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Mathematics Teachers' Attitudes Towards Integrating Ethnic Mathematics in Teaching Mathematical Topics: A Mixed Methods Study

Ibrahim Alhussain Khalil
Asst. Prof. Dr., Mathematics Education, Department of Curriculum and Instruction, College of Education, University of Bisha, Bisha, Saudi Arabia, *ikhalil@ub.edu.sa*

This study aimed to provide an integrated picture of teachers' attitudes toward ethnic mathematics, an approach to teaching school mathematics. It addressed four main dimensions: knowledge of ethnic mathematics, the current extent of its integration in teaching, perceptions toward it as a pedagogical approach and obstacles that limit its integration. The study adopted mixed methods and followed an explanatory sequential design. The quantitative aspect employed the descriptive survey method, collecting data through an electronic questionnaire comprising 33 items distributed over 4 dimensions. This was followed by qualitative interviews conducted to interpret the results of the quantitative analysis. In total, 104 mathematics teachers participated in the quantitative survey and 4 teachers participated in the qualitative interviews. There were several interesting findings, the most important of which are that mathematics teachers' have only an average level of knowledge of ethnomathematics, they hold positive perceptions toward it in general, and they generally have positive conceptions about it. However, there are many obstacles that limit its integration in teaching, including students' beliefs about the limited use of mathematics in daily life. The study also found no statistically significant differences in the level of knowledge and integration of ethnomathematics attributable to gender, teaching experience, or teaching stage. The study makes several recommendations, the most significant being that meetings and workshops are needed to educate teachers about ethnomathematics and how to discover and integrate it in teaching school subjects.

Keywords: integration, ethnomathematics, school mathematics, mixed methods, teachers

INTRODUCTION

This paper addresses the integration of ethnomathematics in the classroom. Ethnic studies are a growing movement of methodological and pedagogical practices that reclaim marginalized voices and histories (Yeh, Martinez, Rezvi, & Shirude, 2021). They are significant as cultural values, traditions and symbols are embodied in the life of every society. Economic, cultural, social, religious, and educational activities all affect

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education—and mathematics education in particular (Fouze & Amit, 2017). However, the application of ethnic studies in mathematics education is limited.

Yeh et al. (2021, p. 76) provide a framework of ethea in ethnic studies for the teaching of mathematics comprising the following aspects: (i) identity, narratives, and agency; (ii) power and oppression; (iii) community and solidarity; (iv) resistance and liberation; and (v) intersectionality and multiplicity. (See Figure 1.)

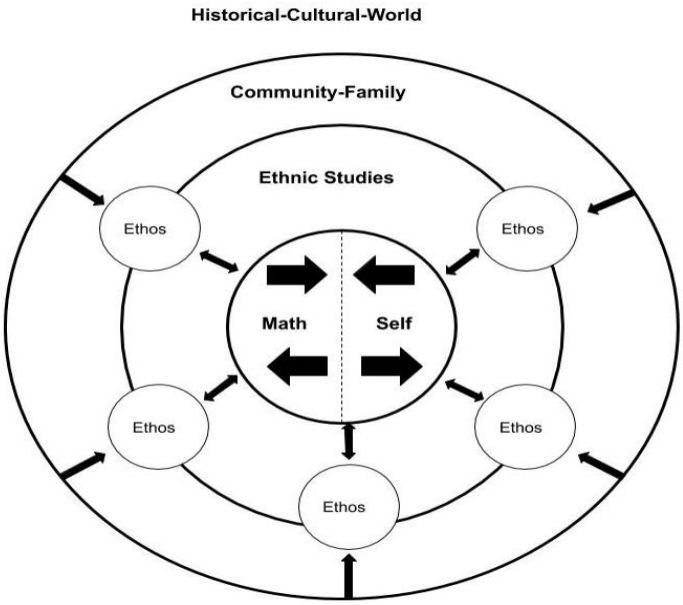

Figure 1
Ethea of ethnic studies in mathematics education (Yeh et al., 2021: 76)

Ethnomathematics is a recent and important trend that can help individuals, society, and students understand mathematics as linked to the surrounding culture (Kurniawan, Anam, Abdussakir, & Rofiki, 2019). There are many definitions of ethnomathematics. D'Ambrosio (2001), for example, defines it as a program that explores the history and philosophy of mathematics and has clear educational implications. Pais (2011) considers it an ethnic program that relates mathematics to humans. Rosa & Orey (2011) describe it as a mathematical perspective in school curricula that helps develop students' intellectual, social, and political learning by using their cultural resources to convey knowledge, skills, and attitudes. Brandt & Chernoff (2015) define it as the mathematics practiced by cultural groups, such as urban and rural communities, worker groups, vocational classes, and children. Based on these perspectives, in this study it is defined as the explicit or implicit mathematical knowledge that can be discovered in the local culture of the community and students, and includes values, traditions, artifacts, textiles, games, and buildings, which can be expressed in a mathematical language that is consistent with the culture of the community. Figure 2 shows the fields of ethnomathematics in different societies.

