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In-service teachers mathematics conceptions through the lens of ethnomathematics

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Abstract

The ethnomathematical perspective brings to light epistemological issues about teachers' conceptions of Mathematics. This study explores teachers' Mathematics conceptions and the evidence in their instruction framed using an ethnomathematical lens that highlights three dimensions: a practical approach that attends to the development of relations of Mathematics to reality, a social approach that proposes a view of Mathematics as a system of meanings of quantity, relationship, and space by a certain group of people, and a cultural approach that focuses on reflections from cultural groups that represent many different perspectives on Mathematics. Many researchers and educators recognize the significant influence of these approaches in interpreting and implementing Mathematics curricula. It influences how teachers' conceptions of mathematics affect their approach to teaching and learning mathematics. The survey adapted from Albanese and Perales and Andrews and Hatch reveals that the three approaches were given importance by the in-service Mathematics teachers of a teacher education institution in determining and developing their conceptions of Mathematics. The findings showed that the in-service teachers' conceptions of mathematics were visible from an ethnomathematical perspective. The practical approach in their instruction was highly evident but was the least important for the in-service teachers. Future research on how these conceptions play a part in the teaching-learning process is recommended. Conducting workshops and training for teachers on including an ethnomathematics approach in their instruction will help them more effectively design a lesson and reflect on the learning environment they would create in their classrooms.

Keywords: Ethnomathematics; In-service Teachers; Practical approach; Social approach; Cultural approach

1. Introduction

Many of today's mathematics problems in education are centered on assessing what students know and do not know, what they understand and do not understand, what they are learning, and what they are not. This focus is essential in developing mathematics instruction supporting our learner's level of understanding. As mathematics teachers try to improve towards making necessary changes in instruction and assessment, an examination of the role and its impact on its changes deems necessary [9]. The teachers' beliefs and conceptions of mathematics influence the facilitation of meaningful changes in instruction and the teaching-learning process. According to Cooney [6], mathematics teachers' beliefs about mathematics, mathematics teaching, and mathematics learning have significantly influenced classroom behavior. Furthermore, according to Thompson [16], there is compelling evidence to support the idea that teachers' conceptions, such as their beliefs, views, and preferences in mathematics and its teaching, have a significant impact on how effective they are as principal facilitators between the subject and the students.

Before enrolling in their first educational courses, most teachers would have developed ideas interconnected with mathematics conceptions and mathematics teaching and learning at school. These conceptions influence how they run their classroom and teach their lessons [8]. As Veronica Albanese and Francisco Javier Perales [2], in their study "Mathematics Conceptions by Teachers from an Ethnomathematical Perspective," identified three approaches which

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are referred to as: practical, social, and cultural. As one of the characteristics of the ethnomathematical perspective, these three approaches are later used in the study to examine further in-service teachers' mathematics conceptions.

The practical approach implies the development of relations of mathematics to reality, emphasizing its origin in concrete practices in daily life [7]. As Barton [4] expressed, the social approach proposes mathematics to be seen as a system of meanings of quantity, relationship, and space by certain groups of people. On the other hand, the cultural approach consists of reflections from cultural groups representing many different perspectives on mathematics, concentrating on the diversity of contents, ideas, and contributions. Many researchers and educators recognize the significant influence of these approaches in the interpretation and implementation of mathematics curricula [5], and their conceptions affect the approach to their teaching and learning of mathematics [12].

Examining in-service teachers' conceptions of the relationship between mathematics and mathematics teaching and learning will help us better understand the behaviors, experiences, and interpretations of what will happen in their classrooms, especially since their conceptions will be challenged, reconstructed, or refined when teaching.

It is then aligned with the purpose of the study to examine the mathematical conceptions of in-service teachers through the lens of ethnomathematics. Specifically, the study aims to:

- Describe the socio-demographic profile of the respondents.
- Are the lenses of ethnomathematics evident in the teaching of in-service teachers which are:
    - Practical,
    - Social, and
    - Cultural?
- Analyze the mathematical conceptions of in-service teachers through the lens of ethnomathematics, which are:
    - Practical,
    - Social, and
    - Cultural?

