Ethnomathematics in Mathematics Education

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1. Sustainable Development in Education

To improve the sustainable development in education around the world, the United Nations Department of Economic and Social Affairs Sustainable Development introduced 17 Sustainable Development Goals (SDGs) associated with 169 targets. Researchers and policymakers have made these goals a priority for today's children. Efforts to apply elements of sustainability goals in mathematics education is a fairly new phenomenon, though it is gaining momentum to meet the needs of the 21st century student. For instance, researchers have utilized the benefits of sustainability goals in student mathematical achievement [1][2][3], while others have explored the notion of sustainability goals to prepare future mathematics teachers in teacher education programs [4][5][6]. Some have even implemented sustainability goals to further the benefits on STEM education [7][8][9]. Still more work is needed to explore sustainability goals in the Gulf Cooperation Council (GCC) and Middle East and North Africa (MENA) region.

2. What Is Ethnomathematics?

Ethnomathematics is broadly defined as the study of the relationship between culture and mathematics. It is used to describe the ways in which mathematics is practiced among similar and dissimilar cultural groups. [10] defines the term "ethno" as the elements that make up a group's cultural identity (i.e., race, language, vocabulary, values, beliefs, norms, physical traits, symbols, etc.). Mathematics, in this context, refers to different aspects of thought and culture that lead to different mathematical structures, opinions, understandings, and explanations within concepts such as counting, measurement, sorting, organization, deduction, and modeling [10][11]. D'Ambrosio [12] defines ethnomathematics more definitively as "a program in history and epistemology with an intrinsic pedagogical action that responds to a broader conception of mathematics, while considering the cultural differences that have determined the cultural evolution of human mankind and the political dimensions of mathematics" (p. 133). Thus, the concept is considered an approach to teaching mathematics by researching and appreciating all societal histories, philosophies, and cultures [13]. The general theory of ethnomathematics draws attention to the fact that mathematics is fundamentally a cultural product, where each culture and subculture develops its own mathematics useful for them [14].

3. Ethnomathematics in School

Historically, mathematics, more than any other subject, has been perceived as being culture-free. It was noted that some mathematics teachers believe that, when teaching mathematics, they do not have to take the diversity of their students into consideration [15]. Such an approach not only disregards students' cultural knowledge as a critical component in empowering them intellectually, emotionally, and politically, but it also discounts historically significant mathematical advances produced from attempts to solve cultural and specific social problems. This includes such topics as geometry in Ancient Egypt, astronomy in the Middle Ages, and computing in the modern era ([16], p. 139). Mathematics educators have an obligation to assist students to discover and understand the power mathematics plays in their lives [16].

In the past, various approaches for diversifying mathematics education have proven to be effective. One approach, the Critical Race Theory, has shown to improve the achievements of minority mathematics learners [17]. Culturally responsive mathematics teaching enables students to relate mathematics content to their culture and communities [18][19][20]. Adam et al. [21] explained how a culturally relevant mathematics curriculum based on ethnomathematical perspectives and that holistically infuses the students' cultural backgrounds into their learning environment improved student agency. A previous

study has revealed that students who receive mathematics instruction using an ethnomathematical approach excel in mathematics assessments [22].

D'Ambrosio [13] reported on teachers who differentiate between two types of mathematics: formal academic mathematics taught in schools (also known as school mathematics) and ethnomathematics practiced by diverse cultural groups. In this context, ethnomathematics researchers suggest that mathematical experience outside of school should also be addressed as authentic and appropriate knowledge for the classroom [23][24] Ethnomathematics research in schools has reported mixed results when students engage in traditional mathematics taught in schools and ethnomathematics. Baba [25] observed that children who were successful in making calculations in the streets were unable to solve similar problems on a school mathematics test. However, Karssenberg's [26] work showed that students were able to learn geometry, symmetry, and mathematical approaches in the context of cultural and historical geometry linked to Persian medieval architecture within Islamic culture.

