Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Exploration of the Benefits of Linking the Teaching and Learning of Geometry at the Senior High School to the Akan Cultural Practices

SETH AMOAKO ATTA (sethamoako@rocketmail.com)
AAMUSTED https://orcid.org/0000-0001-5085-0044

Research Article

Keywords: Akan culture, Artefacts, Curriculum, Egalitarianism Geometry, Ethnomathematics

Posted Date: December 28th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-3811653/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: The authors declare no competing interests.

Abstract

The purpose of the study was to investigate the paybacks of linking senior high school geometry to Akan cultural practice. The study area was the Ashanti region, which houses a chunk of the Akan people. The targeted population for the study included experienced mathematics teachers and people who are well-versed in Akan traditional art. Ten participants were recruited, including seven experienced mathematics teachers and three craftsmen, using purposive and snowball sampling methods. Data collection was conducted through interviews to elicit in-depth information from participants using a semi-structured interview guide. The data was analysed using thematic analysis. According to the analysis, teaching geometry with an Akan cultural perspective fosters conceptual understanding and raises academic achievement through lifelong learning. Secondary, it produces students who are patriotic and innovative, ready to face real-life challenges instead of becoming a burden on society. The researchers concluded that the Akan culture is embedded with concepts that are geometric, and it serves as good tool for teaching and learning geometry at the Senior High School

Introduction

The branch of mathematics that studies shapes, spatial relationships, and space is known as geometry (Authors, 2023a). Originating from Greek terms signifying "Earth measurement," geometry is among the most ancient fields of mathematics, formulated to address real-world issues such as surveying (Baah-Duodu et al., 2020). Later on, it was found that even the most abstract ideas and concepts could be developed and represented using geometry. Different fields of geometry include non-Euclidean geometry, differential geometry, projective geometry, analytic geometry, and topology.

A kind of mathematics education known as ethnomathematics incorporates students' cultures freely into the standard mathematics curriculum. Students expand on their knowledge and cultural experiences in such a classroom (González, Moll, & Amanti, 2005). These experiences are used to understand how mathematical ideas are developed, integrated into systems, formulated, and applied in culture, rather than to serve as inspiration or an introduction. Basic mathematical concepts and the usefulness and potency of conventional methods are grasped thanks to the connection between this mathematical knowledge and conventional mathematics.

The goal of ethnomathematical techniques is to enhance education by giving pupils a deeper understanding of mathematics. A mathematics curriculum that is focused on students' comprehension is required, giving teachers greater leeway and creative control over the subjects they choose to teach. Teachers can work with students to build the mathematics curriculum through dialogue. Instructors may ask students to conduct an ethnomathematical analysis of both their own and the dominant culture. Research has supported the inclusion of a specific social group's maths practices and customs in the curriculum. Given that adding ethnomathematical knowledge to a maths curriculum helps bring about social transformation. For example, Rosa (2010) proposed that an ethnomathematical-based culturally

appropriate mathematics curriculum integrates students' cultural backgrounds holistically. It is imperative that the mathematics learning experiences of pupils consider their cultural backgrounds and experiences.

The ethnomathematical approach in teaching mathematics offers pedagogical tools to connect students' varied, culturally ingrained modes of knowing and learning with academic mathematics. In order to create more inclusive developmental programmes for the varied groups serviced by educational institutions, it investigates scholarly and culturally rich approaches (D'Ambrosio, 1990). With this teaching strategy, a mathematics curriculum is developed based on the interests and cultural background of the pupils (Rosa, 2005). By imparting mathematical knowledge and pedagogical strategies for mastering academic arithmetic, teaching mathematics from an ethnomathematical perspective aids students in understanding reality, culture, society, environmental concerns, and themselves. In opposition to Eurocentrism, an ethnomathematical perspective in mathematics education suggests culturally appropriate teaching strategies (Authors, 2023). This viewpoint places a strong emphasis on education with historical and cultural significance.

Research have shown that students view geometry as an essential component of their life when social-cultural concepts are taught to them (Authors, 2023b; Owusu-Darko et al., 2023). There is no disturbance and the students feel comfortable. There, students gain cultural awareness while advancing social justice, a component of democratic values (loyalty and adherence to the law, tranquilly and peace, tolerance, patriotism, leadership abilities). As a result, teachers may easily access resources and instructional materials. Furthermore, the school integrates with the community. This implies that mathematics education continues outside of the classroom as students can use their surroundings as a learning tool to use what they have learned to solve problems in the real world.