2. Material and methods

Table 1 Evidence of the lenses of ethnomathematics

Scale	Level of Evidence	Description
2	True	Evident
1	False	Not evident

Table 2 Conceptions of In-Service Teachers of Mathematics through the lenses of ethnomathematics

Scale	Level of Agreement	Description
5	Strongly Agree	Very Important
4	Agree	Important
3	Neutral	Neither
2	Disagree	Unimportant
1	Strongly Disagree	Very unimportant

The participants of this study were in-service teachers from different schools in the Philippines, both public and private schools. Purposive random sampling was employed to determine the 40 participants of the study. Participants were given a survey questionnaire through a google form, which includes the informed consent form and the socio-demographic profile. Questions comprising the different perspectives on Mathematics and evidence in their instructions based on the three identified characteristics of the ethnomathematical perspective are also included in the questionnaire. Descriptive analysis was used to make sense of the data gathered. After gathering the data, descriptive data were analyzed using MS Excel. Percentages and frequency were utilized in the gender of the respondents and their school affiliation. An assigned value was used to determine the level of evidence of the in-service ethnomathematics

perspective. Mean, and its indicated verbal description was used for the conceptions of Mathematics. The researchers will rank each perspective based on the mean average to determine which approach is prevalent among in-service teachers.

3. Results and discussion

This chapter contains detailed presentation and discussion of data analysis and the results of this investigation. The research findings are presented under the following key headings: socio-demographic profile of the respondents, evidence of the lenses of ethnomathematics, and conceptions of in-service mathematics teachers through the lenses of ethnomathematics.

3.1. Socio-Demographic Profile of the Respondents

Table 3 Gender of the Respondents

Gender	Frequency	Percentage
Male	18	45%
Female	22	55%

Table 3 shows the frequency and percentage of the gender of the in-service teachers. Of 40 teacher participants, 22 (55%) were female, and 18 (45%) were male.

Table 4 School Affiliation of the Respondents

School Affiliation	Frequency	Percentage
Public School	30	75%
Private School	10	25%

Table 4 exhibits the frequency and percentage of school affiliations of in-service math teachers. 30 out of 40 (75%) in-service math teachers were from public high schools, while 10 out of 40 (25%) were from private high schools.

3.2. Practical Lens of Ethnomathematics

Table 5 Evidence of Practical Lens of Ethnomathematics

Statement	Weighted Mean	Verbal Description
Proofs are discussed, but applications of mathematical concepts are much more evident in the lesson proper of my discussion.	1.975	E
I help students connect mathematical learning to their everyday lives.	1.95	E
I create real-life problem-solving activities for my students to utilize mathematics for a more realistic approach.	2	E
Applications of mathematics in the real world, e.g., technology innovation and business, are implied in the discussion of the mathematics lessons.	1.975	E
I believe that mathematics shows that the world is interconnected.	2	E
I believe everyone should know and understand mathematics because it is essential to learn the same as other subjects.	2	E
Rather than only understanding the mathematics lesson, I create a situation where my students see the value of it to their skills and real life.	1.95	E

I enrich my math lessons with problem-based tasks to address 21st-century skills.	1.975	E
I emphasize in the classroom instruction that mathematics, including problem-solving ability and critical thinking skills, is essential to being a 21st-century citizen.	2	E
I use technology as a learning tool for mathematics lessons as a simulation of reality and the world.	2	E

Table 6 Conceptions of In-Service Teachers of Mathematics through the Practical Lens of Ethnomathematics

Statement	**Weighted Mean**	**Verbal Description**
The applications of a mathematical result are more important than its proof.	4.2	A
Skillful use of mathematics is more important than understanding.	3.8	A
A citizen of the 21st century needs to understand mathematics.	4.65	SA
Mathematics has many everyday uses.	4.825	SA
Mathematics is an important tool in building models for explaining the world.	4.775	SA

The conception of the in-service teachers in mathematics through the practical lens of ethnomathematics is evident in the survey conducted. The respondents agreed with a weighted average of 1.9825, showing evidence of the practical lens in the teaching practice of the in-service teachers. All statements were agreed upon by all the respondents, of which 5 statements had a weighted average of 2, depicting a complete agreement by the in-service teachers. These five statements enrich the real-life problem-solving activities of students (1), using mathematics as a way to show the interconnectedness of the world (2), the essentiality of mathematics (3), the 21st-century skills developed through mathematics (4), and the use of technology in learning mathematics in simulating reality and the world (5). This only means that the practical lens of ethnomathematics is perceived by the in-service teachers. In the context of the in-service teachers' teaching method, the practical lens is deemed important, with a weighted mean of 4.45, which shows evidence in their teaching practice. The usage of mathematics in everyday life has the highest weighted mean of 4.825, which only shows that the practicality of mathematics is very important in the teaching practice of in-service teachers. Similar to the finding of Albanese and Perales [2] as their participants value the direct experience of mathematics in the real world and stand out as the concrete element of mathematics that reflects reality.

