant donné que les domaines des connaissances linguistiques et culturelles sont également liés aux systèmes éducatifs traditionnels, il est de plus en plus urgent de remédier à cette incapacité d'atteindre efficacement

tous les étudiants. En ce qui concerne le contexte de la justice sociale, il est nécessaire d'évaluer l'intégration de la perspective culturelle des mathématiques dans la salle de classe, ainsi que de créer les fondements mêmes des approches ethnomathématiques qui se rapportent aux composantes pédagogiques du programme de mathématiques, dans la mesure où elles visent à développer cette production de connaissances. Cette approche met l'accent sur la promotion de la justice sociale et la qualité de l'expérience éducative des élèves. Ainsi, cette diversité socioculturelle a gagné en pertinence éducative, car il s'agit d'un domaine qui cherche à relier la vie quotidienne des élèves au processus d'enseignement et d'apprentissage, ce qui vise à promouvoir l'humanisation des systèmes éducatifs. Dans le contexte de la justice sociale, il est nécessaire d'examiner comment les mathématiques se retrouvent dans toutes les cultures et, en même temps, de se baser sur des pédagogies ethnomathématiques et culturellement pertinentes qui peuvent assumer, dans les programmes de mathématiques, les diverses formes linguistiques et culturelles de la connaissance. L'objectif principal de cette approche est donc la promotion intégrale des expériences quotidiennes des élèves dans le programme scolaire de mathématiques.

Mots-clés : Pédagogie culturellement pertinente, Ethnomathématiques, Enseignement des mathématiques, Action pédagogique, Justice sociale.

Resumo

Um dos desafios enfrentados internacionalmente pelos sistemas de ensino está relacionado com a quantidade crescente de alunos de origens linguística e culturalmente diversas, fato que chama a atenção de professores e pesquisadores. Haja vista que os campos de conhecimento linguístico e cultural também estão vinculados aos sistemas de ensino tradicionais, há uma urgência crescente em resolver essa incapacidade de atingirmos eficazmente a todos os alunos. Com relação ao contexto de justiça social, é necessário avaliar a incorporação da perspectiva cultural da Matemática em sala de aula, bem como criar as próprias bases para as abordagens etnomatemáticas que se relacionam com os componentes curriculares pedagógicos da Matemática, uma vez que visa desenvolver essa produção de conhecimento. Essa abordagem se concentra na promoção da justiça social e na qualidade da experiência educacional dos alunos. Assim, essa diversidade sociocultural tem crescido em relevância educacional, pois é uma área que busca conectar o cotidiano dos alunos com o processo de ensino e aprendizagem, que visa promover a humanização dos sistemas de ensino. No contexto da justiça social, é necessário examinar como a Matemática se encontra em todas as culturas e, ao mesmo tempo,

baseá-la em pedagogias etnomatemáticas e culturalmente relevantes que possam assumir, nos currículos matemáticos, as diversas formas linguísticas e culturais de conhecimento. Então, o principal objetivo dessa abordagem é a promoção integral das experiências cotidianas dos alunos no currículo escolar de matemática.

Palavras-chave: Pedagogia Culturalmente Relevante, Etnomatemática, Educação Matemática, Ação Pedagógica, Justiça Social.

Considerations about Ethnomathematics, Culturally Relevant Pedagogy, and Social Justice in Mathematics Education

One of the challenges faced by many educational systems is related to integrating the growing number of students from diverse linguistic and cultural backgrounds in classrooms. This diversity has attracted the attention of teachers and researchers, since it is an area that seeks to connect new daily experiences of their students with the teaching and learning process aimed at making education systems humanized.

At the same time, traditional school subjects must take into consideration social, political, and cultural contexts brought to the classroom when diverse students join our classrooms. Thus, it is important that teachers are supported as they learn to appreciate the languages and cultures that their new students bring with them. In this regard, an important change in instruction must take place to match demographic changes in school populations in distinct communities. This is also related to issues of social justice.