The ultimate objective of education is to provide students with marketable skills and creative problem-solving techniques that will enable them to become independent and self-sufficient (MOE, 2010). Students will be able to develop and realise their potential in a variety of areas, including dance, drumming, weaving, and art, by incorporating Akan culture into maths lessons. Students who develop into self-sufficient, creative, independent thinkers and problem solvers will contribute to the development of the country as they will be more job creators than job seekers.

Egalitarianism

The philosophical theory of egalitarianism is based on the idea that all people should be treated equally since they all possess a basic worth (Rueden, 2020). The natural observation that every human has intrinsic value since they are all human is the source of the concept of human equality. According to some academics, there are differences amongst persons in terms of their innate abilities, capacities, limitations, vices, and situations that define their life in the world. The existence of poverty and the disparity in wealth between the affluent and the poor constitute the egalitarian problem. As a result, while it is evident that no human being is morally superior to another human being, it also seems inevitable that no human being is equal (Barry, 2002).

People vary from one another in a variety of ways, including their personalities, situations, abilities and shortcomings, capacities and inabilities, virtues and vices; morality, political beliefs, religious convictions, artistic tastes, and personal endeavours; degree of reasonableness and unreasonableness; degree of development of natural endowments; degree of benefit to others or harm to others; degree of hard work and discipline in the past and likely to continue in the future; and so on. It has always been accepted as true that humans are naturally unequal (Elsässer et al., 2021). According to the Greeks, people are inherently and fundamentally different from one another, which causes them to have distinct personalities and lifestyles. The way that men of unequal rank should be handled in social relationships is naturally determined by this worldview.

According to the Greeks, the concept of universal citizenship is a product of the political state of the polis, which acts as an artificial institutional framework to guarantee the equality of people who were born into inequality (Schemmel, 2021). The first egalitarian framework was offered by the Stoics, who effectively qualified this broad viewpoint. According to them, the rationale behind the order of the natural law and the ability for virtue that stems from it are shared by all persons, making them equal. The Stoics therefore believed that "the unique quality of man is his endowment with Reason." This distinguished him from all other creatures; nonetheless, in this regard, all men were equal and similar as mankind (Rufus & Lutz, 2020).

Being a human was by definition having such gifts; there was no doubt about it, for better or worse (Narine et al., 2022). It is important to note that everyone has the ability to learn if they are given equal learning opportunities. In culturally based learning, all students are taught that they possess a certain level of intelligence from birth and that everyone has the same capacity to learn, but in a different fashion. As a result, it is the responsibility of maths teachers to devise original lesson plans that cater to students' varying rates of cognitive development.

Historical Background of Curriculum

Regardless of the beginnings and objectives of the first curricula, by the time of ancient Babylonia, the role of instilling culture had become apparent. Greek and Latin language proficiency were encouraged in ancient Roman curricula, with a focus on studying classical poetry. The curriculum of mediaeval and Renaissance education was impacted by the idea that; it is a body of subjects or subject matter prepared by the teachers for the students to learn. That has been the conventional understanding of the curriculum in the early 1900s which was equivalent to the terms "syllabus" and "course of study".

The curriculum, as an idea, has its roots in the Latin word for race-course, according to John Franklin Bobbitt, who explained the curriculum as the course of deeds and experiences that help children become the adults they should be to succeed later in life in The Curriculum, the first textbook published on the subject in 1918 and referenced in (Coşkun Yaşar & Aslan, 2021). The curriculum also includes all formative acts and experiences that occur both within and outside of schools, including those that are

consciously aimed at the formation of adult members of society as well as those that are spontaneous and unplanned.

According to Bobbitt, the curriculum is a field of social engineering. According to his cultural presumptions and social definitions, his curriculum formulation consists of two noteworthy components: first, that scientific professionals would be the most qualified and justified in establishing curriculum based on their expert knowledge of which experiences would generate these characteristics and what characteristics are desirable in adult members of society (Narine et al., 2022). The activities and experiences a student must have in order to grow into the adult they should be are referred to as curriculum. Therefore, he presented the curriculum as an ideal rather than characterising it as the tangible reality of the deeds and experiences that mould people into who and what they become.