3.3. Social Lens of Ethnomathematics

The social lens of ethnomathematics is also apparent in the instruction of in-service teachers. In fact, the in-service teachers consider all statements the researchers designed evident (see Table 7). Statement 2 in Table 7 is about communicating the mathematics knowledge and experiences involving the subject with the students, and all in-service teachers who participated in this study agreed with it. As studied by Naresh [11], in promoting social changes within the classroom, educators must be responsible for having empathy, consideration, and skills to properly communicate the instruction along with their intent to help students love and value mathematics, as mentioned in Table 7, Statement 9. Overall, the social lens of ethnomathematics is clearly evident among the in-service teachers' teaching practices, with a 1.9575 weighted mean (see Table 8).

With this, the social lens of ethnomathematics as a conception of mathematics considers “Important” (4.48) for in-service teachers. Most identified statements obtained a “Strongly Agree” verbal description, which encapsulates how the in-service teachers value the social aspect of mathematics. The essentiality of discussion in mathematics teaching (4.6), mathematical games as part of mathematics teaching (4.55), and promoting love for mathematics learning (4.675) acquired a "Strongly Agree" from the respondents. Meanwhile, the whole class approach (4.15) and the importance of group work (4.425) obtained an "Agree" response from the in-service teachers. As reported in Albanese and Perales' (2020) study, the importance of valuing work in small group activities and educational games is an effective strategy in teaching mathematics. The educational implications are tied to social constructivism, a paradigm emphasizing knowledge acquisition in small groups and agreement on shared experiences [13].

Table 7 Evidence of Social Lens of Ethnomathematics

Statement	Weighted Mean	Verbal Description
Communication of knowledge or experiences is essential in my teaching-learning process in mathematics.	2	E
Sometimes I allow my students to do lesson presentations to enable them to study independently and share their understanding with the class, which can create an opportunity for a whole class discussion of their solutions and answers.	1.85	E
I create opportunities that make students cooperate and collaborate with their classmates (e.g., collaborative work like experiments, solution checking, and reporting).	1.975	E
I ask the right questions that will induce an answer from my students as it will guide them through the discussion and give them a goal or a vision of the result.	1.975	E
It is important for the discussions to be structured in order for the students to get the most from them.	1.975	E
I incorporate educational games in teaching math to motivate my students to find creative solutions and drive them to accelerate their learning while having fun.	1.95	E
I motivate my students to collaborate with their classmates or peers during group work or study whenever possible.	1.95	E
I occasionally give group work to my math instructions as much as possible so that my students can explore their own thinking and that of their classmates.	1.95	E
My love for mathematics extends to lending a hand to anyone needing help valuing the subject.	2	E
I embedded myself as the classroom facilitator instead of being the absolute authority of knowledge inside the classroom.	1.95	E

Table 8 Conceptions of In-Service Teachers of Mathematics through the Social Lens of Ethnomathematics

Characteristics	Weighted Mean	Verbal Description
Discussion is an essential part of mathematics teaching.	4.6	SA
Mathematical games should be part of mathematics teaching.	4.55	SA
Students should experience whole class teaching.	4.15	A
Teachers act as a facilitator who promotes love for mathematics learning.	4.675	SA
Group work is an essential part of mathematics teachers' repertoire.	4.425	A

3.4. Cultural Lens of Ethnomathematics

The last conception of mathematics is the cultural approach from an ethnomathematical perspective, evident among in-service teachers. The following are the two statements obtained a weighted mean of 2: (1) teachers contextualize teaching and learning by relating Mathematics to the students' lives and cultures through examples and activities, and (2) teachers use mathematics to describe and appreciate the beauty of their culture, which may urge them to develop and preserve it. Sunzuma and Maharaj [14] have the same finding that incorporating culture in teaching mathematics

gives another flavor to the teaching-and-learning process, thus making it more effective. The necessity of learning to think in new ways (having an open mind) and embracing the diversity of emerging ideas are valued in the modern classroom and upsetting the traditional classroom presentation [2]. Furthermore, by analyzing the survey, the importance of in-service teachers' mathematical ideas can be viewed through an ethnomathematics cultural perspective. In-service teachers strongly agree with the following claims: (1) Mathematics contributes a distinctive addition to knowledge, (2) Mathematics is an essential component of a balanced education, and (3) Mathematics is a creative art. It is supported by Sunzuma, Masocha, and Zezekwa [15], who asserted that geometry benefits students' spatial awareness and intuition, representations, and real-life problem-solving.