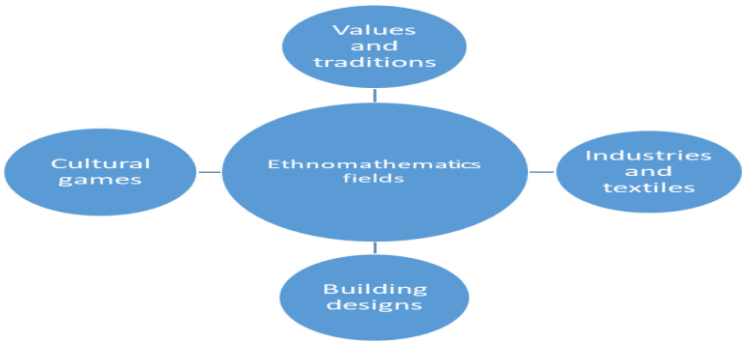

Figure 2
Fields of ethnomathematics in different societies

Ethnomathematics has three interrelated dimensions, practical, social, and cultural, related to the study of the social and cultural origins of mathematical knowledge (Albanese & Perales, 2015). According to Kurumeh, Onah, &Mohammed (2012), the method undertaken in ethnomathematics is as follows: learning and problem-solving are placed in the real-life context, rich in material-components information; learners are asked to relate the past to the present to construct the future; the teacher then explores learners' cultural experiences to build on their previous experiences and link them to their environmental benefits. Ethnomathematics seeks to humanize the classroom (Yeh et al., 2021). In the same vein, Zhang & Seah (2021) and Prastika & Abidin (2021) assert that mathematics education cannot be separated from the surrounding environment and the specific culture, nor is it separated from interactions among people.

As pointed out by Näslund-Hadley et al. (2022), there are many reasons for making use of ethnomathematics: it helps students better understand mathematics based on their own informal knowledge and culture; it enhances self-esteem and motivation to learn; it gives value to students' culture, improving their attitudes toward their cultural heritage; it gives students a sense of mastery, effectiveness, and self-confidence; and it improves learning in general. Legacies and artifacts implicitly include mathematical ideas that motivate students to learn mathematics and contribute to the formation of positive attitudes to school mathematics (Pradhan & Orey, 2021). Figure 3 shows the relations between cultural activities and school mathematics.

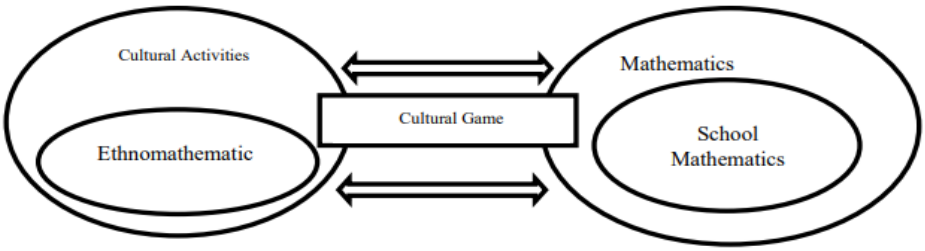

Figure 3
Relating cultural activities to mathematics (Pardhan, 2018: 199)

Studies have shown that ethnomathematics has numerous benefits, including helping students see the interrelationship between social and cultural contexts and content and teaching methods in school mathematics (Al-Mahdi, 2021). It also makes learning mathematics fun and brings students closer to their own culture (Prastika & Abidin, 2021). Learning mathematics becomes more interesting through engagement in familiar activities and daily interaction with the cultural environment. It helps in communicating mathematical ideas. Moreover, cultural games, which are among the ethnomathematics materials, stimulate the learning of mathematics, enable students to develop logical thinking to solve mathematical problems, reduce anxiety about mathematics, and link cultural activities and classroom activities (Pardhan, 2018a, 2018b; Putri & Zaenuri, 2022). It also improves the level of mathematical skills and reduces the gap in mathematical achievement (Näslund-Hadley et al., 2022). It develops mathematical communication (Kurniawan et al., 2019) and contributes to improving students' ability to solve mathematical problems (Irawan, Kencanawaty, & Febriyanti, 2018). It develops students' abilities in mathematical creative thinking and stimulates curiosity to learn mathematics (Saironi, 2022).

To integrate ethnomathematics into school mathematics, it is important for the teacher to have deep specialized knowledge, historical knowledge of mathematics, educational knowledge that helps the quality of integration, and knowledge of the culture of the surrounding environment and popular heritage, as shown in Table 1.

Table 1
Knowledge needed to integrate ethnomathematics in school mathematics topics

Basic knowledge for integrating ethnomathematics in teaching mathematical topics			
Specialized knowledge	Historical knowledge of mathematical concepts	Educational knowledge	Knowledge of students' community culture

Teachers should focus on reinforcing new mathematical knowledge related to cultural understanding by making use of the history of mathematics and community mathematics or inviting learners to use their cultural insights in learning mathematics (Sunzuma & Maharaj, 2020). Ethnomathematics can help teachers and students understand mathematics in the context of ideas, methods, and practices used in everyday life, which fosters an understanding of academic mathematics in schools (Kholid, Fitriana, Adnan, Hendriyanto, & Sahara, 2022).