In the context of social justice, it is necessary to examine the incorporation of mathematics and cultures and, to use this opportunity to integrate aspects of an ethnomathematics program and culturally relevant pedagogies that use various linguistic and cultural forms of knowledge. Thus, the objective of this approach is related to the promotion of student daily experiences in the school mathematical curriculum.

In this regard, Rosa and Orey (2016) criticize aspects of dominant mathematical curriculum-educational paradigms that traditionally focus on the transmission of the mathematical content where less attention is given to social justice and cultural issues, and more on assessment. Consequently, concerns with equity in mathematical education are a vital topic of international discourse. According to Rosa and Orey (2017), this event, along with content-related consequences, includes issues regarding current mathematical content and reinforces issues related to injustice, corruption, and violence, which is in opposition of the assumptions of a *nonkilling mathematics*.

This context enabled D'Ambrosio (2007) to observe that educating students for social justice consists in teaching mathematical concepts that includes concepts of equity. This includes helping learners to develop an awareness of the values linked through cultural and linguistic aspects of this knowledge to the power mathematics gives us. This approach enables teachers to recall how mathematical knowledge often seems meaningless for many students unless it is connected to a context.

As part of a context, a certain sense of social justice is based on relevant aspects of a political dimension of mathematics, which can guide teaching and instruction. Thus, social

justice teaching encourages exploration, interpretation and reconsiderations about the history, context, role, and nature of mathematical knowledge in society (D'Ambrosio, 2007).

This reasoning about the social and political dimensions of mathematics provides important perspectives for societies that are still *globalized*³ instead of being *glocalized*⁴. These societies acknowledge that people and cultures develop methods and unique explanations that enable members of distinct cultures to understand, transform, and guide changes in their own realities (Rosa & Orey, 2017).

Creating inclusive educational contexts may help teachers to guide classrooms towards an equitable learning environment, which helps students to develop positive beliefs about mathematics and to see how it integrates with other disciplines (D'Ambrosio & Rosa, 2008). This pedagogical action helps students to perceive connections between school mathematics and the kinds of experiences they experience in their own sociocultural contexts. Thus, when students realize that the kind of mathematics taught in the schools is not related to their own experiences and/or culture, they feel disconnected and uncomfortable in participating in the activities proposed in the classrooms (Rosa & Orey, 2017).

In this regard, applying a students' cultural context enables them to fully participate in the mathematical activities and they are supported in making a connection between the mathematical content they learn in schools to the mathematical knowledge they acquire in their daily lives (Rosa, 2010).

The use of mathematical ideas, procedures, and practices developed by members of distinct cultures enables students to perceive how mathematical knowledge is different from that available in the school curricula. Accordingly, Rosa and Orey (2010) argue that teachers must be supported to construct activities that create both awareness and understanding among students' mathematics, language, and culture in order to encourage the development of basic skills, as well as increasingly more complex critical and reflective thinking.

This approach is based on what was referred to as *border pedagogy*, which comes from borderline regions where several different cultural resources interact and allows for the creation of new identities within the existing power configurations. The focus of this debate is related

³ Globalization is the ability a culture has, at the time to meet other cultures, to absorb influences they interact with in order to be enriched and, consequently, to resist events that are alien and compartmentalized so that, although different, they can be appreciated and celebrated as different (Rosa & Orey, 2016).

⁴ Glocalized societies require members of distinct cultural groups to be equipped with enhanced sets of core knowledge and abilities that enables them to solve problems as well to gather and evaluate evidence that empowers them to make sense of information gained and accumulated from diverse media sources in order to develop their decision-making processes. This context enables these members to develop their own ability to adapt new ideas and influences that naturally fit into and enrich their cultures (Rosa & Orey, 2017).

to the understanding of power relations, meanings, and structural identities, since they aim towards encouraging tolerance, ethical sophistication, and acceptance (Jiminez, 2004).

It is important to work with students based on three domains that encourage equity:

- a) using alternative evaluation systems,
- b) assessing student knowledge about other worldviews and cosmologies, and
- c) determining how they perceive and respond to the process of understanding different languages and cultures (Rosa & Orey, 2017).

