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Misuse in Ethnomathematics Research: A Review of Philosophy of Mathematics and Mathematics Education

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Abstract

This research was inspired by a study conducted by Pais (2011), which presents criticisms and contradictions in ethnomathematics. The criticism presented refers to the philosophy of ethnomathematics which is considered contrary to the purpose of ethnomathematics itself. Reflecting on Pais' (2011) study, this research aims to examine forms of misuse in ethnomathematics research. A philosophical approach is used to show that such misuse is often unconscious and has deviated from the original purpose of ethnomathematics. This research uses a qualitative approach with a literature study type. The literature analyzed came from books, scientific articles, and documents related to ethnomathematics and the philosophy of mathematics education. The results of this study identified two main categories of misuse in ethnomathematics research, namely oversimplifying mathematical content and cultural value distortion in ethnomathematics research. The findings are expected to contribute to redirecting ethnomathematics research in accordance with the philosophical foundations proposed by its originators.

Keywords: misuse, ethnomathematics, critique, mathematics education philosophy

Abstrak

Penelitian ini terinspirasi dari studi yang dilakukan Pais (2011), yang menyajikan kritik dan kontradiksi pada etnomatematika. Kritik yang dipaparkan mengacu pada filosofi etnomatematika yang dianggap bertentangan dengan tujuan etnomatematika itu sendiri. Berkaca dari studi Pais (2011), penelitian ini bertujuan untuk mengkaji bentuk-bentuk penyalahgunaan (*misuse*) di dalam berbagai penelitian etnomatematika. Pendekatan filosofis digunakan untuk menunjukkan bahwa penyalahgunaan tersebut sering kali tidak disadari dan telah menyimpang dari tujuan awal etnomatematika. Penelitian ini menggunakan pendekatan kualitatif dengan jenis studi literatur. Literatur yang dianalisis berasal dari buku, artikel ilmiah, dan dokumen yang berkaitan dengan etnomatematika dan filsafat pendidikan matematika. Hasil penelitian ini mengidentifikasi dua kategori utama penyalahgunaan (misuse) dalam penelitian etnomatematika, yaitu penyederhanaan berlebihan (*oversimplifying)* terhadap konten matematika serta distorsi nilai budaya (*cultural value distortion)* pada penelitian etnomatematika. Temuan ini diharapkan dapat memberi kontribusi untuk mengarahkan kembali penelitian etnomatematika sesuai dengan landasan filosofis yang diajukan oleh para pencetusnya.

Kata kunci: kesalahan penggunaan, etnomatematika, kritik, filsafat pendidikan matematika

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INTRODUCTION

Ethnomathematics was first defined by D'Ambrosio (1985) as mathematics practiced in various cultural groups, such as ethnic communities, working groups, children, and professional classes. This means that it is practiced by different cultural groups and can differ from the formal mathematics known and recognized today (Barton, 1999). Meanwhile, Ascher & D'Ambrosio (1994) consider ethnomathematics as mathematical ideas wherever mathematics is applied. Thus, ethnomathematics was initially defined as mathematics applied by certain ethnic groups or primitive mathematics.

Subsequently, the term ethnomathematics evolved from simply 'ethnic mathematics'. D'Ambrosio (1999) defines ethnomathematics as a research program in the history and philosophy of

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mathematics (with pedagogical implications) that focuses on the arts and techniques (*tics*) for explaining, understanding and coping (*mathema*) with various phenomena in a socio-cultural (*ethno*) context. This change in terms explicitly demonstrates D'Ambrosio's (2007) attempt to avoid confusion with the terms ethnic mathematics or primitive mathematics, as understood by many (François & Van Kerkhove, 2010; Rowlands & Carson, 2002). Thus, ethnomathematics is now understood more broadly than cultural mathematics as an in-depth research program.

