

# A Systematic Review on Ethnomathematics Integration in Secondary Education

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## Abstract

Several studies have highlighted the positive impact of integrating ethnomathematics into the formal secondary mathematics curriculum. However, there is limited literature discussing the state in which ethnomathematics is effectively integrated into secondary schools. To address this gap, this systematic review examined 37 studies on the ethnomathematics-integrated approach in secondary mathematics classrooms from 2009 to 2023. The findings reveal that local daily activities, farming, and weaving are the most prevalent cultural elements considered in ethnomathematics-based lessons, with the contextual learning model as the most prevalent instructional approach used. Among the 37 studies, 67.5% were conducted under geometry, with two-dimensional shapes as the most chosen topic. The findings further reveal that integrating ethnomathematics at the secondary level results in learners' improved mathematical performance, characterized by increased mathematics achievement, conceptual understanding, and enhanced higher-order thinking skills (HOTS). In addition, ethnomathematics fosters learners' positive attitudes, demonstrated by increased interest and motivation toward the subject of mathematics.

**Keywords:** Ethnomathematics, Contextual Learning Model, Secondary Mathematics, Mathematics Instructional Approach

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## 1. Introduction

The integration of ethnomathematics into secondary education represents a growing field of inquiry within mathematics education research. Ethnomathematics, a discipline that explores the cultural dimensions of mathematical knowledge and practices, has gained increasing recognition for its potential to enrich learners' learning experiences and foster greater engagement with mathematical concepts (Günay & Takunyaci, 2023).

In recent years, several studies have investigated the effects of ethnomathematics integration on learners' motivation, attitudes, and achievement in mathematics classrooms. These studies have demonstrated the potential of ethnomathematics to enhance learners' understanding of mathematical concepts by contextualizing them within cultural frameworks. Studies conducted by Lipka, Wong, & Ihrke (2012) and Amit & Abu Qouder (2017) have highlighted the positive impact of ethnomathematics integration on learners' mathematical performance and attitudes towards the subject.

While previous studies have highlighted the positive impacts of integrating ethnomathematics into educational practices, demonstrating its potential to enhance learners' motivation, attitudes, and achievements in mathematics classrooms (e.g., Achor et al., 2009; Ozofor & Onos, 2018; Sunzuma et al., 2021), there remains a notable gap in the literature regarding comprehensive reviews and practical guidance for educators on how to effectively integrate ethnomathematics into teaching practices (Alangui, 2010). More so, it is necessary to examine the recent development of ethnomathematics and define its characteristics when integrated in the context of secondary education.

This review study sought to address this gap by providing a comprehensive synthesis of the current state of ethnomathematics integration in secondary education across different countries. By synthesizing existing

research findings and identifying key trends in the field, this study aimed to contribute to a deeper understanding of the potential of ethnomathematics integration at the secondary level. Through exploration of the instructional design, content, and learning outcomes associated with ethnomathematics integration, this study aimed to provide valuable insights for educators, policymakers, and researchers in terms of knowledge about the potential grounds of ethnomathematics integration.

As such, this study aimed to determine the trend in which ethnomathematics is integrated into secondary schools. Moreover, it sought to address the following research questions:

- 1) How is ethnomathematics integrated into secondary-level education?
- 2) What are the content areas from which an ethnomathematics lesson can be designed?
- 3) What are the learning outcomes of ethnomathematics integration in secondary schools?

## 2. Method

This review was conducted to analyze and synthesize studies relevant to answering the research review questions. The study followed the process of a literature review given by Kitchenham & Charters (2007). Figure 1 presents the diagram of the phases of article selection process:

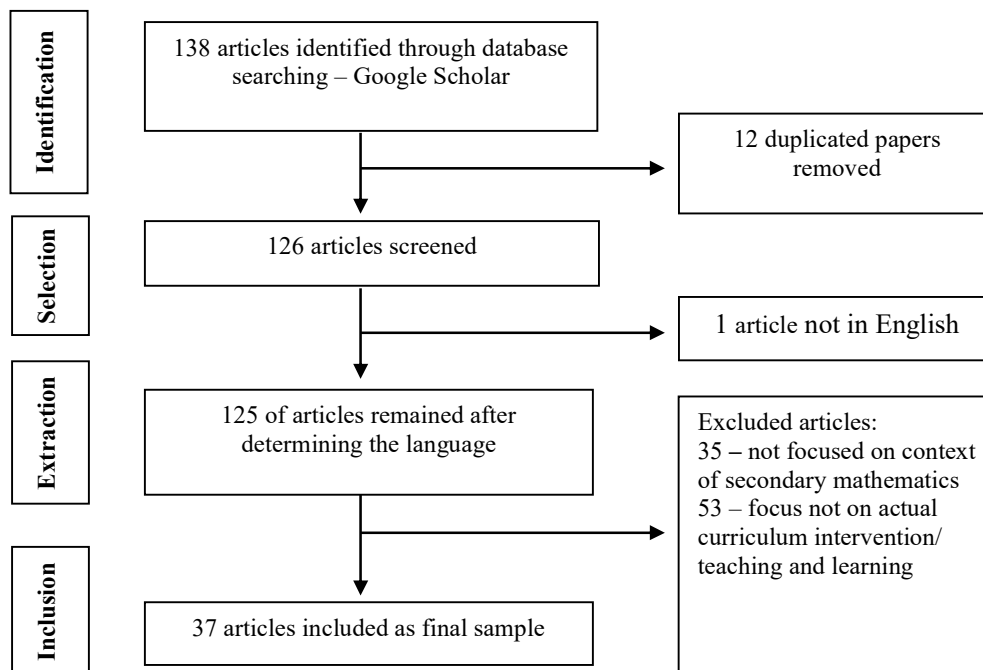


Figure 1. Diagram of the phases of the article selection process

Articles published in scientific journals, from January 2009 to March 2024 were considered in the inclusion criteria for the final sample article. The studies considered were published in at least peer-reviewed journals. The searches for relevant articles were done on Google Scholar. Evidence suggesting that Google Scholar is a highly effective tool for searching scholarly literature was established, and hence, this database is widely used by researchers as sources or relevant literature (De Winter et al., 2014; Gehanno et al., 2013). This review study utilized the following search strings: “Ethnomathematics” AND “Secondary” OR “High School”; and “Contextualization” OR “Culture” AND “Mathematics” AND “High School” OR “Secondary”.

After a comprehensive search, a total of 138 articles were initially identified. Duplicated records were then identified, and a total of 12 duplicate papers were rejected from the article sample. The articles were then reviewed, and one (1) article was identified as being communicated in another language, i.e., not in English, which was then also excluded from the list.

A total of 125 articles were initially selected and were subject to exclusion criteria. The first inclusion criterion was the article’s focus on curriculum interventions, i.e., the study must have actual development or

implementation of instructional interventions in ethnomathematics. The second inclusion criterion was that the study's focus of curriculum intervention must be on learners in the secondary. Abiding by this criteria, 35 articles were identified as being conducted outside the context of secondary levels, and another 53 articles were identified to have neither involved a development nor implementation of instructional intervention in ethnomathematics. Hence, there were 37 articles that were considered part of the final review sample. It is important to emphasize that several articles were found in the database that were published across countries, however, only 37 of them passed the set inclusion criteria.

Meanwhile, all articles included as the final sample were published in different years, from 2009 until 2003. The distribution of the year of publication is presented in Figure 2 below.