Accordingly, border pedagogy aims at the decolonization and revitalization of the teaching and learning process because it promotes the development of freedom and social justice to all students. This pedagogy involves students in distinct reference points with a set of diverse cultural codes, experiences, and languages, which helps to construct their own narratives and histories. As well, this pedagogy makes use of the democratic process through linguistic, social, environmental, political, economic, and cultural negotiations (Romo & Chavez, 2006).

In this regard, it is important that teachers are supported to develop a sense of equity that promotes student progress in mathematics. Equity depends on teachers' detailed attention on how learners from distinct cultural and linguistic origins can be encouraged to participate in the learning practices they perform in classrooms (Gutiérrez, 2015).

Sergiovanni and Starrat (1998) argued that professors' development is forged by a set of "beliefs, opinions, values and attitudes that must support their practices" (p. 113). This includes personal educational values and beliefs known as an "educational platform" (p. 113). The platform aims at guiding pedagogical action and decision-making by teachers who evolve along with their pedagogical work, and which helps them to make informed decisions and plan instruction.

In this context, it is important to highlight how some investigations in mathematics education are related to a sense of social justice, with an emphasis on ethnomathematics, in response to concerns about the marginalization of members of sociocultural groups. Other research focuses on assessing the influence of a culturally relevant pedagogies on the academic performance (Ladson-Billing, 1995; Rosa & Orey, 2010). This is why, it is important to discuss the interactive nature of the roles of culturally relevant pedagogies, ethnomathematics, and the social justice movement, as connect and interact with mathematics education.

Culturally Relevant Pedagogy

Any focus on ideas related to culturally relevant pedagogies value different cultures from students' own home life to teach mathematics in a socioculturally educational environment (Ladson-Billings, 1995). The process of this pedagogy highlights students' connection to their home culture and provides a way for teachers to support cultural connections in their school community. It also seeks to validate and embody the cultural backgrounds, history, and interests of their students as the construct daily instruction and pedagogical practices.

A culturally relevant pedagogy approaches students' socio-emotional needs as it uses different materials and artifacts for the development of pedagogical action in the classroom (Scheurich & Skrla, 2003). Accordingly, Ladson-Billings (1995) has shown how this educational approach empowers students in intellectual, social, emotional, and political ways through using cultural and historical references to outspread knowledge and academic skills, as well as to change students and teachers' attitudes towards mathematical academic instruction.

A culturally relevant pedagogy both draws and promotes academic success among all students, because an effective learning and teaching process is triggered by cultural environments supported by and centered on the student background and community. According to this approach, *tacit knowledge*⁵ brought by students to school are identified, nurtured, and used to promote their educational performance. Thus, the academic accomplishment of students coming from diverse cultural and linguistic origins improves when teachers ensure that classroom instruction is relevant, indeed useful in understanding scientific relations found in family-community contexts (Ladson-Billing, 1995).

As mentioned above, the basic assumption of culturally relevant pedagogy shows that teachers teach by using philosophies and methods that respect, value, and use strong points found in students' home culture, context, and language (Scheurich & Skrla, 2003). For example, Moll, Amanti, Neff, and Gonzalez, (1992) assessed minority ethnicity students in

⁵According to Rosa and Orey (2017), tacit knowledge is the unwritten, unspoken, and hidden knowledge held by members of distinct cultural groups, which is based on their emotions, experiences, insights, intuition, observations, and internalized information developed through the resolution of phenomena they face in their daily life. In this regard, Rosa (2010) states that tacit knowledge is relevant to the development of the consciousness of these members because it is acquired through association with members of *other* cultural groups and requires joint or shared activities to be imparted from one to another. It constitutes a set of informally developed knowledge and forms the underlying framework that makes explicit knowledge possible.

Mexican-American communities, in Tucson, Arizona, as way to empower them by supporting their school performance.

These researchers have assessed the unique influence of the teacher as co-learners that learn family-community culture by practicing acts of reciprocal teaching. This process directly connects students' culture to academic mathematics to improve academic outcomes.

Additional evidence of this phenomenon resulted in the study conducted by Lipka and Adams (2001), who approached the application of culturally relevant pedagogy to determine the efficacy of a mathematics instruction units about perimeter and areas set by students enrolled in the sixth grade through a culturally supported learning. The conclusion has favored the development and efficacy of curricular activities based on Inuit students' culture in Alaska.