Nonetheless, contemporary curriculum approaches, which reject certain facets of Bobbitt's postulates, maintain that the foundation of curriculum—the series of events that shape individuals into persons—remains unaltered. Curriculum-based personal development is investigated in cultures and societies (e.g., professional formation, academic discipline via historical experience) as well as at the individual level. John Dewey (1859–1952), who sharply disagreed with Bobbitt on a number of important points, also highlighted curriculum as a series of formative experiences throughout his work, even though this idea initially surfaced in Bobbitt's description.

While researchers and curriculum authors largely agree on this substantive definition of curriculum, Bobbitt and Dewey's utopian use of the term "curriculum" is not the same as the limited usage that exists today. Development is more than just clearing your head of thoughts. What is truly desired is the evolution of experience into experience. Because of this, a curriculum can be viewed as a field of study. It comprises knowledge domains, research hypotheses, guiding principles, and the philosophical, historical, psychological, and sociological underpinnings of each (Belbase et al., 2022).

The topic of study covered in the curriculum ought to be scholarly and theoretical. The field focuses on broad, intellectual, historical, and philosophical social issues. "Curriculum" was first defined by John Kerr and was later adopted by Vic Kelly in his seminal work on the subject. Mark Smith begins by providing the following definition of the term: All the learning which is planned and guided by the school, whether it is carried out in groups or individually, inside or outside of the school.

A curriculum, in the words of Marsh and Willis, is all of the "in-class experiences that are planned and enacted by teachers, as well as learned by students." For education to be realistically effective and productive, any definition of a curriculum needs to include much more than just a list of the subjects that it is meant to teach, convey, or give. If this is the case, the curriculum is "hidden" only from or to the students, and the values can be clearly taught from a portion of what is planned for the students. Some would contend that the values implicit in the arrangements made by schools for their students are quite clearly in the consciousness of teachers and planners, especially when the planners are politicians. Since there are valid doubts regarding the validity of these practices, they must be recognised as an essential part of the curriculum and given prominent placement.

Statement of the problem

Greek and European mathematics are prioritised while indigenous knowledge is disregarded, despite the fact that Ghanaian Senior High Schools' core mathematics curriculum mandates that mathematics be taught contextually (MOE, CRDD, 2010). (Authors, 2023b). According to Albanese (2021), ethnomathematics is the study of the relationship between mathematics and culture. This is the kind of mathematics that certain ethnic groups use. In order to foster an appreciation for both, ethnomathematics aims to advance both mathematical and cultural understanding (Meaney et al., 2021).

According to researchers that support ethnomathematics and mathematics education, it's critical to help students understand the cultural context of mathematics by teaching them in a way that is appropriate for their culture (Rosa, 2020; Rosa et al., 2016). Mathematics instruction must be based on cultural relevance and firsthand experiences that provide students a deeper grasp of reality, culture, society, and themselves if it is to have an impact on the political and social dynamics of culture (Authors, 2023b).

Researchers from Ghana, such as Owusu-Darko et al. (2023), aimed to show how the Akan culture may be incorporated into the teaching of geometry and mensuration. In contrast to the present investigation (Owusu-Darko et al., 2022), it appears that the limited number of research conducted in Ghana have concentrated on emphasising the relationship between the Akan culture and formal school mathematics. In the meantime, the high school core mathematics curriculum is theoretical, inflexible, and abstract, according to a study by the authors (2023). This meant that a study focusing on culturally responsive pedagogy needed to be conducted. Therefore, the goal of the current study is to investigate the advantages of linking the teaching of geometry education to the Akan culture.

Purpose of the study

The study's goal was to find out how connecting Senior High School geometry instruction to Akan cultural customs pays off.

Objective of the study

The objectives of the study was to explore the benefits of linking geometry instruction at the senior high school to the Akan culture in terms of;

a. Academic achievement

b. Economic emancipation

Methodology

This non-experimental study used the case study method, which entails a thorough examination of a specific circumstance, event, schedule, or activity protocol. Data collection and analysis were conducted

using the interpretive paradigm that gave rise to the qualitative (Kothari, 2017). The third-largest region in Ghana, the Ashanti Region, served as the study's location. The region, which is part of the country's central belt, is well-known for its abundant gold and cocoa output. The targeted group for the study includes both knowledgeable Akan traditional artists and seasoned mathematics teachers. In order to make sure that every member of the intended population has enough experience and expertise, purposeful and snowball sampling techniques were used (Hu & Chang, 2017). Ten participants were enlisted, consisting of three craftsmen who are knowledgeable about Akan cultural customs and seven seasoned mathematics teachers.