When referring to Ernest's (1991) view, the philosophy of ethnomathematics can be viewed in terms of the philosophy of mathematics and the philosophy of mathematics education. In terms of the philosophy of mathematics, ethnomathematics is seen as an antithetical form of absolutism, namely fallibilism (Ernest, 1991). Ethnomathematics contradicts Platonism's view of mathematics as pure, holy, solid, absolute, and free from "dirty human values" such as politics, culture, and language (Bishop, 1990; Pais, 2011; Žižek, 1997). In contrast, ethnomathematics represents a fallibilist view that sees mathematics as something that can change (Appelbaum & Stathopoulou, 2023; Ernest, 1991), and can even be constructed and reconstructed by society (Bishop, 1997). As described by D'Ambrosio (2016), ethnomathematics is a form of 'resistance' to 'Eurocentric' mathematics that colonizes indigenous mathematics. This 'colonization' discredits, discards, and considers mathematics that is naturally constructed by ethnic groups as something that is not mathematical (Bishop, 1990; D'Ambrosio, 2016; Orey & Rosa, 2022).

On the other hand, the philosophy of mathematics education views ethnomathematics as part of an epistemology of pluralism (François & Van Kerkhove, 2010). Ethnomathematics recognizes the diversity of sources of knowledge, as described by Ascher & D'Ambrosio (1994), namely mathematical ideas wherever mathematics is applied. Ethnomathematics is also supported by the social constructivism approach in the philosophy of mathematics education. Social constructivism views mathematics as a result of social construction influenced by culture and history (Ernest, 1991). In other words, mathematics can be influenced by culture and can be constructed differently in each cultural group even though the essence remains the same (Bishop, 1988; Harding, 2021; Pais, 2011). Barton (1999) cited the example of the sailing navigation culture developed by two different Pacific tribes on different islands, but they used the same mathematical principle of analyzing ocean waves in three dimensions.

In addition, the cultural relativism view in educational philosophy also asserts that the meaning and value of mathematics is different in each society, as described by Wittgenstein (2009) in the concept of 'language games' which are seen as rules in mathematics (Ernest, 1991; Knijnik, 2012; Vilela, 2010). This relativist philosophy challenges the absolutist view of mathematics, which sees mathematics as objective and universal (Barton, 1999; François & Van Kerkhove, 2010). This relativist approach is considered more inclusive and humanistic towards mathematics education (Albanese, 2021; Ernest, 1991).

As a research program, ethnomathematics has now developed rapidly. This is indicated by

various trends in ethnomathematics research that are increasingly mushrooming (Alghar & Radjak, 2024; Nuryadi et al., 2021; Pradana et al., 2022). However, in practice, researchers have found many misuses in ethnomathematics research. Misuse that occurs can reduce the philosophical and pedagogical value of ethnomathematics (Pais, 2011; Xu & Ball, 2024). For example, misuse in ethnomathematics research considers geometric shapes on cultural artifacts as a form of 'exploratory research', without an in-depth study of its geometric elements mathematically. This can reduce the essence of ethnomathematics and trivialize a mathematical concept without proving or analyzing the properties of the concept (Rosa & Orey, 2016; Xu & Ball, 2024). It also undermines other approaches that are 'similar' to ethnomathematics, such as contextual mathematics, realistic mathematics, and ethnomodelling (Alghar & Jamaluddin, 2024; Desai et al., 2022; Rosa & Orey, 2022).

From a pedagogical perspective, many researchers and teachers only present the study of cultural artifacts and relate them mathematically without exploring the cultural values. This can lose the philosophy of ethnomathematics itself as a form of respect for the values of a culture (Barton, 1999; D'Ambrosio, 2016; François & Van Kerkhove, 2010). As criticized by Žižek (1997), Rowlands & Carson (2002), and Pais (2011), ethnomathematics programs that get off track have serious implications for mathematics learning. Instead of enriching students' understanding, misuse of ethnomathematics can lead to confusion, contradiction, or even discredit a particular culture (Žižek, 1997). Moreover, misuse of ethnomathematics can also undermine the essence of the philosophy of mathematics education, which aims to support inclusivity and respect for intellectual and cultural diversity (Barton, 1999; D'Ambrosio, 2016; Ernest, 1991). Therefore, an in-depth study is needed to look at the various errors in ethnomathematics, identify them from a philosophical perspective, and explore ways to correct them.