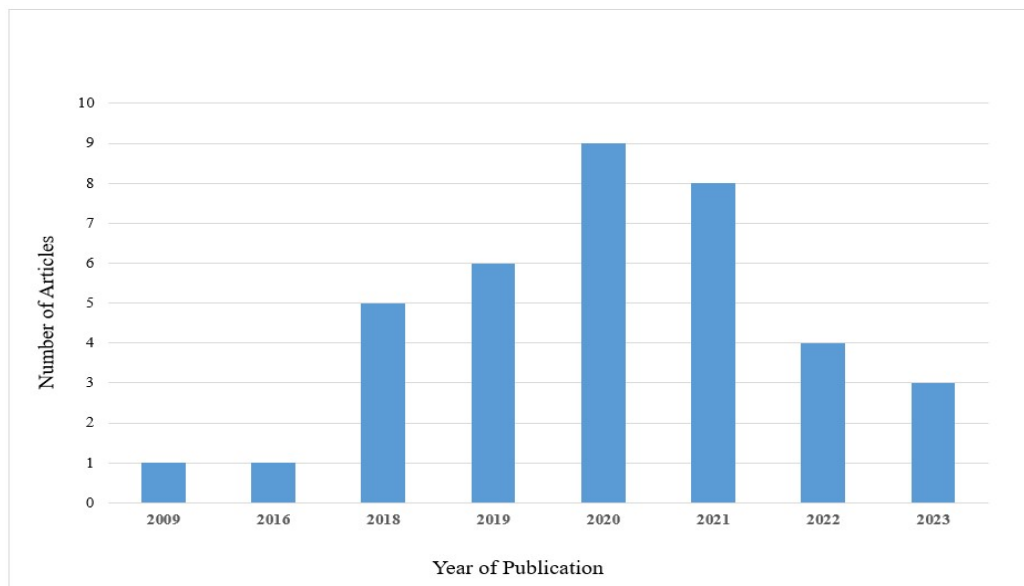


Figure 2. Distribution in the year of publication of the final sample articles

### 2.1 Data Analysis

This study employed content analysis to extract, code, and categorize systematically the articles included with respect to the research questions. Meanwhile, thematic analysis was conducted to determine the learning outcomes of integrating ethnomathematics in secondary education.

## 3. Results and Discussion

Among the 37 articles considered as the final sample, 21 or 57% were fully implemented at the secondary level, while the other 16 or 43% of the articles were only limited to the development of ethnomathematics teaching materials. The following sections present the findings of this study.

### 3.1 Ethnomathematics Integration in Secondary Education

This section presents the context of ethnomathematics integration in secondary-level education. As presented in Figure 3, local daily activities, farming culture, and weaving tradition are the most prevalent community contexts where ethnomathematics instruction is designed at the secondary level. This finding reveals the potential of traditional community activities including daily rituals and prayers (e.g., Kurumeh et al., 2016; Kusumaningsih et al., 2020), farming culture including means of cultivating crops (Marleny et al., 2020), and tribal techniques in weaving various fabrics, as sources of rich mathematical knowledge.

By providing learners with the opportunity to connect their daily life activities with their mathematics lesson through what is referred to as an external mathematical connection (Kusuma et al., 2019), meaningful learning is

fostered and eventually learners' achievement in mathematics could be increased.

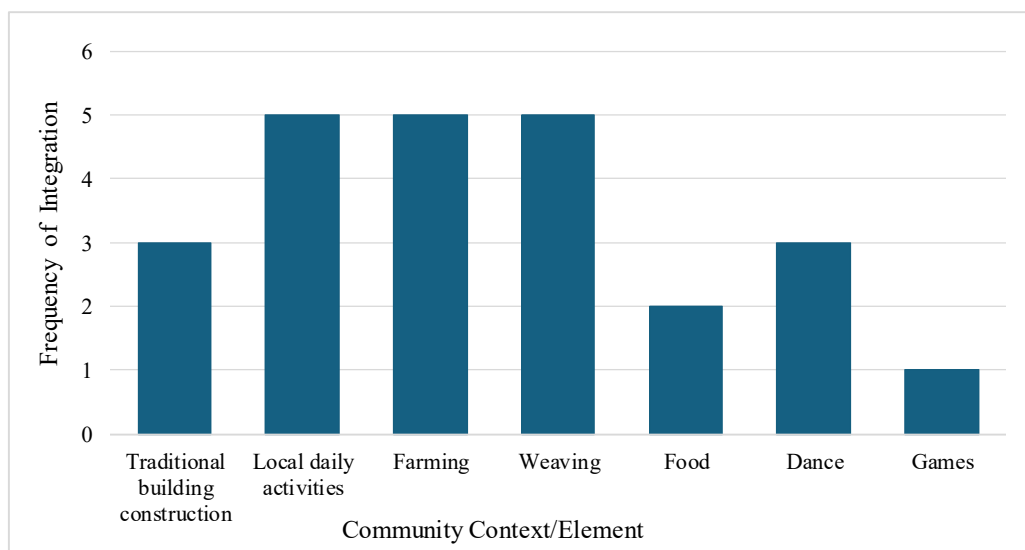


Figure 3. Context of Ethnomathematics Integration

Weaving traditions are also seen as a potent context for ethnomathematical integration since they cater to a wide range of mathematical applications, from complex patterns and sequences (Indriati et al., 2022) to symmetry and spatial reasoning (e.g., Dwi et al., 2021; Hasanah et al., 2021). In addition, the findings reveal that the traditional tools used in farming, the analysis of the probable harvest based on the land area, and the techniques used in crop cultivation are also rich areas where ethnomathematics could be developed (e.g., Herawaty et al., 2020a; Terungwa & Tertsea, 2021).