Previous Studies

Previous studies have dealt with ethnomathematics in different ways. Some studies have focused teachers' knowledge, awareness, and perceptions, while others have addressed the consequences of its use. In addition, research has explored mathematical concepts in legacies, artifacts, and cultural games in different environments. Several relevant studies are reviewed in the following paragraphs.

Sunzuma & Maharaj (2020) undertook a mixed methods study aimed at identifying mathematics teachers' level of awareness of ethnomathematics methods in teaching geometry. They used questionnaires and focus group discussions to collect data from 40

teachers. They found that teachers defined ethnomathematics differently and that there were several obstacles to integrating ethnomathematics in teaching and learning: the teachers had limitations in terms of giving cultural examples, they failed to take into account cultural diversity, they were resistant to change, and they had negative attitudes. Mosimege & Egara (2022) examined teachers' perceptions and attitudes concerning the use of ethnomathematics, employing a survey to which 113 teachers responded. Their most important finding was that there was a low level of use of ethnomathematics by the teachers. They found no significant differences in the use of ethnomathematics attributable to the gender of the participants.

Irawan et al. (2018) implemented an educational program based on a combination of ethnomathematics and realistic mathematics and employed a one-group design experimental method. They found that integrating ethnomathematics and realistic mathematics played a role in improving students' abilities to solve mathematical problems. Sunzuma, Zezwkwa, Gwizangwe, & Zinyekeka (2021) aimed to compare learners studying the mathematics curriculum using the ethnomathematics method and those studying it using the traditional method. Most notably, the study found that the scores of students who studied mathematics using ethnomathematics were much higher than those of the group who followed the traditional method, and that ethnomathematics played a role in improving students' understanding and learning retention.

Gk & Parhmana (2019) aimed to show the relationship between mathematics and culture by exploring the activities of cultural festivals that contain mathematical concepts. They employed ethnographic methodology and used observation and interviews to collect data. They concluded that there is a set of mathematical concepts in cultural festivals, such as the circumference of the circle and the Pythagorean theorem. Noto, Firmasari, & Fatchurohman (2018) aimed to identify mathematical knowledge in relation to ancient wells and the process of mathematical thinking in making wells. The qualitative study concluded that many mathematical aspects are related to what is taught in schools.

Study Importance

The study focuses on an important trend in the field of teaching and learning mathematics, namely ethnic mathematics, which emphasizes the importance of linking school mathematics topics to the students' culture and society. The study addresses the teachers' knowledge of ethnic mathematics, how it is incorporated in teaching, the teacher's attitudes toward it, and the obstacles that teachers face in implementing the ethnic mathematics approach in class. Moreover, it focuses on the teacher as a principal element in the teaching and learning process. Methodologically, the study used different tools to attain an in-depth understanding.

Conceptual Framework

The study investigated the ethnomathematics approach, which is based on social constructivist theory and emphasizes the importance of cultural connections in learning. It considers several interrelated aspects, the integration of which in teaching school mathematics topics can help achieve the desired goals. The study started by measuring teachers' knowledge of the ethnomathematical approach, as knowledge is a principal

requirement for teaching quality. In addition, it measured teachers' perceptions of this approach, as perceptions affect teaching practices, and one of the dimensions of the study concerned measuring the level of practices consistent with ethnomathematics. The study concluded by examining the obstacles that limit integration, which are related to many influential aspects of teaching and learning mathematics (teachers, students, content, evaluation).

Study Problem

There are many modern trends in the field of mathematics teaching, including ethnomathematics, which emphasizes the need to link the student to the local culture. Teachers require considerable experience to assimilate these. Fernandes and Pugalee (2022) point to the importance of training for teachers in teacher preparation programs, as well as planning teaching design in light of the fundamentals of ethnomathematics. Mosimege & Egara (2022), Al-Mahdi (2021), and Kholid et al. (2022) all recommend integrating ethnomathematics in teaching mathematics and educational materials and training teachers to enhance their capabilities in cultural knowledge as this will help support and enrich student learning. They also highlight the importance of including social and cultural dimensions in teacher preparation programs and in-service professional development, and of teachers having a clear understanding of these dimensions. Moreover, the integration of social issues in learning mathematics helps students to raise and solve problems (Türkkan & Karakuş, 2021).

Kurniawan et al. (2019) have argued the importance of integrating local culture in mathematics education so that students can easily understand. They also recommend conducting research in the field of ethnomathematics education. Likewise, Kolluri & Edwards (2023) stress the scarcity of ethnic studies and the need to extend the research base. Moreover, the researcher's experience in the field of teaching mathematics showed a lack of knowledge among teachers and educational supervisors of many modern trends, including ethnomathematics, as well as deficiencies in integrating the approach in teaching school mathematics topics. As a preliminary step prior to understanding the study, the researcher conducted a survey with a sample of 104 mathematics teachers at different stages of schooling to establish the current status of the integration of ethnomathematics in teaching school mathematics topics. The results are reported in Table 2.