Interviews were used to get participant responses in order to collect data. The study investigated the potential integration of Akan cultural practices into mathematics education, with a specific focus on geometry instruction, using a semi-structured interview guide. This approach makes sure that everyone contributes knowledge on the same subjects and delves deeply into intriguing problems.

Informed consent, privacy during interviews, and appropriate ethical clearance and permission from the AAMUSTED Department of mathematics all contributed to the maintenance of ethical standards. Participants' pseudonyms were used to anonymize the data. The participants the interviews were conducted at the convenience of the participants. More so, they were given time to think over whether or not to participate. The primary standards for guaranteeing research rigour in this study were confirmability, credibility, transferability, and dependability. Pilot testing was done to make sure the line of questioning was clear.

The researcher obtained responses in both Twi and English, but subsequently translated them into Twi using a translator to prevent data distortion. After that, the interview transcripts were proofread, arranged, and categorised using a thematic analysis approach. The data analysis process was adapted from Braun and Clarke's (2006) six-step method, which includes familiarising oneself with the data, creating preliminary codes, looking for themes, evaluating themes, defining and labelling themes, and producing a report (Byrne, 2022; Kothari, 2017).

Results

Participants were asked to share their views on some of the benefits for incorporating the Akan culture into the teaching of geometry. The study finds that the Akan culture emphasize practicality, creativity and innovation. As a result, its integration into the mathematics curriculum by adopting their methodology and linking geometry lessons to the indigenous Akan culture will maximize conceptual understanding, ensure leaners are creative and be able to apply what they have learnt to solve real life problems. Respondents disclosed that;

… everyone wants to get a better employment opportunity. So, whenever you're being asked about what you can bring to the table, it will help the students to be able to think outside the box so that they will be able to identity series of tools or equipment or different ways of solving problems. Linking geometry

lessons to Akan culture add to what students already know so that they will be able to grasps the concept, recreate items to solve daily life problems **(Boat, Mathematics Educator)**.

It facilitates teachers' transition from the familiar to the unknown. It helps students understand how useful mathematics is in day-to-day tasks. It makes them see mathematics as not Western but being applied among the Akan as well **(Pablo, Educationist)**

In the Akan culture, those the school system describe as "unintelligent" are able to understand and apply the geometrical designs in their line of work. There is no one who is unintelligent, everyone has the way they learn and understand concepts. Integrating the Akan culture in teaching and learning geometry will reemphasize the need to make lessons practical which appeals to all the various categories of learners. Moreover, the mathematics will be seen as a part of their daily life activities **(Doctor, Adinkra works)**

The benefits are enormous, for example, if a teacher brings some of the Akan artefacts or symbols to the classroom and demonstrate to the students during the teaching of geometry, the students will realize that whatever they see around them has a linkage to whatever is being taught which brings relevance to the topic. Once they appreciate the relevance of the topic, it will motivate them to learn to apply **(Ruf, Mathematics Educator)**

Integrating the Akan culture will enable us appreciate and value what we have as a society and to begin to understand ourselves very well. We will also value and appreciate what we have and may not think that it is only the Europeans or the whites that have concepts that are mathematical. The Akan culture provides a methodology that is able to appeal to the senses of all learners. This will make lessons lively and comprehensible **(WAB, Mathematics Educator)**.