Similarly, Irvine and Armento (2001) suggest that the culturally relevant pedagogy allows professors to elaborate and use significant pedagogical materials, to create learning environments that include culture, customs, and traditions that, assumingly, are different from their own, and that also include lessons that help students to establish significant connections between their lives and experiences related to school.

The results of the study conducted by Azevedo (2012) showed that the propositions of culturally relevant pedagogy, which is defined as a critical pedagogy committed to collective learning and is based on a tripod composed by critical awareness, cultural competence, and academic success. The study found that these helped students to achieve academic success by learning mathematical content related to functions connected to the activities developed daily.

Accordingly, Klotz (2006) states that a culturally relevant pedagogy enables students to access a school subject connected to their cultural experiences and their tacit knowledge, regardless of being represented by different cultural backgrounds. This pedagogy then is defined as an educational system that honors, respects and values diversity in both theory and practice through which the teaching and learning process is relevant and significant for students from different cultures.

Participation in a culturally relevant manner defines teaching as a means for teachers to build links between student family, community, and school environments. This is particularly powerful when they meet the expectations of required school curricula subjects (Ladson-Billings, 1995). This pedagogy uses students' backgrounds, knowledge, and experiences to inform mathematics lesson planning and diverse methodologies.

A culturally relevant pedagogy provides a variety of methods for students to keep their cultural identity whereas they are academically successful (Rosa & Orey 2010). Thus, it is important for teachers to be able to contextualize instruction by applying a culturally relevant

pedagogy in their teaching practices, as well as to embody the relevance and rigor of the educational process. This is also one of the goals of the ethnomathematics program for the development of social justice in schools.

Ethnomathematics

Currently, there is the greater and indeed more sensitive understanding related to the ideas, procedures, and mathematical practices developed by members of distinct cultural groups. This awareness was achieved through work in multicultural studies, anthropology, linguistics, and ethnomathematics. The term ethnomathematics was firstly addressed by D'Ambrosio (1985) to describe mathematical practices performed by identifiable cultural groups that can be taken as the study of mathematical ideas found in any culture.

According to D'Ambrosio (1990), the search for solutions for specific issues by using techniques (*tics*) developed by the members of distinct cultural groups helps to perceive how mathematics is inserted in the sociocultural context (*ethno*). This approach seeks to understand how mathematics is created, accumulated, and diffused throughout history in order to increase understanding related to how problems and situations are triggered in a given context (*mathema*).

Thus, there is a need of taking into consideration the cultural context of mathematical knowledge to understand phenomena present in the daily life of the learners. As well, ethnomathematics is the study of the mathematical ideas, procedures, and techniques developed by members of distinct cultures that provide contextualization of school mathematics and can help teachers to elaborate pedagogical practices (Rosa & Orey, 2007).

This is strongly linked to the development of social justice from a mathematical perspective. One of the features of ethnomathematics lies in helping learners to become aware of, and to develop concepts about the nature of mathematics through its connection to culture (D'Ambrosio, 1985).

From this viewpoint, the ethnomathematics program provides a wider view of mathematics, which includes forms of the unique tacit knowledge, ideas, processes, procedures, techniques, methods, and practices related to diverse cultural environments. This aspect heads towards the expansion of cognitive processes and the development of abilities that help teachers to translate teaching processes that arise in the classroom in a more interdisciplinary context (Rosa & Orey 2016).

For example, Masingila and King (1997) state that ethnomathematics is a feasible pedagogical action that helps students to make connections and to develop a deep understanding of mathematics.

From this perspective, ethnomathematics helps students in developing learning procedures from their own environment and allows to connect to and learn increasingly more and more sophisticated forms of mathematics and science. As well, it is concerned with the development of a deep understanding of daily mathematical practices.