Table 2
Results of an exploratory study of the integration of ethnomathematics in teaching school mathematics topics

Aspect of study	Survey result
Knowledge of ethnomathematics	85% of the supervisors and teachers of mathematics indicated that their knowledge of ethnomathematics is between medium to absent (they do not have any previous knowledge)
Integration of ethnomathematics in teaching	More than 50% of mathematics teachers indicated that their level of integration, after clarifying the concept, is between rare and lacking.
Perceptions of ethnomathematics	Teachers find that inclusion is difficult even though they are convinced of the importance of the approach in improving mathematical achievement.

Based on the aforementioned starting points and justifications, this study aimed to provide a holistic picture of the integration of ethnomathematics in teaching school mathematics topics by examining the level of teachers' knowledge, the extent of integration of ethnomathematics in teaching, their perceptions of such integration, and the most prominent obstacles to incorporating ethnomathematics. The study sought to answer the following questions:

RQ1: What is the level of teachers' knowledge of ethnomathematics?

RQ2: To what extent is ethnomathematics integrated in teaching school mathematics topics?

RQ3: What are teachers' perceptions concerning the integration of ethnomathematics in school mathematics topics?

RQ4: What are the obstacles that limit the integration of ethnomathematics in school mathematics topics?

RQ5: Are there statistically significant differences at the significance level of $\alpha \leq 0.05$ in the level of teachers' knowledge of ethnomathematics and the integration of ethnomathematics in school mathematics topics attributable to the variables of gender, teaching experience, and teaching stage?

RQ6: What are the participants' opinions about integrating ethnomathematics in school mathematics topics?

METHOD

The study used mixed methods, which Creswell (2014) defines as combining quantitative and qualitative data in a single study. It employed an explanatory sequential design, which entails collecting quantitative data first, then collecting qualitative data to interpret the results of the quantitative study. The study collected quantitative data through the descriptive survey method, using an electronic questionnaire with 33 items addressing the 4 study dimensions. Each section of the questionnaire was followed by an open-ended question to identify the reasons underpinning the teachers' attitudes and provide insight into their responses. Then, qualitative interviews aimed to determine the reasons for the quantitative results. Figure 4 shows the design of the study.

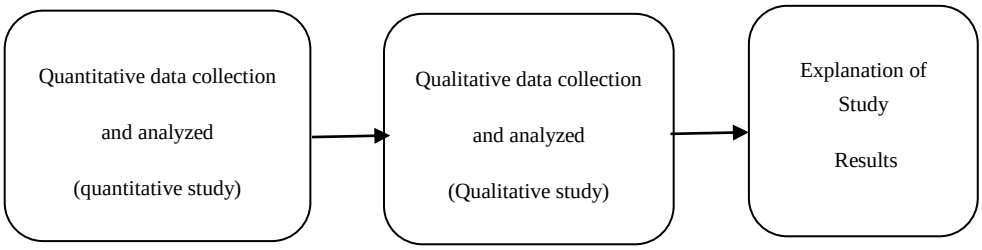

Figure 4
Scheme of the mixed methods study procedures (Explanatory Sequential Design)

Study Population and Sample

The study population comprised 168 male and female mathematics teachers in Saudi Arabia, of whom 104 participated in the questionnaire, representing 61.9% of the study population. The participants' characteristics are shown in Table 3.

Table 3
Distribution of sample according to study variables

Variable	Category	N	Percentage
Gender	Male	61	58.7
	Female	43	41.3
Teaching experience	≤ 10 years	70	67.3
	> 10 years	34	32.7
Teaching stage	Primary	53	50.9
	Intermediate	35	33.7
	Secondary	16	15.4

Study Instruments

Questionnaire

The study used an electronic questionnaire as a data collection instrument, built drawing on the work of Suzuma and Maharaj (2020) and Mosimege and Egara (2022). It consisted of four parts: (i) introduction to the study; (ii) participants' demographic information; (iii) items covering the study dimensions, (iv) open-ended questions. The study dimensions covered the teachers' level of knowledge of ethnomathematics (5 statements), the level of integration of ethnomathematics in teaching mathematics (6 statements), teachers' perceptions of ethnomathematics (10 statements), and obstacles limiting the integration of ethnomathematics (12 statements). The open-ended questions, aimed at collecting qualitative data, were as follows:

1. From your point of view, what are the appropriate methods and procedures for developing teachers' knowledge of the ethnomathematics approach?
2. From your point of view, what are the appropriate measures to improve the previous teaching practices of male and female teachers of mathematics?
3. What are the reasons for your identification of the responses to the axis of mathematics teachers' perceptions of the integration of ethnomathematics when teaching mathematical knowledge?
4. From your point of view, are there other obstacles? What solutions do you propose to overcome the obstacles you face?

At the end, there was also a space for mathematics teachers to express their opinions freely about the content of the study axes or add what they saw fit:

Because the opinions of mathematics teachers are important, here is a free (optional) space where teachers can write what they see as important and related to the topic, such as the reasons for their responses, solutions, other challenges, etc.

Distribution of Response Categories

Due to the diversity of the dimensions of the scale and the importance of choosing responses commensurate with the dimensions, two Likert-type scales were used

depending on the item type, one with three response options and the other with four response options. Table 4 shows the distribution of categories.