Thus, this study aims to provide a critical reflection on ethnomathematics, especially regarding the various misuses in ethnomathematics research, which can undermine the purpose of ethnomathematics itself. It is hoped that this article will not only contribute in presenting various criticisms, but also as a reflection to encourage the application of ethnomathematics that is more qualified, meaningful, and ethical.

METHODS

This study employed a qualitative research approach with a literature study design. The qualitative approach was chosen because the data analyzed were in the form of texts, arguments, and concepts (Flick, 2013). The focus of the study was to identify potential misuse in ethnomathematics research and to analyze it through philosophical perspectives. The data of this research consisted of secondary sources such as books, peer reviewed journal articles, and conference proceedings relevant to ethnomathematics, ethnomodelling, and philosophy of mathematics education. Foundational works by D'Ambrosio (1985), Ernest (1991), Bishop (1988), and Pais (2011) were considered as the primary references because of their significant contributions to ethnomathematics and its critique. Additional

data were obtained from recent publications on mathematics education that connect ethnomathematics. The analysis technique used in this study was content analysis, which involved identifying, coding, and categorizing emerging themes from the literature. The analytical process was carried out in three stages, (1) collecting and reviewing relevant literature, (2) coding recurring issues such as oversimplification or cultural distortion, and (3) interpreting the findings through philosophical frameworks. The philosophy of mathematics perspectives employed included fallibilism, social constructivism, and Wittgenstein's language-game theory.

RESULTS AND DISCUSSION

Ethnomathematics in terms of Philosophy of Mathematics and Mathematics Education

In this section, the researcher tries to present a discussion of ethnomathematics seen from the perspective of the philosophy of mathematics and the philosophy of mathematics education sourced from Ernest (1991). The view of fallibilism represents part of the philosophy of mathematics, while the view of social constructivism and Wittgenstein's view.

a. Fallibilism and Ethnomathematics

Fallibilism is a view that assumes that knowledge (including mathematics) is provisional and fallible (Ernest, 1991). This means that there is no absolute truth in knowledge, including mathematics. Fallibilism rejects the idea that mathematics is a perfect, pure, eternal, and error-free system (Rowlands et al., 2011). Fallibilism opposes the idea brought by Absolutism that mathematical knowledge has absolute truth and cannot be refuted. Instead, fallibilism recognizes that mathematics can be revised and influenced by certain social, cultural, religious, and doctrinal contexts (Ernest, 1991).

The view of fallibilism in mathematics describes a dynamic movement in the discovery of new mathematical concepts. Mathematical truths that were once considered absolute are now proven to have limitations or errors (Ernest, 1991; Glas, 1998). For example, Euclid's geometry, which has always been considered true, turned out to be unable to solve problems in space that is round (solid), giving birth to non-Euclid geometry (Ernest, 1991). This means that fallibilism emphasizes that mathematics can develop through experimentation, discussion, and revision of existing theories, so that mathematical truth is not always absolute.

Fallibilism, which considers mathematics as knowledge that can be revised and influenced by 'human nature', aligns with ethnomathematics (Barton, 1999). Ethnomathematics sees mathematics as a social construction influenced by a group's culture (François & Van Kerkhove, 2010). In other words, no single mathematical system can be considered absolute and comprehensive (Ernest, 1991). Fallibilism "supports" ethnomathematics by asserting that all forms of knowledge, including traditional mathematical systems, are subject to change according to cultural developments and the needs of society (Barton, 1999; D'Ambrosio, 1985). Hence, this view makes room for the diversity of mathematical systems across cultures. This strengthens the argument that formal mathematics, which tends to be

Eurocentric, is not the only way to understand mathematical concepts (Cimen, 2014; François & Van Kerkhove, 2010; Knijnik, 2012).

Fallibilism in ethnomathematics also highlights mathematics as a product of human experience. Traditional mathematical systems, such as the calculation methods of a cultural group (Umbara et al., 2021) or geometric patterns in local art (Alghar & Marhayati, 2023) are the result of adaptations to the environment, practical needs, and representations of the creative ideas of the community (Knijnik, 2012). Fallibilism suggests that traditional mathematical systems are dynamic and evolve or are even replaced over time (Ernest, 1991). Such as traditional calculation methods that may adapt and integrate with modern technology (Umbara et al., 2021).