Thus, as students learn about their own culture, they also learn about the greater mathematical knowledge, as they come to see mathematics an integral part of their own culture (Rosa & Orey, 2007). Thus, the ethnomathematics program promotes two important objectives of mathematics' teaching by:

- a) Setting an interdisciplinary multicultural context for gaining mathematical knowledge and skills, and
- b) It assists students to elaborate mathematical connections with other disciplines (D'Ambrosio & Rosa, 2008).

Accordingly, Rosa (2010) argues that ethnomathematics is a program through which teachers can have positive influence for students who have shown mathematics avoidance and low performance in traditional school mathematics. Thus, ethnomathematics is a program that investigates the ways through which members of distinct cultural groups understand, articulate, and broaden their ideas and mathematical concepts.

The essence of an ethnomathematics program lies in acknowledging the existence of diverse ways of doing mathematics and on taking into consideration the appropriation of academic mathematical knowledge developed by different sectors of society. Ethnomathematics respects the many different modes based on how cultures negotiate techniques to solve problems (D'Ambrosio, 2001).

Furthermore, ethnomathematics can be described as the way through which members of distinct cultures use mathematical ideas, procedures, techniques, and practices to deal with the quantitative, qualitative, relational, and spatial aspects of their lives. This way of conceiving mathematics both validates and reinforces the different experiences inherent to our lives.

Evidence for this assertion is provided by Orey (2000) who stated that cultures involve the unique interactions between its members through language, communication, behavior, and environment. Accordingly, D'Ambrosio (1985) argues that mathematical communication is developed in different cultures based on common features found in their own cultural contexts.

In this regard, to solve specific issues, *ad hoc*⁶ solutions are created, and methods are developed and generalized based on these solutions to solve similar issues, whereas theories are developed according to the use of techniques developed locally. Yet, phenomena recognized as both problems and solutions in one culture may have no meaning or value to members of other cultural groups (D'Ambrosio, 1990).

Part of this is how culture manifests itself through unique mixes of jargons, codes, myths, symbols, utopias, and ways of reasoning. Associated with these are the ethnomathematical practices such as *ciphering*, *counting*, *measuring*, *classifying*, *ordering*, *inferring*, and *modelling*, which constitute the basic core of ethnomathematics.

So, here, a basic question might be posed: *How theoretical should ethnomathematics be?* In this regard, it has long been recognized that local mathematical practices are *known* to the members of distinct cultural groups, yet they may substantially differ from the western or academic ways of *knowing* and *doing*. From the ethnomathematics context, members of different cultural groups know mathematics in ways different from that of the academic mathematics knowledge taught in schools (D'Ambrosio, 2007).

It is important to state that interest in these “*ways of knowing and doing*” has been mainly because of curiosity or sources of anthropological concerns related to learning how diverse and non-traditional members think and act mathematically. Consequently, there is a need to take a step further in trying to find an underlying structure of inquiry in what D'Ambrosio (2007) calls *ad hoc* solutions by posing the following three questions:

1. How are *ad hoc* solutions, problems, and practices developed into methods?
2. How are methods developed into theories?
3. How are theories developed into scientific invention?

It is the purpose of ethnomathematics to develop a structured, alternative body of mathematical knowledge. To achieve this goal, it is essential for researchers to develop these questions in research investigations related to the interactive natures and roles of culturally relevant pedagogies, ethnomathematics, and social justice movements.

At the same time, it is necessary to understand how mathematical practices are developed from *ad hoc* solutions to formalized scientific inventions, as well from experiences to experiments, which are related to scientific methods.

⁶ *Ad hoc* is a Latin expression that means ‘for this end’. Overall, this expression means a solution projected for a specific problem or task, which cannot be generalized, and that cannot be adjusted to other ends.

For example, the ongoing work with learners along the *Ouro Preto Math Trail* suggests that unique forms of *ad hoc* mathematics used by the colonizers and enslaved peoples who built Ouro Preto, were based on *more or less* or *good enough* aspects of the informal measurements that were less than exact, but add a certain charm to the UNESCO Patrimony, the baroque architecture and the cobble stoned streets (Rosa & Orey, 2010).