… what I have observed is that, it will not have been that easy for me to learn Kente weaving with all the geometrical shapes and symbols beautifully embossed if I were to learn following just oral instructions without the practice. If the learner is around, he/she follows what steps you make. In making the geometrical shapes in Kente cloths for instance, you teach the person as you arrange the ropes. The person gets the experience through practice. For us, the learner is always with the trainer and everything is practical unlike what goes on in school. If this mode of instruction is integrated into teaching geometry in schools, learners will not be found wanting and perhaps they may not find the topic as alien **(Vice, Kente weaver)**

From the economic point of, it is worth nothing that all the three participants who are local artisans indicated that they depend on their work for livelihood

*..oh, it has helped me tremendously, as a Youngman I don't depend on anyone, I get everything I want from this job I do, it helps me in my day to day expenses plus some savings on top, I also help others who are in need (***AFA K Tailor***).*

I can confidently say that it has helped me greatly, it is main source of livelihood, it's also a means of preserving our tradition, our forefathers started it, they are no more, we too will hand it over to the next

generation, you see, so we have custom and tradition that we can beat our chest that, this is our own. I feel motivated to finding ways of preserving our culture…. the Kente weaving has made Ntonso a tourist centre. Without which Ntonso would have remain in the dark. Most importantly it gives me exposure, these alone motivate me (**Doctor, Adinkra works** *)*

…. I have not had any negative influence since I started this job and most importantly this is the only work I do, and it has been providing me with all the things I have, it is the proceeds from it that I used to build my house, I got married through it and keeping the family as well (**Vice, Kente weaver** *).*

The seven other participants who are mathematics teachers also stressed on the economic benefits of integrating the Akan culture into the teaching of geometry. The seven mathematics educators had this to say

Students will begin to accept the Akan culture and patronise its products. We may feel proud going to church even in cloth, in Ahenema. We will feel proud and understand that these things are as people put it Abosomsem (idol worshiping) but it is our way of doing things. It will also let us come to together, it will repel conflicts and misunderstanding between homes, between families, between ethnic groups. When all these things are taught in schools and we begin to appreciate it. Someone coming from different cultural background, once he sees it as being Ghanaian, he's going to value it and use it, so it will create social cohesion.

…once we begin to see some of these things as Ghanaian, people will patronize it more than what the artisans are doing and it is going to promote their business. It is likely that it will lead to exportation of some of these things and it can bring foreign exchange into the country and it is going to make the work teachers work very cheap, because the materials that you will to teach will be readily available in the environment and it will make teaching in the classroom more relational but not the instrumental type. You have an artefact that you can use, really use it and demonstrate to the students and they will really come to terms with it. When they go out they see them when they go home they will see them, and they can really appreciate mathematics in those things (**WAB** *)*

RuF believed that when students are taught using examples from Akan traditional settings it will spice up students' interest and it will ginger some of them to either going into it as a vocation or patronize in the products.

……yeah, the benefits are enormous, for example, bring some of the Akan artefacts or symbols to classroom and demonstrate to the students during the teaching of geometry. That will let the students see that whatever they see around is meaningful to whatever we are teaching. So, it brings relevance to the topic. It does a lot though we don't do that, but when we are able to do it will help so much so much

This will only boost production, expand the market and increase returns. The student can have interest in going into those professions when they leave school and then make a living and become entrepreneurs so that they will not depend on anybody or depend on the government for jobs and what have you.

Looking at the religious aspect, most of the attire we were to mosques and churches are imported but if we buy into those cloths and sandals we produce locally, we can take them to church or our various worship canters. The Akan also dominate in Ghana here, for example looking at the northern belt the southern belt most of the people are Akan. So at least it will help a lot (**RUF Mathematics educator** *)*

…if such if teachers adopt the use of local products as examples in teaching geometry it will promote the things we produce locally, the market will be shifted towards that area and then it will make it more attractive for students to also get involved in those areas (**Pablo** *).*

REV believes that people are making a living out of these Akan art without formal education and once High school students are exposed to it in school through geometry, it will bring out a lot of innovations and ingenuity into the art.

… student will be more innovative and that will increase productivity with its resultant economic boast. more designs will come out, it will be pleasing and people will buy them and they will get more money. The students will be well informed and appreciate the culture and it will clear the perception that Christians cannot patronize the local products, we only want to depict culture. Using local products does not change your perception as a Christion. It only identifies you as an Akan

I have a strongest believe that, it is about time we let people understand our culture, the expression of our culture should not prevent us from being religious animal or whatever, I think we should also embrace it in good faith. Wearing these things do not change you from being a Christian. Whatever in you is still in you but, we only want to depict culture but we should do them in moderation so that others sense of thoughts against whatever we do, that is the way I see it (**REV, mathematics Educator** *)*