Table 4
Distribution of categories for likert-type scale responses

Three-point scale	Mean range	Four-point scale	Mean range
Agree	2.41–3.00	High	3.26–4.00
Neutral	1.67–2.40	Average	2.51–3.25
Disagree	1–1.66	Low	1.76–2.50
		Very low	1–1.75

The validity of the questionnaire was verified through a review by a group of professors of curricula and teaching methods of mathematics and a group of educational supervisors and teachers. Based on their opinions, some statements were rephrased, some statements were modified, and the statements for which the rate of agreement among reviewers was 90% and above were approved. The reliability of the instrument was verified using Cronbach's alpha, which was applied to a pilot sample to establish internal consistency. The results are shown in Table 5.

Table 5
Cronbach's alpha reliability coefficients

Dimension	No. of statements	α
First dimension: Level of knowledge of ethnomathematics	5	.760
Second dimension: Level of ethnomathematics integration when teaching school mathematics topics	6	.873
Third dimension: Teachers' perceptions of ethnomathematics.	10	.800
Fourth dimension: Obstacles limiting the integration of ethnomathematics	12	.878
Reliability coefficient of the tool as a whole	33	.864

Interviews

Individual interviews were conducted with four mathematics teachers who responded to the questionnaire to discuss in greater depth the open-ended questions in the fourth part of the questionnaire. The characteristics of the teachers are provided in Table 6.

Table 6
Participants in qualitative interviews

Code	Experience	Teaching stage	Degree qualification
AH	More than 10 years	Intermediate	Master's (doctoral student)
SH	More than 10 years	Intermediate	Master's
ML	More than 10 years	Primary	Bachelor's
ZN	More than 10 years	Primary	Bachelor's

Credibility and Dependability

The study focused primarily on the quantitative data, employing the qualitative component of the research to provide a fuller picture and enhance the validity of the results. Given the nature of qualitative research and the specificities of each study, various standards and strategies can be applied to ensure its quality (Yadav, 2021). To assure credibility and dependability in the study, the researcher followed several procedures. First, he adopted the technique of detailed writing regarding qualitative

data, including the instruments used, the questions, and how they were answered and analyzed, as well as a description of the participants. The tools for collecting qualitative data included open-ended questions in the electronic questionnaire and an interview with four participants. The questionnaire items were also presented for review by experts in the field of mathematics education and with experience of ethnomathematics. Diversity was taken into account by selecting participants representative of the context in terms of gender, teaching stage, and teaching experience. The analysis was reviewed several times.

Ethical Considerations

The researcher explained the aim of the study in detail and participation was optional. Moreover, the open-ended questions in the electronic questionnaire were optional and not binding, unlike the quantitative items. Participation in the interviews was also voluntary and the participants could determine what they wanted to communicate. The researcher carefully considered the appropriate duration of interviews, the participants were free to express their views and answer questions without constraint and could ask for clarification in the case that a question was not clear.

Study Context

The qualitative data were collected in two ways. First, there were open-ended questions in the questionnaire, giving participants the opportunity to respond freely without any influence or constraint. Moreover, answering the qualitative questions was optional. Second, individual interviews were conducted focusing on the same open-ended questions to allow additional space for responses. The interviews lasted 15–20 minutes. Table 7 presents the instruments and mechanisms for collecting qualitative data and the number of participants.

Table 7
Description of instruments and mechanisms for collecting qualitative data

Instrument	Application stage	No.	Description
Electronic questionnaire	First (in conjunction with quantitative questions)	23	Open-ended questions on each dimension of the quantitative study
Individual interview	Second (after the quantitative study)	4	Open-ended questions based on the quantitative study

Data Analysis Methods

To analyze the quantitative data, the SPSS program was used, and the following measures were employed: arithmetic mean, standard deviation, independent samples *t*-tests, and one-way analysis of variance (ANOVA). To analyze the qualitative data, deductive analysis was used.

FINDINGS

To answer the first question concerning the teachers' level of knowledge of ethnomathematics, the arithmetic means and standard deviations were calculated for the statements in the questionnaire, as shown in Table 8.

Table 8
Teachers' knowledge of ethnomathematics

No.	Statement	*M*	*SD*	Level of agreement
1	My level of knowledge of ethnomathematics	2.30	.888	Low
2	My level of knowledge of the historical development of the mathematical concepts I teach	2.92	.692	Medium
3	My level of knowledge of cultural heritage, resources and games related to school mathematics topics	2.79	.649	Medium
4	My level of knowledge of the local culture of my student community	3.36	.667	High
5	My level of knowledge of appropriate educational methods for integrating ethnomathematics into the topics I teach	2.73	.791	Medium
Overall		2.82	.737	Medium

Table 8 shows that the overall mean for the level of male and female teachers' knowledge of ethnomathematics was 2.82, i.e., average. The statement "My level of knowledge of the local culture of my student community" had the highest mean (3.36), while the statement "My level of knowledge of ethnomathematics" had the lowest (2.30).

Table 9 presents the means and standard deviations for responses to the second research question concerning actual use of ethnomathematics when teaching school mathematics topics.

