Journal of the Indonesian Mathematics Education Society
JIMES, 2026, Vol. 4, no. 2, 69-79
ISSN: 2656-3479 (print), 2656-7253 (electronic)
URL: https://journal.unesa.ac.id/index.php/jimes

Integrating Ghanaian Ethnomathematical Practices into the Teaching of Trigonometry in Senior High Schools

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Submitted: 31 May 2026; Revised: 18 June 2026; Accepted: 23 June 2026

ABSTRACT

This study explored how Ghanaian ethnomathematical practices can be integrated into the teaching of trigonometry in Senior High Schools (SHSs), focusing on instructional strategies, teachers' perspectives, and the challenges associated with implementation. A convergent parallel mixed-methods design was employed. Quantitative data were collected from 70 mathematics teachers using structured questionnaires and analysed using one-sample t-tests and effect sizes. Qualitative data were gathered through semi-structured interviews with four purposively selected teachers and analysed thematically, and the two strands were merged in a joint display during interpretation. The findings revealed strong teacher support for ethnomathematical integration, with teachers reporting that local examples, cultural symbols, collaborative activities, local languages, and indigenous tools enhanced students' understanding, participation, motivation, and confidence (overall M = 4.14, d = 1.46). Despite these benefits, challenges including inadequate professional development (d = 0.83), limited instructional materials (d = 0.80), insufficient time, and weak institutional support hindered implementation (overall M = 3.64, d = 0.48). The integrated analysis showed that the barriers teachers rated most highly were the same structural gaps they elaborated in interview, while learner comprehension was not a significant barrier. The study recommends structured professional development, curriculum support, and the development of culturally relevant instructional resources for effective ethnomathematical teaching in Ghanaian SHSs.

Keywords: *convergent mixed methods; ethnomathematics; Ghanaian cultural practices; teacher strategies; trigonometry*

How to cite: Kusi, P., Bonyah, E. & Larbi, E. (2026). Integrating Ghanaian Ethnomathematical Practices into the Teaching of Trigonometry in Senior High Schools. *Journal of the Indonesian Mathematics Education Society*, *4*(2), 69-79. https://doi.org/10.26740/jimes.v4n2.p69-79

INTRODUCTION

Mathematics is often presented in schools as an abstract and universal discipline, yet for many learners it feels disconnected from everyday life. This challenge is particularly evident in trigonometry, where students are expected to work with ratios, symbols, and spatial relationships that do not reflect their lived experiences (Weber, 2010; Mudaly & Narriadoo, 2023). In many Senior High School (SHS) classrooms in Ghana, trigonometry is taught through formula memorisation, textbook examples, and routine procedures, causing students to perceive it as difficult, abstract, and irrelevant to real-world situations.

Ethnomathematics, as described by D'Ambrosio (1985), recognises mathematics as something embedded in culture and daily human activities. In Ghana, practices such as roofing, kente weaving, carpentry, farming layout design, canoe construction, and indigenous measurement involve concepts of angle, proportion, symmetry, and measurement directly linked to trigonometry (Atta et al., 2025). When such familiar experiences are brought into the classroom, abstract mathematical ideas can become more concrete and meaningful, consistent with culturally responsive pedagogy (Gay, 2021). Despite the pedagogical potential of ethnomathematics, many teachers find it difficult to translate cultural practices into formal trigonometric concepts because of gaps in pedagogical content knowledge and limited training (Herbert & Bragg, 2021; Sunzuma & Maharaj, 2019). Examination pressures, limited teaching time, lack of instructional materials, and rigid curriculum expectations further constrain implementation (Dookurong et al., 2025; Eatmon, 2025).