Boat on his part stressed on the fact that we have depended so much on anything foreign and some people even believe that there can be nothing new again. But he thinks if we train the students with our cultural values they will become innovative and will bring out inventions.

we have the idea that whatever needs to be invented has already being invented but as time goes people are inventing new things. So, when we train students to become innovative through the use of local art they are going to pull up and make others understand the need to preserve their culture and patronise in their local products (**Boat** *).*

Discussion

This study revealed that integrating the Akan culture into geometry has two main benefits, enhancing conceptual understanding and providing economic emancipation. The first part is in line with the findings of (Owusu-Darko et al., 2023) which demonstrated how the Akan Symbols like Adinkra and other utensils like earthenware the Pots mad-houses, artefacts and some practices of the Akan are connected with mathematical concepts especially geometry. The paper stressed that the Akan is full of geometry and using this culture to develop geometry concepts in the classroom was like adding icing to the cake. Since

the students are already familiar with the Akan culture, once the concept of geometry is link to the culture it makes the lesson so real and thereby increase student interest, remove fear and improve on academic achievement as found by (Arthur, 2019; Arthur et al., 2022). Researcher across Africa have also come up with similar studies in their jurisdictions where local practices were linked to mathematics concepts (Nur et al., 2020; Sharna et al., 2021; Turugari, 2022). The constructivist learning comes in where the environment of the student becomes avenue for learning. This learning does not end in the classroom but the classroom just set the base for self-directed learning. The egalitarian principle has it that all human beings are the same, when the right opportunities are provided each and everyone will do their best.

Secondly, this study has demonstrated that if the Akan culture is integrated to the teaching of geometry, it will produce learners who are critical thinkers, innovative, creative, problem solvers, and above all, conscious about their environment. These are the very principle expose in the (MOE, 2010) with the hope that the student at the end will become self-reliant through innovate ways of solving real life problems like unemployment, environmental degradation, loyalty, and respect for one another. Its worth nothing that UN SDG4 believes that providing lifelong learning can accelerate global peace and security and that is exactly what this study has come up with. If students develop interest in the local produce, they will value it and patronise it and it becomes economic venture. When people have something to life on, social vice like arm robbery, thievery drug abuse, teenage pregnancy and what have you, will be put under check if not eliminated completely.

Findings

The study found that integrating the Akan culture into the teaching of geometry promote conceptual understanding and improve academic achievement through life-long learning.

Secondary, it produces students who are patriotic and innovative ready to face the real-life challenges instead of becoming a burden on society. It will also bring economic growth and development and finally, it will imbibe democratic values and principles in students.

Conclusion

learning in Akan setting is by practice, hence incorporating their way of teaching and learning especially into the concept of geometry which is an antient concept will enhance students conceptual understanding. Teaching geometry using the things around the students makes the student see the mathematics classroom as home annex. This makes him feel at home as he learns mathematics. The classroom is now extended to cover the entire environment for conscious considerations. The student therefore tries to challenge real life situations and come up with real-time solutions. This is the only way the student through critical thinking come up with innovative problem-solving strategies. The researchers therefore wish to conclude that the Akan culture is embedded with concepts that are geometric, and it serves as good tool for teaching and leering of geometry at the Senior High School.