Table 9 Evidence of Cultural Lens of Ethnomathematics

Statement	Weighted Mean	Verbal Description
New areas of mathematics are introduced in my lesson proper (multi-disciplinary and contextual), which allows my students to see mathematics in every aspect that involves our lives (e.g., mathematics in science and technology).	1.975	E
When teaching mathematics, I emphasize its importance and effects on our world's current problems.	1.95	E
I create complex learning tasks within the global context with multiple parts that allow each student to contribute to the overall activity goal.	1.7	E
Mathematics is also a medium to create bigger things or ideas involving different art forms.	1.975	E
I contextualized teaching and learning by connecting Mathematics to the students' lives and their communities by including examples and activities, such as games found in the local and regional context.	2	E
I promote inclusivity and diversity in different aspects of the mathematics teaching-learning process by using a heterogeneous grouping structure based on race, gender, ability, levels of knowledge, language, etc.	1.9	E
My students find it easier to understand the topic through patterns because the media I use relates to my students' cultural practices.	1.875	E
I empower urban and diverse students to construct a strong "mathematical identity" and to deconstruct the belief that they are incapable of learning mathematics.	1.925	E
I apply strategies that involve our cultures, like using old songs, games, dance, and traditions in teaching Mathematics.	1.8	E
I use mathematics to describe and appreciate the beauty of their culture, which may encourage them to improve and preserve it.	2	E

Table 10 Conceptions of In-Service Teachers of Mathematics through the Cultural Lens of Ethnomathematics

Statement	Weighted Mean	Verbal Description
Mathematics makes a unique contribution to knowledge.	4.65	SA
Students are working on different subtasks of global tasks.	4.325	A
Mathematics is an essential element of a balanced education.	4.7	SA
Mathematics is a creative art.	4.55	SA
Mathematics exhibits cultural richness.	4.4	A

3.5. Evidence and Conceptions of the Lenses of Ethnomathematics

Table 11 Evidence of the Lenses of Ethnomathematics

Lenses of Ethnomathematics	Weighted Mean	Verbal Description
PRACTICAL	1.9825	E
SOCIAL	1.9575	E
CULTURAL	1.91	E

Table 12 Importance of the Lenses of Ethnomathematics of In-Service Teachers

Lenses of Ethnomathematics	Weighted Mean	Verbal Description
PRACTICAL	4.45	I
SOCIAL	4.48	I
CULTURAL	4.525	VI

The conception of the in-service teachers in mathematics through ethnomathematics, practical, social, and cultural lenses. Table 11 shows that practical lenses of ethnomathematics received the highest mean (1.9825) out of the three lenses. This shows that respondents agreed that practicality in mathematics is evident in their instruction. According to Mulbar and Zaki [10], the process of learning and teaching mathematics using realistic (practical) mathematics education makes the students be more active in learning, become more motivated to learn, and has a good impact on improving students learning achievement in mathematics. While the cultural aspect is evident, it received the lowest mean of 1.91. However, based on the importance of this aspect in the conception of the respondents, table 12 shows that the cultural lens of ethnomathematics is "Very Important" in the instruction of the in-service teachers. On the other hand, the practical lens of ethnomathematics only received 4.45 as a mean with a verbal description of "Important." The study by Acharya [1] examined the relevance of the primary education curriculum from a cultural perspective in Nepal. He concluded that the primary education curriculum addresses the importance of practical and everyday use of mathematics to some extent. However, these present curricular materials are not prepared to consider the cultural perspective of mathematics education. Furthermore, he added that this curriculum could not address the multicultural environment of the classroom. This relates to what the researchers found out: although the cultural lens of ethnomathematics is "Very Important" to the in-service teachers, it is not much "Evident" in their classroom as the practical lens of ethnomathematics.

4. Conclusion

The initial goal of describing and analyzing conceptions of in-service mathematics teachers about the nature of mathematics has been met. The survey results revealed that the teachers' conceptions of mathematics are visible from an ethnomathematical perspective. The respondents agreed that practicality in mathematics is evident in their instruction but less in the cultural approach to teaching. This demonstrates that respondents acknowledged that their mathematics instruction mostly uses real-world situations and applications. Even though the practical approach has been more evident in teaching instruction, the cultural approach has been deemed very important in the teaching process of in-service mathematics teachers based on the importance of this feature in their ideas.

The three approaches of ethnomathematics are all essential in developing the conceptions of mathematics teachers. Thus, more thorough research with participants from diverse cultural backgrounds is worth recommending. It is also recommended to study how these conceptions affect the teaching style of the in-service mathematics teachers, how they deal with problems accordingly as they arise inside the classroom, and how they affect the student's learning achievement. Workshops and seminars for math teachers should be held to teach them how to include an ethnomathematics approach in their lessons. Instead of acting as passive curriculum implementers, math teachers should be involved in its planning and creation. Also, all educational institutions should incorporate an ethnomathematics approach into their curricula. Analyzing the conceptions of in-service teachers through the lens of ethnomathematics allows them to be aware of the ethnomathematical perspective evident in their instructional strategies. Additionally, it will also help future researchers study the correlation between teachers' conceptions of mathematics and their learners' motivation to learn.

Compliance with ethical standards

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Disclosure of conflict of interest

There are no conflicts of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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