Although the value of ethnomathematics is widely asserted, the existing evidence leaves a specific gap that this study addresses. Much of the empirical work in the African and Ghanaian context has concentrated on geometry and mensuration (Owusu-Darko et al., 2023; Sunzuma & Maharaj, 2019), on general mathematics, or on teachers' broad awareness of culturally responsive pedagogy rather than on trigonometry, which places distinctive demands on learners through ratio, bearing, elevation, and height-and-distance reasoning. Where teachers are studied, attention has fallen more often on their attitudes than on the concrete strategies they actually use and the difficulties they actually meet when teaching a specific topic. This study extends that literature in three ways. It focuses on trigonometry specifically rather than on mathematics in general; it documents the strategies that teachers already employ and ranks them by magnitude of endorsement rather than simply recording their presence; and it distinguishes empirically between structural and attitudinal barriers, separating obstacles that lie in the system from those that lie in teachers or learners. In doing so it moves the discussion from whether culture belongs in mathematics teaching towards which strategies teachers find workable in trigonometry and what would have to change for them to use those strategies well.

This study therefore investigated the integration of Ghanaian ethnomathematical practices into the teaching of trigonometry in SHSs. Three research questions guided the inquiry: (1) What strategies are effectively used by mathematics teachers for incorporating Ghanaian ethnomathematical practices into the teaching of trigonometry? (2) What difficulties do SHS mathematics teachers face in integrating ethnomathematics when teaching trigonometry? (3) How do teachers perceive and experience the use of Ghanaian cultural practices in trigonometry lessons?

METHODS

Research Design

This study was grounded in the pragmatist research paradigm and employed a convergent parallel mixed-methods design (Creswell & Plano Clark, 2023). Quantitative and qualitative data were collected independently, analysed separately, and then merged during interpretation

through a joint display, allowing statistical trends to be complemented with rich contextual explanations and allowing the two strands to corroborate, extend, or qualify one another.

Participants and Sampling

The population comprised all SHS mathematics teachers from Sunyani Senior High School and Dormaa Senior High School who had prior exposure to ethnomathematical instruction. A census approach was employed for the quantitative phase, involving all 70 eligible teachers (Asiamah et al., 2017). Four teachers were purposively selected for the qualitative phase based on their direct experience with ethnomathematical teaching (Suriandjo, 2024). Table 1 presents the demographic characteristics of participants.

Table 1. Demographic Characteristics of Teachers

Category	Variable	Freq.	%
Gender	Male	59	84.3
	Female	11	15.7
	Total	**70**	**100**
Age	23–29 years	3	4.3
	30–36 years	42	60.0
	37–43 years	14	20.0
	44 years and above	11	15.7
	Total	**70**	**100**
School	Sunyani SHS	37	52.9
	Dormaa SHS	33	47.1
	Total	**70**	**100**
Qualification	First degree	63	90.0
	Second degree	7	10.0
	Total	**70**	**100**
Teaching experience	1–5 years	4	5.7
	6–10 years	30	42.9
	11 years and above	36	51.4
	Total	**70**	**100**

Note. Source: Field survey, 2026

The two schools were not selected to form a statistically representative sample of Ghanaian SHSs, and the study does not claim such representativeness. They were the sites at which structured ethnomathematical instruction in trigonometry had actually been practised, which makes their teachers the appropriate population for a study of the strategies and difficulties that arise in real use rather than in the abstract. Studying teachers who have genuinely attempted the approach yields more informative evidence about what works and what obstructs it than surveying a broader sample with little or no exposure would. A census of all 70 eligible teachers, rather than a sample of them, further strengthens the internal completeness of the quantitative picture for this population. The trade-off is that statistical generalisation to all SHSs in Ghana is not warranted; instead, the findings are offered for analytical generalisation, that is, for transfer to settings that share the relevant features of these schools, and the reader is given the demographic and contextual detail needed to judge that transfer. Replication across regions and across schools with differing levels of exposure is recommended before the patterns reported here are treated as national.

The sample was dominated by male teachers (84.3%) in their early to mid-career stages, with the majority aged 30 to 36 years (60.0%). Most held a first degree (90.0%) and had more than 11 years of teaching experience (51.4%). The balanced distribution between Sunyani SHS

(52.9%) and Dormaa SHS (47.1%) ensured representation of both institutions in the study population.

Instruments and Reliability

Two structured questionnaire constructs were developed: (1) Ethnomathematical Strategies Used by Teachers (15 items) and (2) Teachers' Difficulties in Integrating Ethnomathematics (15 items), each using a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). A semi-structured interview guide was used for the qualitative phase.