References

1. Albanese, V. (2021). Bundles of Ethnomathematical Expertise Residing with Handicrafts, Occupations, and Other Activities Across Cultures. *Handbook of Cognitive Mathematics*, 1–34.
2. Arthur, Y. D. (2019). The Effect of Background on Students' Interest in Mathematics: The Mediation of Students' Motivation and Perception in Ghana. *Asian Journal of Probability and Statistics*, 1–13. https://doi.org/10.9734/ajpas/2019/v5i330135
3. Arthur, Y. D., Dogbe, C. S. K., & Asiedu-Addo, S. K. (2022). Enhancing Performance in Mathematics Through Motivation, Peer Assisted Learning, And Teaching Quality: The Mediating Role of Student Interest. *Eurasia Journal of Mathematics, Science and Technology Education*, *18*(2), em2072. https://doi.org/10.29333/ejmste/11509
4. Authors (2023a). *Contemporary Mathematics and Science Education*,
5. Authors (2023b). *Journal of Mathematics and Science Teacher*,
6. Baah-Duodu, S., Osei-Buabeng, V., Cornelius, E. F., Hegan, J. E., & Nabie, M. J. (2020). Review of Literature on Teaching and Learning Geometry and Measurement: A Case of Ghanaian Standards Based Mathematics Curriculum. *International Journal of Advances in Scientific Research and Engineering, IJASRE (ISSN: 2454-8006)*, *6*(3), 103–124.
7. Barry, B. (2002). *Culture and equality: An egalitarian critique of multiculturalism*. Harvard university press.
8. Belbase, S., Sharma, B., Pant, B. P., Khanal, B., Panthi, R. K., Kasemsukpipat, W., & Al Farra, N. K. R. (2022). Philosophical foundations for curriculum decision: A reflective analysis. *SN Social Sciences*, *2*(4), 39. https://doi.org/10.1007/s43545-022-00344-5
9. Byrne, D. (2022). A worked example of Braun and Clarke's approach to reflexive thematic analysis. *Quality & Quantity*, *56*(3), 1391–1412. https://doi.org/10.1007/s11135-021-01182-y
10. Coşkun Yaşar, G., & Aslan, B. (2021). Curriculum theory: A review study. *International Journal of Curriculum and Instructional Studies (IJOCIS)*, *11*(2). https://avesis.ankara.edu.tr/yayin/c3f94eaa-e311-4d87-a82a-6dbd519c7b64/curriculum-theory-a-review-study
11. Elsässer, L., Hense, S., & Schäfer, A. (2021). Not just money: Unequal responsiveness in egalitarian democracies. *Journal of European Public Policy*, *28*(12), 1890–1908.
12. Hu, C.-P., & Chang, Y.-Y. (2017). John W. Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. *Journal of Social and Administrative Sciences*, *4*(2), Article 2. https://doi.org/10.1453/jsas.v4i2.1313
13. Kothari, C. R. (2017). *Research Methodology methods and techniques second edition*. New Age.
14. Meaney, T., Trinick, T., & Allen, P. (2021). Ethnomathematics in education: The need for cultural symmetry. *Handbook of Cognitive Mathematics*, 1–29.
15. MOE. (2010). MINISTRY OF EDUCATION. *TEACHING SYLLABUS FOR CORE MATHEMATICS (SENIOR HIGH SCHOOL)*, 66.

16. Narine, C. W., Jones, D., & Dawidowicz, P. (2022). Culturally Responsive Curriculum Implementation of Middle School Principals in Southern Texas. *Journal of Instructional Pedagogies*, *27*. https://eric.ed.gov/?id=EJ1347521
17. Nur, A. S., Waluya, S. B., Rochmad, R., & Wardono, W. (2020). Contextual Learning with Ethnomathematics in Enhancing the Problem Solving Based on Thinking Levels. *Journal of Research and Advances in Mathematics Education*, *5*(3), 331–344.
18. Authors (2023). *Education Research International*, *2023*,
19. Owusu-Darko, I., Apoenchir, H. K., & Mensah, J. Y. (2022). Mathematical Constructs–What are These, and Their Interconnection with Ethnomathematical Concepts. *Indonesian Journal of Ethnomathematics*, *1*(2), 89–104.
20. Owusu-Darko, I., Sabtiwu, R., Doe, F., Owusu-Mintah, B., & Ofosu, E. K. (2023). Akan ethnomathematics: Demonstrating its pedagogical action on the teaching and learning of mensuration and geometry. *Journal of Mathematics and Science Teacher*, *3*(2).
21. Rufus, M., & Lutz, C. E. (2020). *That One Should Disdain Hardships-the Teachings of a Roman Stoic*. Yale University Press.
22. Schemmel, C. (2021). *Justice and egalitarian relations*. Oxford University Press.
23. Sharna, S., Sharma, S., Doyle, P., Marcelo, L., & Kumar, D. (2021). Teaching and learning probability using games: A systematic review of research from 2010-2020. *Waikato Journal of Education*, *26*(2), 51–64.
24. Turugari, M. (2022). *Integration of ethnomathematics in the teaching of probability in secondary school mathematics in Zimbabwe* [PhD Thesis].
25. von Rueden, C. (2020). Making and unmaking egalitarianism in small-scale human societies. *Current Opinion in Psychology*, *33*, 167–171.