Fallibilism in ethnomathematics reinforces the assumption that "error" is a natural part of knowledge development (Ernest, 1991). Errors that build knowledge are not things to be avoided, but rather opportunities to open up other, more relevant concepts. This reflects the core of fallibilism, which is that knowledge can change based on new experiences or different needs (Ernest, 1991; Glas, 1998). Thus, fallibilism reflects ethnomathematics as a framework that recognizes the social presence in constructing mathematical knowledge (Appelbaum & Stathopoulou, 2023; Barton, 1999; D'Ambrosio, 2016; Harding, 2021).

b. Social Constructivism and Ethnomathematics

Social constructivism is an important approach in the philosophy of mathematics education (Ernest, 1991). Social constructivism considers that mathematical knowledge is not only discovered individually, but is the result of a process of social interaction (Vygotsky, 1978). Ernest (1991) explained that mathematics is a human construction that develops with the culture of society. This means that mathematical knowledge is not static, but something that continues to change along with the social and cultural context.

One important aspect of social constructivism is the recognition of the role of cultural context in the formation of mathematical knowledge (Barton, 1999; Cobb & Yackel, 1996). Ernest (1991) criticized the traditional view that views mathematics as a universal science independent of culture. Instead, he argued that the mathematical concepts we learn today are the result of a long cultural evolution. This process is influenced by practical needs, social customs, and symbol systems developed in a particular society (Ascher & D'Ambrosio, 1994; Barton, 1999; Ernest, 1991).

Social constructivism has strong links with ethnomathematics (Barton, 1999). In ethnomathematics, mathematics is seen as a product of social construction rooted in the traditions, beliefs and activities of the community (D'Ambrosio, 2016). Mathematics is not only universal, but also rich with local meanings influenced by cultural context (Knijnik, 2012). Therefore, ethnomathematics provides a new perspective on how mathematical knowledge is created, learned and applied.

In the educational sphere, social constructivism in ethnomathematics emphasizes the importance

of engaging students in the exploration of the relationship between mathematics and their culture (Barton, 1999; Rodrigues et al., 2021). This learning process involves recognizing that students' experiences are influenced by their social and cultural environments. For example, in Rodrigues's et al., (2021) 'math trails', students learn mathematical concepts through hands-on exploration of cultural heritage buildings. The teacher acts as a facilitator who helps students connect formal mathematical knowledge with cultural artifacts. In this way, students can understand mathematics as part of life, not as an abstract concept separated from reality (Rodrigues et al., 2021).

Within the framework of social constructivism, ethnomathematics serves not only as a pedagogical approach, but also as a social movement that 'challenges' the 'colonial' paradigm in mathematics (Barton, 1999; D'Ambrosio, 2016; Orey & Rosa, 2022). This approach invites educators to view mathematics as an integral part of people's social and cultural lives. By integrating ethnomathematics in education, students not only learn about mathematics but also understand their cultural values and identity (Rodrigues et al., 2021). Ultimately, social constructivism in ethnomathematics offers a new way to understand and teach mathematics that is more inclusive, relevant and meaningful to students.

c. Wittgenstein Philosophy and Ethnomathematics

In his book, Ernest (1991) explains the view of Ludwig Wittgenstein which links language and mathematical philosophy. Wittgenstein (2009) views mathematics not as an absolute truth, but as a social practice that is constructed through certain rules like language. Ernest (1991) adopted the idea of Wittgenstein that mathematics is "Language Game". This means that the meaning of a mathematical concept is determined by its use in people's lives (Wittgenstein, 2009). Indirectly, this view considers mathematics not only logical and abstract, but also related to social, cultural, and language context.

In the view of Wittgenstein (2009), the meaning of mathematics depends on the way humans use it in various life activities. This view is reinforced by (Ernest, 1991) who rejects the idea that mathematics is a closed system and is separated from the real world. In addition, Wittgenstein explained the idea of "Agreement in Form of Life", namely the meaning of mathematics depending on social agreements in its use (Knijnik, 2012; Vilela, 2010; Wittgenstein, 2009). This idea highlights the role of the community in building and spreading mathematical knowledge.