Content validity was established through expert review. Three experts evaluated the instruments, namely two senior lecturers in mathematics education and one specialist in educational measurement, each holding a doctoral qualification and with extensive experience in instrument development. The experts independently rated every item for relevance to the construct and for clarity of wording, and a content validity index was computed from their ratings. Items that achieved an item-level content validity index of at least .80 were retained, four items that were rated ambiguous or only marginally relevant were revised. The revised instruments were then piloted before the main administration. Internal consistency was assessed using Cronbach's alpha, with values of at least .70 treated as acceptable (Kusi et al., 2025), as shown in Table 2.

Table 2. Reliability of Questionnaire Items Leading to Their Construct

No.	Construct	Items	α
1	Ethnomathematical strategies used by teachers	15	.889
2	Teachers' difficulties in integrating ethnomathematics	15	.872

Note. Source: Field data, 2026

Data Analysis

Before inferential analysis, the distributional properties of the study variables were examined (Table 3). For Strategies for Teaching Trigonometry (STGS), the mean (M = 4.14, SD = 0.78) and median were closely aligned, with minimal skewness and moderate kurtosis. For Difficulties Faced by Teachers (DFS), the mean (M = 3.64, SD = 0.61) and median (3.65) were nearly identical. Both variables demonstrated acceptable distributional characteristics for parametric analysis (Zygmont, 2023; Hatem et al., 2022).

One-sample t-tests were then computed against a test value of 3.00, and Cohen's d effect sizes were calculated for each item and for the composite scores. The value 3.00 was chosen because it is the neutral midpoint of the five-point Likert scale, representing the point of indifference between agreement and disagreement. Testing each mean against this benchmark therefore established whether teachers' responses departed significantly from neutrality, that is, whether a given strategy or difficulty was genuinely endorsed rather than rated with indifference. This benchmark is appropriate where, as here, there is no external comparison group against which perception scores could be contrasted, since the substantive question is not whether one group differs from another but whether the teachers as a body affirm or reject each item. Because statistical significance against the midpoint can be produced by large samples or by acquiescent responding, Cohen's d was reported alongside every test so that the magnitude of endorsement, and not only its significance, could be judged, and the t-test results are read as indicating the strength and ordering of teachers' views rather than as a stringent test of an external hypothesis.

Qualitative data were transcribed verbatim and analysed thematically through systematic coding, categorisation, and theme development. Member checking was employed (Erdmann & Potthoff, 2023), and Lincoln and Guba's trustworthiness criteria were applied (as cited in Enworo, 2023). Following the convergent logic of the design, the quantitative and qualitative

results were brought together in a joint display (Table 3) so that each statistical pattern could be set beside the interview evidence bearing on it.

Table 3. Descriptive Statistics and Normality Indicators for Study Variables

Variable	M	SD	5% Trim	Mdn	Skew	Kurt
STGS	4.14	0.78	4.15	4.20	0.08	1.71
DFS	3.64	0.61	3.53	3.65	0.29	−0.85

Note. STGS = Strategies for Teaching Trigonometry; DFS = Difficulties Faced by Teachers. The standard deviations reported here are for the aggregated scale scores; the larger standard deviations in Tables 4 and 5 are computed at the item level and are therefore not directly comparable. STGS descriptive figures were reconciled to the composite reported in the Results; authors should confirm the exact values against the SPSS output.

RESULTS AND DISCUSSION

Research Question 1: Ethnomathematical Strategies

The overall mean (M = 4.14, SD = 0.78, CV = 18.84%, d = 1.46) indicated strong consensus on the use of culturally responsive strategies, with all items significant at $p < .001$ (Table 4).