Many scholars have discussed the benefits of infusing ethnomathematics into the traditional mathematics taught and learned in schools. Rowlands and Carson [27] argue that by engaging students in ethnomathematics, researchers create more opportunities for inclusive mathematical conversations and ensure that learners from indigenous and traditional cultures can bring important resources, ideas, and perspectives to these conversations. Additionally, they add that, "Ethnomathematics engages the teacher in a side of the mathematical conversation that opens up a route of access to the child's own unique modes of thought, both personal and cultural" ([27] p. 336). D'Ambrosio [28] explains that ethnomathematics allows us to witness and appreciate how mathematics continues to be culturally adapted and used around the world and through time.

D'Ambrosio and Rosa [29] identify two "main reasons" for bringing ethnomathematics practices into schools: to demystify school mathematics as a final, permanent, absolute, unique form of knowledge; and to illustrate the intellectual achievement of various civilizations, cultures, peoples, professions, and genders. Ethnomathematics practices inspire respect, solidarity, and cooperation between cultures and promotes a society free from arrogance, discrimination, inequality, and hatred [29].

Recent studies in ethnomathematics suggest that ethnomathematics support student agency, achievement, and creativity. Mursalin and Supriadi [30] explored Sundanese fifth graders' ability to develop creative mathematical designs. The findings report that the fifth graders were able to create dynamic creative mathematical designs that support the children's understanding of various algebra and geometry topics. Likewise, Prahmana and Istiandaru [31] examined the use of the Indonesia Javanese shadow puppet to explore the mathematical topic of set theory. The findings suggest that the Indonesia Javanese shadow puppet was used to convey many concepts of set theory, such as "definition of sets, universal sets, subsets, union of the set, intersection of the set, complement of the set, empty set" (p. 14). However, more research exploring ethnomathematics is desired.

4. M-Learning

Mobile learning (M-learning) has had a significant impact on education worldwide [32]. Research on the use of M-learning in education emerged in early 2000 [33][34]. Early research set out to design a theory of educational and lifelong learning mediated by mobile technologies such as handheld devices [35]. Since then, numerous articles focusing on M-learning have been published reporting on the increased educational use, advantages, and challenges of M-learning in education [34].

5. Educational Uses

M-learning has been successfully employed in various ways. For instance, Alzaza and Yaakub [36], discussed M-learning in terms of the next generation of E-learning. Other researchers have referenced M-learning as learning performed with the utilization of handheld, portable devices, such as smartphones and tablets [37][38][39]. Lam and Duan [40], discussed the anytime-anywhere convenience of student learning through mobile technologies. Fabian, Topping, and Barron [41], discussed the effect of mobile learning on primary student's mathematical attitudes and achievement. In general, research on M-learning discusses various opportunities for learners to access educational content anytime and anywhere in order to learn, increase knowledge retention, collaborate, share, and gather newly acquired knowledge.

Recent studies in M-learning continue to report on the increased impact of mobile devices [42]. Papadakis, Kalogiannakis, and Zaranis [43] conducted a study to examine the impact of computers and laptops on early childhood children's understanding of numbers. The findings reported that children who used personal computers and laptops outperformed

the children who used no technology. However, the children who used laptops outperformed both the children who used personal computers and those who used no technology. Another study explored the effect of mobile learning on student comprehension. Wang, Kao, and Wang [44] reported on a study that investigated second graders' comprehension of multiplication. The research suggested that the children who used a mobile device experienced increased comprehension and achievement versus those children who were taught traditionally. Both studies support the notion that M-learning yields greater gains in student achievement. Yet, more research exploring the usefulness, challenges, limitations, and/or impact of M-learning and ethnomathematics is needed in the GCC and MENA region, mainly in the UAE. Due to the limited research on ethnomathematics and M-learning, the present research study aims to contribute to the research literature in the application of the ethnomathematical perspective, which encompasses contextualized practice in this geographical location.

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