Table 9
Actual integration of ethnomathematics in class

No.	Statement	*M*	*SD*	Frequency
1	I refer to the historical development of mathematical concepts	3.08	.797	Sometimes
2	I relate mathematical concepts to the surrounding culture of my students	3.50	.591	Always
3	I use the games and cultural resources of my student community when teaching mathematical subjects	3.08	.821	Sometimes
4	I motivate my students to discover the mathematical knowledge that they study in their own environment and culture	3.07	.775	Sometimes
5	I take into account the traditions and values of the community when designing mathematical activities and problems	3.05	.776	Sometimes
6	I show my students the role of mathematics in serving humanity	3.56	.587	Always
	Overall	3.22	.725	Sometimes

Table 9 shows that in general the integration of ethnomathematics in teaching school mathematics topics was average (M = 3.22) and happened "sometimes." The statement "I show my students the role of mathematics in serving humanity" had the highest mean (3.56) at the level of "always," while the statement "I motivate my students to discover the mathematical knowledge that they study in their own environment and culture" had the lowest (3.07) at the level of "sometimes."

The means and standard deviations for teachers' responses to the third question concerning their perceptions about integrating ethnomathematics in school mathematics topics are presented in Table 10.

Table 10
Teachers' perceptions of the integration of ethnomathematics in class

No.	Statement	*M*	*SD*	Level of agreement
1	I can use environmental resources to teach mathematical concepts	2.79	.410	Agree
2	Ethnomathematics helps in the practical application of the mathematics knowledge that I teach	2.67	.471	Agree
3	Ethnomathematics helps develop students' awareness of the importance and usefulness of mathematics	2.77	.423	Agree
4	There is a scarcity of environmental resources that match the topics I teach	2.55	.637	Agree
5	It is difficult to integrate ethnomathematics because it does not cover many of the topics I teach	2.23	.611	Neutral
6	The integration of ethnomathematics contributes to the development of academic achievement	2.49	.623	Agree
7	The integration of ethnomathematics contributes to the development of the attitude towards learning mathematics	2.62	.563	Agree
8	Integrating ethnomathematics helps students take pride in their own culture	2.70	.519	Agree
9	Teaching in the light of ethnomathematics contributes to deepening the teacher's knowledge of mathematical content	2.64	.501	Agree
10	Teaching in the light of ethnomathematics depends on the teacher	2.36	.637	Neutral
	Overall	2.58	.596	Agree

As shown in Table 10, the teachers' perceptions about integrating ethnomathematics in teaching school mathematics topics were positive overall (M = 2.58), signifying "agree" with statements concerning its benefits. The statement "I can use environmental resources to teach mathematical concepts" had the highest mean (2.79) at the "agree" level, while the statement "It is difficult to integrate ethnomathematics because it does not cover many of the topics I teach" had the lowest (2.23) at the "neutral" level.

The fourth research question addressed the obstacles to the integration of ethnomathematics in school mathematics topics. The teachers' responses are presented in Table 11. As can be seen, the teachers were "neutral" overall concerning the obstacles to integrating ethnomathematics when teaching school mathematics topics (M = 2.23). The statement "Students believe that mathematics has limited usefulness in everyday life" had the highest mean (2.58), at the "agree" level, while the statement "The teacher fails to change the style and method of teaching" had the lowest (1.94), at the "neutral" level.

Table 11
Obstacles hindering the integration of ethnomathematics in class

No.	Statement	*M*	*SD*	Level of agreement
1	*The Teacher Handbook* does not contain specific directions and aids for incorporating ethnomathematics when teaching school mathematics topics	2.32	.754	Neutral
2	Lessons in the *Student Book* do not include activities related to ethnomathematics	2.13	.746	Neutral
3	The Mathematical Achievement Assessment does not allow (does not include) the addition of ethnomathematics-related tasks (questions)	2.14	.674	Neutral
4	The teacher fails to change the style and method of teaching	1.94	.722	Neutral
5	The teacher lacks knowledge of the ethnomathematics approach	2.10	.704	Neutral
6	Students lack interaction with the cultural activities of their community	2.36	.749	Neutral
7	The teacher is deficient in knowing the culture of their students' society	1.95	.742	Neutral
8	There is a deficiency in discovering mathematical concepts from the cultural resources and activities associated with the students' environment	2.17	.730	Neutral
9	Families and students have negative attitudes towards learning mathematics	2.50	.639	Agree
10	There is a deficiency in professional development programs dealing with modern trends in the field of teaching and learning mathematics	2.20	.729	Neutral
11	Students believe that mathematics has limited usefulness in everyday life	2.58	.602	Agree
12	Integration of ethnomathematics requires a lot of effort and time	2.42	.649	Neutral
	Overall	2.23	.704	Neutral

To address the fifth research question, the following hypothesis was posed:

There are no statistically significant differences at the level of significance $\alpha \leq 05$ in the level of knowledge of ethnomathematics and the integration of ethnomathematics in school mathematics topics attributable to the variables of gender, teaching experience, and teaching stage.

The hypothesis was tested using *t*-tests and one-way ANOVA. Tables 12 and 13 present the results. Table 12 shows the results of *t*-tests and indicates that there are no statistically significant differences in knowledge of ethnomathematics or the integration of ethnomathematics attributable to gender or teaching experience. This means accepting the null hypothesis that "there are no statistically significant differences at the level of significance $\alpha \leq 0.05$ in the level of knowledge of ethnomathematics and the integration of ethnomathematics in school mathematics topics attributable to the variables of gender and teaching experience."