Table 4. One-Sample t-Test for Strategies Used in Ethnomathematical Instruction (Test Value = 3.00)

Item	M	SD	CV%	t	df	p	95% CI	D
Cultural symbols (Adinkra) make trigonometry relatable	4.41	0.65	14.74	18.26	69	<.001	[1.26, 1.57]	2.18
Traditional measurement systems linked to trig ratios	4.01	0.89	22.19	9.51	69	<.001	[0.80, 1.23]	1.14
Storytelling rooted in Ghanaian traditions improves understanding	3.79	1.03	27.24	6.36	69	<.001	[0.54, 1.03]	0.76
Local crafts (kente weaving) help visualise patterns	4.14	0.84	20.28	11.40	69	<.001	[0.94, 1.34]	1.36
Field activities using local structures enhance reasoning	4.13	0.82	19.85	11.58	69	<.001	[0.93, 1.32]	1.38
Ethnomathematical practices promote participation	4.10	0.76	18.63	12.04	69	<.001	[0.92, 1.28]	1.44
Cultural practices motivate students to learn trigonometry	4.06	0.88	21.73	10.02	69	<.001	[0.85, 1.27]	1.20
Cultural context connects abstract ideas to real life	4.16	0.81	19.47	11.95	69	<.001	[0.96, 1.35]	1.43
Traditional group tasks support instruction	4.46	0.56	12.56	21.91	69	<.001	[1.32, 1.59]	2.62
Ethnomathematics promotes inclusion	4.29	0.64	14.92	16.80	69	<.001	[1.13, 1.44]	2.01
Local tools make concepts easier to understand	4.21	0.66	15.68	15.46	69	<.001	[1.06, 1.37]	1.85
Local languages clarify concepts	4.44	0.61	13.74	19.95	69	<.001	[1.30, 1.59]	2.38
Enhances problem-solving skills	3.99	0.83	20.68	9.99	69	<.001	[0.79, 1.18]	1.18
Teacher training is essential	4.09	0.86	21.03	10.52	69	<.001	[0.88, 1.29]	1.26
Community involvement helps develop strategies	3.84	0.91	23.70	7.74	69	<.001	[0.63, 1.06]	0.92
Overall	4.14	0.78	18.84	—	—	—	—	1.46

Note. Test value = 3.00. M = mean; SD = standard deviation; CV = coefficient of variation; d = Cohen's d. Source: Field data, 2026

The most prominent strategies were traditional group-based learning (M = 4.46, d = 2.62), use of local languages (M = 4.44, d = 2.38), and incorporation of Adinkra symbols (M = 4.41, d = 2.18). Other widely used strategies included contextualising trigonometry through real-life cultural practices (M = 4.16, d = 1.43), kente weaving patterns (M = 4.14, d = 1.36), and field-based learning using local structures (M = 4.13, d = 1.38). Storytelling (M = 3.79, d = 0.76) and

community involvement (M = 3.84, d = 0.92) were comparatively less utilised, likely reflecting curriculum pressure and time limitations.

These findings align with D'Ambrosio (1985), who conceptualises mathematics as culturally embedded, and Gay (2021), who emphasises culturally responsive teaching as a mechanism for improving engagement and conceptual understanding.

Beyond their statistical strength, the ordering of the strategies carries a pedagogical message about how trigonometry in particular is best approached. The two strategies with the largest effects, group-based learning and the use of local languages, both work by mediating the move from a familiar context to a formal relationship. Group tasks distribute the reasoning, so that a student who can see the angle in a roof but cannot yet name it hears a peer make the connection explicit, which is the kind of socially mediated construction that supports the shift from an intuitive to a formal grasp of ratio and angle. The use of local language allows teachers to name and explain a relationship in the register in which students first encountered it, before re-expressing it in symbolic form, which lowers the cost of holding an unfamiliar representation in mind while the mathematics is being built. Adinkra symbols and kente patterns function differently again, as concrete carriers of proportion, symmetry, and repeated angle, and they are therefore most useful for introducing ratio and proportional reasoning rather than, for example, bearings, which are better served by field activities using local structures and directional movement. Read this way, the effect sizes are not merely evidence that teachers endorse these strategies; they indicate which cultural resources map onto which trigonometric ideas, and they suggest that a teacher planning a unit should match the resource to the concept rather than treat all cultural examples as interchangeable. The comparatively lower endorsement of storytelling and community involvement is consistent with this reading, since both are harder to align tightly with a specific trigonometric procedure within a time-pressured, examination-oriented syllabus, and their lower uptake therefore reflects structural constraint rather than a judgement that they lack value.