The concept of ethnomathematics is based on the interconnectedness of these relations as given by *ad hoc practices* \Rightarrow *methods* \Rightarrow *theories* \Rightarrow *inventions* (Rosa & Orey, 2017). These three questions are essential to help members of distinct cultural groups to develop their own scientific ideas, methods, and theories (D'Ambrosio, 1990). However, there is unquestionably a timelag between the appearance of mathematical ideas, procedures, and practices outside of the circle of its academic practitioners with the recognition that they can be theorizable into mathematics through ethnomathematics.

Mathematics is identified in cultural activities of different societies embodied by cultural practices through the acknowledgement that all cultures have developed unique methods and sophisticated explanations to facilitate communication of findings, understanding and changes observed in reality itself (Orey, 2000).

Ethnomathematics then becomes a means to study diverse techniques developed and used by people that allows them to seek, to explain, and to understand their world in order to respond to the issues, struggles and efforts for their survival and transcendence (D'Ambrosio & Rosa, 2008).

This approach includes people's material needs, as well as their art and forms of spirituality, by developing and using artifacts that are objects created by members of a specific cultural group that, inherently, offers opportunities for teachers to connect to current events, to the relevance of these artifacts in the ethnomathematics, history and cultural contexts (Rosa & Orey, 2010).

Other ethnomathematical assumptions suggest that this program values other worldviews, explanations, and understandings, which are formulated and accumulated by members of distinct cultural groups often over long periods of time. This knowledge is seen as part of the evolutionary process of cultural dynamism taking place in diverse sociocultural environments (D'Ambrosio, 2001).

In this regard, studies about the different ways through which people solve problems by using practical algorithms based on mathematical perspectives show the relevance of any real understanding of mathematical concepts and practices developed over time (Rosa & Orey, 2017).

Thus, ethnomathematics aims at valuing students' cultural experiences and practices, their communities and overall society by using them as vectors that make mathematics learning meaningful, to allow for the embodiment of cultural and linguistic contexts of students in relation to diverse forms of mathematical knowledge.

A central objective of the ethnomathematics program looks to reaching a true sense of equity among students through the incorporation of social justice into mathematics education.

Social Justice

It is even more necessary to empower students by teaching them about real world issues in connection to linguistic, social, and cultural backgrounds, and how they interact with each other. Accordingly, D'Ambrosio (2007) states that students who do not believe in or who do not learn to value their mathematical background, or their cultural roots, can easily assimilate the dominant culture without critically reflecting on its values. Essentially, this is related to forms of pedagogical colonization.

Thus, teachers must understand the historical and cultural variations in ideas, procedures and mathematical practices that change overtime, as well as the culture of origin, race, ethnicity, sexual orientation, and other sociocultural features (Rosa, 2010). School mathematics curriculum needs to be concerned with questioning oppression and with promoting more social justice focused on the process of teaching and learning of mathematics in the ways through which teachers' beliefs, practices, and school policies, such as tracking, which can be considered as forms of racism (Gutiérrez, 2015).

Consequently, it is important for teachers to acknowledge the way popular education reforms in mathematics can have different effects on their students who were, historically, marginalized (Gutiérrez, 2015). Currently, a discussion in relation to educational mathematical aspects helps teachers to reflect on their own internal models of beliefs, thoughts, and behaviors. It can be performed by contemplating the potential of pedagogical work that takes into consideration the student sociocultural contexts, as well as mathematics learning experiences based on meaning and empowerment (Rosa & Orey, 2016).

The suggestion for starting with mathematical concepts known by students, or the family, is another way to allow a critical evaluation of these concepts. The consequence of this approach for teachers' professional development is quite significant because these professionals need to be supported and encouraged to know more about the context of the mathematics and additional pedagogical competences they will use, and how this connects to

specific needs of their communities. Consequently, this is a task that can help researchers, teachers, and students to understand the connection between mathematics and culture.

The justification for investigating the development of social justice in mathematics education is related to its implication for the development of a given school curricula and innovative of teaching practices, of teachers' professional development, of public policy formulation, and of its connection to efforts focused on reducing arrogance, iniquity, and intolerance in society.