Table 12
Results of *t*-tests for differences in the dimensions of knowledge and integration of ethnomathematics attributable to the variables of gender and teaching experience

Dimension	Variable	Category	*N*	*M*	*SD*	*p*	Sig.
Knowledge of ethnomathematics	Gender	Male	61	14.44	2.76	.112	Not significant
		Female	43	13.60	2.42		
	Teaching experience	1–10 years	70	14.00	2.61	.597	Not significant
		> 10 years	34	14.29	2.75		
Integration of ethnomathematics while teaching	Gender	Male	61	19.77	3.66	.072	Not significant
		Female	43	21.00	2.97		
	Teaching experience	1–10 years	70	20.27	3.44	.975	Not significant
		> 10 years	34	20.29	3.47		

Table 13
Results of one-way ANOVA for differences in knowledge and integration of ethnomathematics attributable to teaching stage

Dimension		Sum of Squares	Df	Mean Square	*F*	*p*
Knowledge of ethnomathematics	Between groups	20.659	2	10.329	1.490	.230
	Within groups	700.380	101	6.934		
	Total	721.038	103			
Integration of ethnomathematics in teaching	Between groups	23.445	2	11.722	.995	.373
	Within groups	1189.469	101	11.777		
	Total	1212.913	103			

Table 13 shows no statistically significant differences in knowledge of ethnomathematics ($F(2, 101) = [1.490]$, $p = .230$) or the integration of ethnomathematics attributable to teaching stage ($F(2, 101) = [.995]$, $p = .373$), which means accepting the null hypothesis that "there are no statistically significant differences at the level of significance $\alpha \leq 0.05$ in the level of knowledge of ethnomathematics and the integration of ethnomathematics in school mathematics topics attributable to the variable teaching stage.

Qualitative Results

The qualitative follow-up interviews covered four key topics. The results are reported in the following paragraphs.

I. Developing Teachers' Knowledge of Ethnomathematics

The first topic in the qualitative analysis addressed the teachers' theoretical and applied knowledge of the concept of ethnomathematics. In general, there was agreement among

most male and female teachers that their knowledge of the ethnomathematics approach did not rise to the level hoped for having been familiarized with it through the study. As Participant AH noted, “The term is completely new and I haven't heard of it before.” This was also the case for Participant ZN, who said “It's actually the first time I hear about ethnomathematics.” During discussions with the teachers about how to develop knowledge of ethnomathematics, they proposed holding workshops and training courses on the topic. Moreover, Participant SH suggested "It is preferable to add lessons related to ethnomathematics explicitly within the textbook." Some teachers also mentioned making leaflets and video clips drawing on reliable sources to introduce modern trends in the field of teaching and learning mathematics.

II. Integrating Ethnomathematics in School Topics

The second topic focused on the teaching practices used by teachers when incorporating ethnomathematics in teaching and their proposals for improving these. Having clarified the general idea of the ethnomathematics approach, some teachers could see that in some cases their teaching addressed ideas consistent with the concept of ethnomathematics, even though they were not previously aware of the concept. For example, Participant AH said "It is natural that I take into account the values, traditions and customs of the community where I teach," and Participant ML reported “I respect the local culture of my students in every lesson and ensure activities and attitudes are consistent with the culture of the surrounding community.”

In terms of how to improve teaching practices to integrate ethnomathematics more fully in the teaching of mathematics topics, there was agreement on the importance of holding training courses that included examples of application in lessons to ensure the quality of implementation. One of the participants pointed out the importance of designing educational experiences that apply ethnomathematics as a model for teachers that can be simulated. There was also agreement on the importance of knowing the cultural resources and games that could be used appropriate to the stage of schooling, and of making an effort to discover mathematical knowledge in cultural legacies and resources.

III. Reasons for Teachers' Perceptions of Ethnomathematics Integration

The third topic concerns the reasons that prompted the participants to take certain positions on the statements in the section on teachers’ perceptions in the questionnaire. This came after the two sections on knowledge and the level of integration, gave a good general overview of perceptions concerning ethnomathematics. Their justifications varied. Most teachers reported that they chose “neutral” because of their insufficient knowledge of the ethnomathematics approach and it was this study that clarified the concept for them. For instance, Participant SH stated “my limited knowledge of ethnomathematics” as the reason and Participant ML noted “I do not have sufficient background on the subject.” Participant AH justified his position by saying “I projected the statements on my teaching performance because I had been observing the ideas of ethnomathematics before I knew the concept. I practice this without concentration." In contrast, there was another teacher who believed that his previous knowledge of

ethnomathematics and his earlier reading on the topic made his position positive in many respects.