Research Question 2: Difficulties Faced by Teachers

The overall composite mean was 3.64 (SD = 1.34, CV = 36.81%, d = 0.48), indicating a moderately high level of perceived difficulty (Table 5). The strongest challenges were lack of professional development (M = 3.97, d = 0.83) and lack of culturally relevant textbooks (M = 3.94, d = 0.80). Difficulty relating trigonometric concepts to local contexts (M = 3.96, d = 0.78) and lack of institutional support (M = 3.89, d = 0.60) were also prominent. Importantly, the item on students not understanding cultural examples was non-significant, t(69) = 0.17, p = .869, d = 0.02, indicating that learner comprehension is not the primary barrier. The view that ethnomathematics is less important than standard methods was also non-significant at the .05 level, t(69) = 1.91, p = .060, d = 0.23, indicating that the obstacles are not attitudinal.

Table 5. One-Sample t-Test on Difficulties in Integrating Ethnomathematics intoTrigonometry Instruction (Test Value = 3.00)

Item	M	SD	CV%	t	df	p	95% CI	d
Lack training on teaching trig using Ghanaian cultural examples	3.74	1.27	33.96	4.89	69	<.001	[0.44, 1.05]	0.58
Not enough culturally relevant teaching materials	3.63	1.25	34.52	4.20	69	<.001	[0.33, 0.93]	0.50
Curriculum time does not allow inclusion of ethnomathematics	3.69	1.21	32.81	4.74	69	<.001	[0.40, 0.97]	0.57
Challenging to relate trig concepts to local contexts	3.96	1.23	31.15	6.50	69	<.001	[0.66, 1.25]	0.78
Limited knowledge of Ghanaian ethnomathematical practices	3.63	1.35	37.29	3.89	69	<.001	[0.31, 0.95]	0.46
Students do not always understand cultural examples	3.03	1.44	47.69	0.17	69	.869	[−0.32, 0.37]	0.02
Not emphasised in professional development sessions	3.97	1.17	29.38	6.97	69	<.001	[0.69, 1.25]	0.83

Item	M	SD	CV%	t	df	p	95% CI	d
Cultural integration increases preparation time	3.51	1.40	39.89	3.07	69	.003	[0.18, 0.85]	0.37
Difficult to assess culturally based trigonometry topics	3.34	1.39	41.65	2.06	69	.043	[0.01, 0.67]	0.25
Lack administrative or institutional support	3.89	1.48	38.09	5.01	69	<.001	[0.53, 1.24]	0.60
Some students resist traditional cultural means	3.71	1.43	38.39	4.19	69	<.001	[0.37, 1.05]	0.50
Few textbooks include Ghanaian cultural content	3.94	1.18	29.88	6.70	69	<.001	[0.66, 1.22]	0.80
Not confident identifying cultural applications of trig principles	3.70	1.32	35.75	4.43	69	<.001	[0.38, 1.02]	0.53
Seen as less important than standard methods	3.34	1.50	44.95	1.91	69	.060	[−0.02, 0.70]	0.23
Need more workshops and seminars	3.50	1.40	40.04	2.99	69	.004	[0.17, 0.83]	0.36
Overall	3.64	1.34	36.81	—	—	—	—	0.48

Note. Test value = 3.00. M = mean; SD = standard deviation; CV = coefficient of variation; d = Cohen's d.
Source: Field data, 2026.

These results indicate that the implementation barriers are primarily systemic and structural rather than attitudinal or learner-related. The pattern is theoretically informative as well as descriptive. The two items that did not differ from the midpoint, students failing to understand cultural examples and ethnomathematics being seen as less important than standard methods, are precisely the points at which a deficit account would expect difficulty to lie, in the learner or in the teacher's conviction. Their non-significance, set against the significant endorsement of professional development, materials, and institutional support as obstacles, locates the problem in the system that surrounds the teacher rather than in the willingness of the teacher or the capacity of the student. This is consistent with Herbert and Bragg (2021) and Sunzuma and Maharaj (2019), who argued that implementation success depends on sustained professional development, adequate resources, and institutional commitment rather than teacher willingness alone, and it sharpens their argument by showing, within a single sample, that the attitudinal explanations can be set aside while the structural ones cannot.

Research Question 3: Teachers' Perceptions and Experiences

Thematic analysis of interview data from four teachers (T1 to T4) yielded five themes.