Connecting Ethnomathematics, Culturally Relevant Pedagogy and Social Justice

Any connection between ethnomathematics, culturally relevant pedagogy and social justice suggests that teachers must contextualize the learning of mathematics by relating its content to the real experiences of their students. Thus, an important change in mathematical instruction must take place, one that encourages an adjustment that is clear, powerful, continuous and progressive and incorporates important changes in the demography of their community.

Early guidelines of both the *National Council of Teachers of Mathematics* (NCTM, 1991) and of the *Ministry of Education and Culture in Brazil* (Brasil, 1996) highlight the importance of establishing connections between students' mathematics and culture. Accordingly, when practical problems or phenomena based on culture are assessed in an appropriate sociocultural context, local mathematics is not trivial because it reflects topics that are deeply linked to the daily routines of students (Rosa & Orey, 2007).

According to teachers who work from a variety of culturally relevant perspectives, all students are competent, regardless of gender, race, or social class. Teachers must focus on providing instruction during classes rather than on managing behaviors, to understand such thinking in a way that goes beyond what is known by students, as well as to show the deep knowledge and mathematical content (Ladson-Billings, 1995).

Knowledge development from a culturally relevant perspective can be perceived as a version of the ethnomathematics program. This occurs when teachers respect and value the community's knowledge (*ethno*) or its local mathematical knowledge, and then use this to create lessons that connect to their culture and experiences (*mathema*), which allow them to create and develop a certain awareness and critical thinking (*tics*) (Rosa, 2010).

Accordingly, Orey (2000) states that "ethnomathematics can be featured as tool to act in the world" (p. 250), this happens when it provides information that allows teachers and learners alike to see the social role of school and academic mathematics in a context for social

justice. A culturally relevant pedagogy focuses on the role of mathematics within sociocultural contexts that concern necessary ideas and concepts for the solution of daily problems (Rosa & Orey, 2016).

Mathematics' teaching for social justice explores different methods that enables teachers to organize mathematical ideas and practices, as well as to solve daily problems. Thus, ethnomathematics as pedagogical action shows how this same mathematics can be contextualized and supported by the needs and expectations of the community using it. A core objective of ethnomathematics lies in contributing to the greater context and understanding that occurs when culture and mathematics meet dialogically with *alterity*⁷.

According to D'Ambrosio (2007), an important component of mathematics education then becomes when curriculum moves from mechanical grammatical exercises towards learning to restate and restore the cultural dignity of students and their community, as they participate in activities that reflect the needs, knowledge and their own people.

Thus, learning to value and perceive the mathematics used in these environments and to develop respect for those who are using it becomes essential. Teaching for social justice demands that students acquire the necessary mathematical knowledge, while simultaneously keeping their own cultural dignity intact, so that they can be prepared for true participation in society (D'Ambrosio, 2007).

Ethnomathematics helps the understanding and acceptance of cultural roots of the members of marginalized groups by understanding and valuing their ideas, procedures, and mathematical practices. This program acknowledges the power, needs and applications of academic mathematics while promoting the ideas, procedures and mathematical practices developed by other cultures (Rosa & Orey, 2016).

This program also recognizes the mathematics of the dominant culture. Members of marginalized groups must have access to the tools needed to participate fully in their own community (Rosa & Orey, 2007).

Teachers who understand both the historical and cultural variations of ideas, procedures and mathematical practices, of culture origin, race, ethnicity, gender, sexual orientation and of other sociocultural features are better equipped to promote equity and social justice, as well as to review and deeply analyze their own practices and pedagogical actions (Rosa, 2010).

⁷Alterity is derived from the Latin term *alter* that is related to the quality of being different, which is linked to a philosophical principle of exchanging one's own perspective of being for that of others in order to put oneself in their place (Rosa & Orey 2010).

For example, results in the study conducted by Pinheiro (2017) show the importance of teacher collaboration in the development of the curriculum process, which allowed the progress of academic and professional competencies that helped in the inclusion of deaf students and for the full exercise of their citizenship rights.

Furthermore, teachers need to know and understand complex relations of cultural and linguistic contexts of students when it comes to mathematical performance. Thus, it is essential for teachers to become sensitive to the diverse needs of their students (Rosa, 2010).