On the other hand, the idea of Wittgenstein is in harmony with the ethnomathematics approach (François & Van Kerkhove, 2010; Vilela, 2010). Wittgenstein views mathematics as part of the "language game" that refers to the rules, such as axioms, postulates, and definitions, in society (Wittgenstein, 2009). The idea of Wittgenstein is in line with ethnomathematics which sees mathematical construction that is influenced by local traditions and habits. In addition, the Wittgenstein approach in language philosophy also supports the view that mathematics is pluralistic (Vilela, 2010). There is no one form of mathematics that is "superior" compared to other forms. In ethnomathematics, this view confirms the importance of respecting the traditional mathematical system that is often ignored

in formal education (Knijnik, 2012; Vilela, 2010). This confirms that mathematics, as language, is a human product that is influenced by various cultural backgrounds.

Thus, ethnomathematics in Wittgenstein's philosophy see mathematics as a dynamic and inclusive social practice. This approach encourages respect for the diversity of culture and livelihoods of dialogue between formal and non-formal mathematics. In this way, ethnomathematics becomes a bridge that connects mathematics with real life from a social group (Barton, 1999; Knijnik, 2012; Vilela, 2010).

Misuse in Ethnomathematics Research

This study identifies several categories in misuse (misuse) in the context of ethnomathematics research. Researchers also reviewed this error and their impact in terms of philosophy of mathematics education.

a. Oversimplification of mathematical concepts in ethnomathematics research

One of the mistakes that is often found in ethnomathematics research is excessive simplification of mathematical concepts. Many ethnomathematics studies have reduced mathematical concepts in a cultural object, such as artifacts, without deepening the concept. Simplification of mathematical concepts does not reflect the complexity, wealth, and true beauty of mathematics (Pais, 2011). In fact, mathematics is a science that is constructed hierarchically and tiered, so that the concept is built on the structures that strengthen each other and valid (Rowlands & Carson, 2002; Žižek, 1997). Simplifying mathematical concepts in various ethnomathematics studies gives the impression of the neglect of the hierarchy of mathematics itself.

For example in several ethnomathematics studies that explore geometric concepts in cultural artifacts, such as batik (Sari et al., 2021; Zayyadi, 2017). Not a few studies that only "announce" the existence of a mathematical concept in the cultured artifact without him validating the truth of the concept. These studies tend to state the existence of "triangular concepts" in a cultural heritage building without validating, such as measurement or calculation, to prove that the object meets the triangular forming requirements so that it can be said to contain triangular concepts. That is, such research injury to how mathematical concepts are built formally.

In addition, in determining whether a cultural object meets certain mathematical concepts, validation is needed that involves mathematical activities. As explained by Bishop (1988), mathematical activity in a cultural group involves calculating, measuring, determining location, designing, playing, and explaining. The absence of activities such as designing, measuring, and calculating objects that allegedly contain a mathematical concept makes the validity in the study doubted (Pais, 2011). What a 'damage' an ethnomathematics study that states an object fulfills a mathematical concept without doing a valid proof of the object (Pais, 2011; Rowlands & Carson, 2002). In other words, this error not only injured the 'ethics' of mathematical research, but tarnished the nature of mathematics itself as a structured, logical, and inductive science (Pais, 2011; Žižek, 1997).

b. Cultural Value Distortion in Ethnomathematics Research

Misuse in other ethnomathematics research, cultural value distortion. Researchers termed cultural value distortion as a mistake in understanding, interpreting, or representing the cultural values of a group of people, so as to produce meaning that deviates from its original context (Pais, 2011; Žižek, 1997). Researchers view this error due to the weak ethnographic methodology used, the use of references that are not sourced from the original, to resource persons who are not 'key characters'.