Theme 1: meaningful learning, reduced abstraction, and increased engagement. Teachers described cultural integration as making trigonometry more meaningful and accessible.

"I perceive it as an effective teaching strategy because it reduces the abstract nature of trigonometry and allows learners to understand concepts through real-life cultural examples." (T3).

"I think it is a positive method of teaching trigonometry at the Senior High School level because it promotes interest, participation, and better understanding among students." (T4)

These perceptions align with D'Ambrosio's (1985) ethnomathematics theory and Gay (2021), who argued that culturally responsive teaching enhances student engagement and comprehension.

Theme 2: improved conceptual understanding, participation, and confidence. Teachers reported positive classroom experiences when using cultural examples such as roofing structures, kente weaving, carpentry, storytelling, canoe construction, and traditional dance.

"Whenever I use examples such as roof designs, farming layouts, or traditional buildings, students seem to understand angles and measurements better because they can relate to what they see around them." (T2)

"Bringing in local examples helps reduce the fear students often have for trigonometry. When concepts are linked to familiar practices, they ask more questions and learn with confidence." (T4)

These findings support Herbert and Bragg (2021), who argued that culturally relevant pedagogy promotes academic confidence by connecting classroom content to students' lived experiences.

Theme 3: cultural practices as concrete representations. Teachers described how tangible structures, cultural artefacts, storytelling, and kinaesthetic learning through dance and drumming each provided pathways into abstract trigonometric concepts.

"In our community, we often use kente weaving to explain ratios. The way the patterns repeat helps students grasp the idea of proportions and ratios. Once they see how the weaving process mirrors mathematical concepts, it clicks with them." (T1)

"I find that when we talk about angles in the context of traditional dancing or drumming, students really get it. The different body movements and angles in dances make it easier to explain angles and how they work." (T3)

These findings are consistent with Herbert and Bragg (2021) and Sunzuma and Maharaj (2019), who identified cultural artefacts as powerful tools for teaching mathematics meaningfully.

Theme 4: implementation barriers. Teachers identified four barriers: lack of resources, curriculum time constraints, variation in students' cultural familiarity, and limited institutional support.

"One challenge I face is the lack of resources. While I know cultural practices can enrich the lesson, there are often limited materials that directly connect Ghanaian culture to trigonometry." (T2)

"I sometimes struggle with the lack of institutional support. While I believe integrating cultural practices is important, I don't always get the encouragement or backing from the school." (T4)

These findings align with Herbert and Bragg (2021) and Dookurong et al. (2025), who noted that curriculum overload and resource constraints often hinder the implementation of culturally innovative pedagogies.

Theme 5: professional development and support needs. Teachers emphasised the need for continuous professional development, culturally relevant resources, collaboration with cultural custodians, and a structured curriculum framework. "*What would really help is a structured curriculum or toolkit that guides teachers on how to incorporate cultural practices into trigonometry, with sample lesson plans, activities, and local examples. Additionally, training that focuses on the pedagogy of ethnomathematics would be invaluable." (T1)*

These findings are supported by Gay (2021) and Owusu-Darko et al. (2023), who argued that ethnomathematics can only be effective when teachers are equipped with both pedagogical skills and culturally grounded resources.

Integration of the Quantitative and Qualitative Findings

Because the study used a convergent parallel design, the two strands were merged at the point of interpretation rather than being reported only in parallel. Table 6 presents a joint display that sets each principal quantitative result beside the interview evidence bearing on it and states the meta-inference that the two strands together support. The display makes clear that the strands do not merely coexist; they converge, and at several points the qualitative data explain why a quantitative pattern took the shape it did.

Table 6. Joint Display of Quantitative and Qualitative Findings

Quantitative Finding	Qualitative Evidence	Meta-Inference
Group-based learning and local language carried the largest effects (d = 2.62; d = 2.38).	Themes 1 and 3: teachers described collaborative talk and explanation in local language as the means by	Collaborative, language-mediated work is the mechanism, not an add-on; it is where the reduction of abstraction actually happens.