As well, it is necessary that teachers be supported to acknowledge and approach all preconceived ideas that may impact student linguistic and cultural backgrounds. Oftentimes, they experience, indeed suffer, a sense of misfortune or frustration due negative social perceptions about academic skills and abilities, conquests, and successes.

Accordingly, VanTassel-Baska and Baska (2004) have highlighted how teachers may use their own perceptions as the judgement of their skills to structure a given pedagogical action aimed at producing expected results for students from different cultural and linguistic contexts, because these perceptions can be powerful vectors of this behavior.

This pedagogy brings along a sense of ethics, full attention, care, respect, and the responsibility of professionals who work as culturally and linguistically different students (Klingner, Artiles, Kozleski, Harry, Zion, Tate, Durán, & Riley, 2005). These practices help implement learning environments that develop reasoning, investigation, and mutual support by teachers, especially those who work with diverse linguistic and cultural contexts (Torres-Velásquez & Lobo, 2004).

This perspective is an essential component of culturally relevant pedagogies because they suggest how teachers contextualize mathematics teaching and learning processes when they relate their content to student linguistic and cultural realities.

As stated earlier, ethnomathematics supports the learning process of school/academic mathematics, this is important to emphasize again here, because members of minority or marginalized groups must have equal access to the powerful scientific and mathematical knowledge used by the dominating culture (D'Ambrosio, 2001).

This program explores the academic and cultural means to allow more inclusive pedagogical programs for diverse populations assisted by educational institutions (D'Ambrosio, 2007). Thus, classrooms should not be isolated from their own communities.

In this context, the classroom, curriculum, and the school community should be part of the overall sociocultural environment that includes specific mathematical practices that focus on the teaching and learning processes applied to mathematics. For example, Bandeira and

Lucena (2004) identified cultural mathematical knowledge and its acquisition in traditional schools.

Similarly, Rosa (2010) states that classrooms are environments that enable the development of pedagogical actions to be promoted in the classrooms due to the use of ethnomathematical approaches in the mathematics curriculum, as well as in the school communities.

Because these practices cover student sociocultural contexts, Chieus (2004) states that the pedagogical work linked to an ethnomathematical perspective allows for a broader analysis of school context. This is because the pedagogical elements necessary for the development of an ethnomathematics program are found in the school community itself.

This approach is essential for the development of an ethnomathematical perspective linked to culturally relevant pedagogy for social justice through the investigation of the cultural aspects of mathematics that take into consideration the contributions from people from other cultures (Rosa & Orey, 2010).

Although culture is connected to mathematics, teachers are not always aware of their own influence over the learning process applied to mathematical knowledge the share (Rosa (2010). Consequently, if not supported by academic leadership, teachers may not explicitly learn how to value or perceive possible connections between culture, mathematics, and teaching practices.

Final Considerations

It is important know how perceptions, beliefs, behaviors, and worldviews guide teachers towards the enhancement of teaching practices for the development of social justice in order to change and/or transform society (Airasian & Gullickson, 1997).

A deeper understanding of culture and language and the many diverse connections found in science and mathematics and how it forms an important source of knowledge that can help teachers to develop strong pedagogical actions in classrooms. Ethnomathematics, as one tool towards this goal, emphasizes a sense of social justice that demands the empowerment of members of diverse cultural traditions to encourage active participation in their own community.

In this context, the link between culturally relevant pedagogies and ethnomathematics enables teachers to develop a deep evaluation of cultural, social, political, economic, and environmental influences over the mathematical teaching and learning processes of the students from distinct sociocultural groups (Rosa, 2010).

In this regard, these processes include a sense of engagement that aides in challenging social injustices and the opportunity to reason about educational challenges by identifying both obvious and subtle individual, institutional, linguistic, mathematical, social, and cultural actions that surround educational structures.

Accordingly, teachers who are encouraged to value and understand the diverse linguistic and cultural differences of their students and the school community learn to search for techniques and strategies that lead to improvements in mathematical learning experiences of the students. Thus, these educational professionals perform a fundamental role that encourages and supports pedagogical practices for all students in the classrooms.

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