IV. Obstacles to the Integration of Ethnomathematics

The fourth topic addressed the most prominent obstacles to the integration of ethnomathematics in class related to students and teachers. There was broad agreement that a lack of motivation among students for learning mathematics and a lack of interest on the part of families were among the most prominent obstacles to the integration of ethnomathematics. Also, some teachers believed that their lack of knowledge of ethnomathematics prevented it from being well integrated in mathematics topics, and that integration required effort, time, and consideration. In this vein, Participant AH said, "We need to get acquainted with the modern trends in teaching and learning mathematics and how to implement them." He added, "I think that one of the biggest challenges is the lack of teachers' knowledge of the current generation of the culture of the previous generation."

DISCUSSION

The results of this study demonstrate that the level of teachers' knowledge of ethnomathematics was generally medium, and the level of their knowledge of the concept of "ethnomathematics" was low. This is consistent with the results of the qualitative analysis, as most teachers confirmed they were not sufficiently familiar with the term. The findings are in line with the studies of Mosimege and Egara (2022) and Sunzuma and Maharaj (2020), which indicated that the concept of ethnomathematics is new to teachers, and there are discrepancies and differences in teachers' definition of the concept. This is because development programs lack components dealing with modern trends in teaching mathematics and focus instead on general precepts.

Moreover, the level of integration of ethnomathematics in teaching school topics was generally middling, with some aspects being included "sometimes"; that is, aspects of ethnomathematics are not well embedded in teaching. In general, there is agreement between the results of the quantitative and qualitative elements of the study, as the teachers confirmed in the interviews that they had been practicing some ideas of ethnomathematics without knowing it, only hearing of the concept during the study. The results of this study differ from those of Mosimege and Egara (2022), which could be attributed to several reasons. First, the diverse concepts related to trends in teaching mathematics are not necessarily distinct from each other in content; rather, there may be many points of agreement in terms of the main ideas and the lack of integration may be due to a lack of knowledge of the concept. Indeed, the lack of training programs and applications dealing with how to integrate ethnomathematics confirms this. Register et al. (2022) have highlighted the importance of teacher training in planning and teaching design to promote ethnomathematics.

As for teachers' perceptions when it came to integrating ethnomathematics, they were generally positive, indicated by their agreement with most of the positive statements. This also reflects the findings of Kholid et al. (2022) that teachers have positive perceptions of ethnomathematics. The statement related to the difficulty of integrating

ethnomathematics because it did not cover most of the lessons was rated “neutral”. This result is consistent the findings from the interviews, in which the participants reported they had insufficient knowledge of the concept. In contrast with the study of Mosimege and Egara (2022), this study found the teachers perceived that ethnomathematics contributes to the development of mathematical achievement and positive attitudes toward learning mathematics, in line with the studies of Irawan et al. (2018) and Sunzuma et al. (2021), who also highlighted the role of ethnomathematics in enhancing students' ability to solve problems. The teachers held the conviction that it is important to link ethnomathematics to the daily life and culture of the learner in studying school mathematics topics.

With regard to the obstacles that limit the integration of ethnomathematics, opinions varied. However, there was agreement that the negative attitude of students toward mathematics and their vision of its limited usefulness in daily life were the biggest obstacles. In terms of the teacher, they were broadly “neutral,” unlike those in Sunzuma and Maharaj’s (2020) study, which found that teachers’ negative attitudes and their resistance to change were the most important obstacles to integration.

Finally, the study found no statistically significant differences in the knowledge of ethnomathematics and the level of its integration in teaching school mathematics topics attributable to the study variables of gender, teaching experience, and teaching stage. This may be attributed to the fact that all teachers receive the same professional development programs. Moreover, these programs are general and do not focus on modern trends and concepts in teaching and learning mathematics.

CONCLUSIONS

The study results indicate that mathematics teachers have positive attitudes toward ethnic mathematics and an awareness of the value of integrating it when teaching school mathematics subjects. They see the importance of linking mathematics to students’ local culture and of both the teacher and the student understanding the culture of the surrounding community. However, teachers’ knowledge of ethnic mathematics and how it might be practiced in the classroom environment did not reach the desired level. Therefore, there is a need to educate teachers about this approach and how to integrate it in the classroom, thus enabling and training them to extract mathematical knowledge from the students’ surrounding environment. It is also important recognize the challenges teachers face in applying ethnomathematics, which are typically related to the teacher, the family, and the student, and address these.

RECOMMENDATIONS

The results of the study illustrate the significance of ethnomathematics for the educational field. Future studies are needed to develop appropriate training for teachers on ethnomathematics and its application in their own environments. In addition, it is important to hold meetings and workshops to educate teachers about ethnomathematics, and to conduct professional development programs in the same field. Moreover, qualitative and quantitative research could be undertaken to determine teachers' beliefs about the value of integrating ethnomathematics in teaching, the extent of their

competence in integrating ethnomathematics in class, and the effect of integrating ethnomathematics on performance and affective variables, such as productive desire, productive struggle, mathematical self-esteem, and confidence in mathematics.

LIMITATIONS

The first part of the study used an electronic questionnaire as a tool for collecting quantitative and qualitative data and obtained responses from 104 male and female teachers from different school stages. A larger sample would have been beneficial to improve the validity and reliability of the results. In addition, of the respondents, only a limited number answered the open-ended questions as these were optional. In the second part of the study, only four participants expressed their consent to participate in interviews; greater participation might have yielded a wider range of views and been more representative of the study population.

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