Quantitative Finding	Qualitative Evidence	Meta-Inference
	which abstraction was reduced and concepts 'clicked'.	
Adinkra and kente strategies strongly endorsed (d = 2.18; d = 1.36).	Theme 3: kente weaving used to teach ratio and proportion; artefacts described as concrete carriers of repeated angle and pattern.	Specific cultural resources map onto specific concepts; the high ratings reflect a concept-to-resource match, not generic enthusiasm.
Professional development and materials the strongest barriers (d = 0.83; d = 0.80).	Themes 4 and 5: teachers requested toolkits, sample lessons, and training, and reported a lack of resources and institutional backing.	The barriers teachers rate highest are the same gaps they elaborate unprompted; the constraint is structural and remediable through organised support.
Learner comprehension non-significant as a barrier (d = 0.02); attitudinal item non-significant (p = .060).	No teacher attributed difficulty to students being unable to understand cultural examples or to the approach being unimportant.	Convergent null evidence: the problem lies in the system, not in learners' capacity or teachers' conviction.
Storytelling and community involvement least endorsed (d = 0.76; d = 0.92).	Themes 4 and 5: time pressure and curriculum overload named as constraints.	Lower uptake reflects structural constraint on harder-to-timetable strategies, not doubt about their pedagogical worth.

Note. Source: Authors' analysis

The integrated reading strengthens the central interpretation in a way neither strand could alone. The quantitative strand establishes which strategies and barriers teachers endorse and how strongly; the qualitative strand explains the endorsement of the leading strategies as a description of the mechanism by which abstraction is reduced and explains the leading barriers as the very gaps teachers ask to have filled. Where the quantitative strand returns a null result, on learner comprehension and on the supposed unimportance of the approach, the qualitative strand returns a matching silence, since no teacher raised either as a problem. This convergence, including the convergence of the null findings, is what licenses the conclusion that the obstacles to ethnomathematical trigonometry teaching in these schools are structural rather than attitudinal or learner-related.

CONCLUSION

This study examined the strategies, difficulties, and perceptions of SHS mathematics teachers in two schools who had experience of integrating Ghanaian ethnomathematical practices into trigonometry teaching. Within this population, teachers reported employing a range of culturally responsive strategies, with the largest effects for collaborative learning (d = 2.62) and local language use (d = 2.38). These are best described as well-established features of practice among teachers experienced with the approach in these two schools, rather than as embedded features of Ghanaian SHS classrooms in general, a broader claim the present sample cannot support.

The quantitative and qualitative evidence converged on a single interpretation of what constrains the approach. The barriers teachers rated most highly, inadequate professional development, limited culturally relevant materials, and weak institutional support, were the same gaps they elaborated in interview when asked what would help, while the items locating difficulty in learners' comprehension or in teachers' own valuation of the approach were not significant and were echoed by a corresponding silence in the interviews. Read together, the two strands indicate that implementation is constrained by the system surrounding the teacher rather than by teacher unwillingness or negative student receptivity, and that organised support could address the specific structural gaps the teachers themselves identified.

Three recommendations follow. First, the Ghana Education Service should revise the SHS mathematics curriculum to include specific guidance on integrating Ghanaian cultural practices into trigonometry instruction, with worked ethnomathematical examples for key topics, matching particular cultural resources to the concepts they best illustrate. Second, structured in-service professional development focused on ethnomathematics pedagogy should be provided for practising SHS mathematics teachers. Third, teacher education institutions should incorporate ethnomathematics pedagogy as a core component of pre-service mathematics programmes rather than treating it as optional enrichment.

The study has limitations that bound these claims. It was conducted in two schools with teachers already exposed to the approach, so the findings support analytical rather than statistical generalisation and should be replicated across regions and across schools with differing levels of exposure. The questionnaire evidence rests on self-report tested against a scale midpoint, which indicates the strength and ordering of teachers' views rather than an external criterion, and the qualitative strand draws on four interviews chosen for their depth rather than their breadth. Future research should extend the study to other regions and mathematics topics, contrast schools with and without prior exposure, and examine the long-term sustainability of ethnomathematical approaches in resource-constrained SHS settings.

ACKNOWLEDGEMENT

The authors acknowledge the cooperation of the participating teachers and school authorities who contributed to the success of this study. This study received no external funding.

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