In terms of ethnographic methods, researchers should be able to distinguish between qualitative methods of ethnographic types with other qualitative types, such as phenomenology, exploration, and case studies (Flick, 2013; Spradley, 1997). That is, a researcher's understanding of ethnographic research needs to be deepened before conducting ethnomathematics research (Pais, 2011). If this is not possible, researchers can follow the stages of ethnographic research from credible sources, not the 'as if' research stages.

Then, the mismatch of cultural values is also caused by the references used. Not a few researchers who give the meaning of a cultural object based on previous ethnomathematics articles, without him referring to valid articles (Sari et al., 2021; Zayyadi, 2017). Supposedly, the cultural meaning of a cultural object is quoted from a source of reputable or journal with a scope of history, anthropology, sociology, and the like (François & Van Kerkhove, 2010). This is to minimize the mistakes made by researchers in including the cultural value of the object under study. In addition, research was also found that conducted interviews with figures who were not 'key figures' or did not even use the interview method of traditional leaders (Sari et al., 2021; Zayyadi, 2017). This is seen as something that is 'dangerous' because it can eliminate, refract, and damage the cultural values of a group (Flick, 2013; Spradley, 1997). Therefore, interviews with 'key figures' who truly understand the cultural values of the object being studied are things that are necessary in ethnomathematics research (François & Van Kerkhove, 2010; Spradley, 1997).

Researchers cited the cultural value of distortion in ethnomathematics research such as the meaning of batik motifs from a cultural group. Not a few studies that present cultural values of batik motifs whose interpretations are wrong or even do not present the interpretation of cultural values (Pais, 2011; Žižek, 1997). Like the rhombus motif in Madura batik which is rarely studied its meaning (Sari et al., 2021; Zayyadi, 2017). Researchers only focus on presenting the concept of flat shapes, such as rhombus, in Madura batik without looking at the cultural values of the motif. Even though the cultural value of the rhombus motif symbolizes the *bhajit* (*wajik*) which represents the permanence, harmony, and eternity of love from the bride who wears the batik (Suhaimi, 2020). These things are often neglected from ethnomathematics research. Whereas the delivery of cultural values is a characteristic of ethnomathematics, which distinguishes it from contextual and realistic mathematical mathematics (Desai et al., 2022; François & Van Kerkhove, 2010; Pais, 2011).

In addition, researchers also saw the cultural value of distortion that injured the philosophy of mathematics education, such as social constructivism and Weitgestin's views. From the perspective of

social constructivism, cultural value distortion can eliminate the characteristics of cultural values that form the basis of the construction of knowledge in a group of people (Barton, 1999; Pais, 2011). As a result, the interpretation of mathematics presented is irrelevant to the real experience of the community. While from the perspective of Wittgenstein's philosophy, cultural value distortion destroys the authentic meaning of social practices which form the basis of local mathematical activity (Ernest, 1991; Vilela, 2010). Wittgenstein's view emphasizes the importance of "practice" as a source of meaning from a cultural group, which will be distorted if cultural values are understood wrongly (Knijnik, 2012; Pais, 2011; Vilela, 2010).

Thus, cultural value distortion not only harms ethnomathematics research in terms of methodology, but also injures the philosophical values of mathematical education, such as social constructivism and Wittgenstein's views. Solutions that make it possible to overcome this problem include strengthening ethnographic research methodologies, the use of credible references, and the involvement of key figures in interpreting cultural values. By paying attention to this solution, it is expected that the quality of ethnomathematics research can be more accountable, relevant, authentic, meaningful, both in terms of academic and socio-cultural side.

CONCLUSION

This study confirms that ethnomathematics can be viewed from mathematical philosophy, such as fallibilism, and philosophy of mathematical education, such as social constructivism and Ludwig Wittgenstein’s views. In addition, this study also explained the existence of misuse in ethnomathematics research that can harm the philosophical value and the purpose of ethnomathematics. Two categories of misuse presented include oversimplification of mathematical concepts and cultural value distortion in ethnomathematics research. Help by paying attention to these two categories, ethnomathematics research in the future will more appreciate the philosophical values of a culture and strengthen the logical, structured, and inductive principles in mathematics, so that it has an impact on the achievement of the objectives of the ethnomathematics approach.

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