It can also be observed that traditional games are the least utilized context of ethnomathematics integration at the secondary level. This is despite the fact that traditional games are widely considered as an area of integration at the primary level (Zayyadi et al., 2018; Fouze & Amit, 2018). However, it could be emphasized that all the contexts of integration produce positive results in terms of learners' learning outcomes.

On the other hand, the learning approaches for implementing ethnomathematics vary. Figure 3 presents the different learning approaches that serve as vehicles for integrating ethnomathematics in secondary schools. It can be observed that contextual learning is the most frequent approach utilized by researchers in implementing ethnomathematics. It is worth noting that in studies where contextual learning is used as a teaching approach to ethnomathematics, the development of problem-solving skills alongside conceptual understanding is commonly aimed at (e.g., Nur et al., 2020; Widada et al., 2020a). This is congruent with the claim that the contextual learning approach effectively fosters mathematical problem solving since it allows learners to build understanding by linking it to their daily experience (Surya et al., 2017).

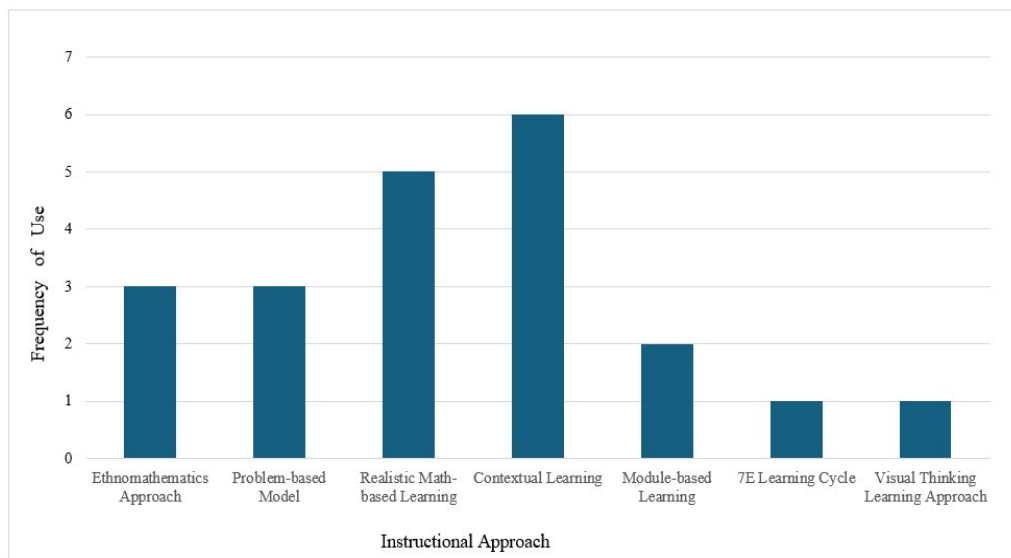


Figure 3.2 Instructional Approaches in Integrating Ethnomathematics in Secondary Level

Moreover, realistic mathematics-based learning is also a prevalent approach in teaching ethnomathematics at a secondary level. Realistic mathematics-based learning (RmBL) provides learners with the opportunity to apply what they have learned in real-life activities (Nurina & Ama, 2018). For instance, the study conducted by Marleny et al. (2020) designed RmBL ethnomathematics-based instruction that enables learners to identify and apply geometric patterns to maximize spacing in planting palm oil to maximize growth and harvest. This study particularly enables learners, both at high and low cognitive levels, to efficiently apply what they have learned mathematically.

Based on the findings, the Ethnomathematics Teaching Approach (ETA) is characterized by either a practical, immersion-based, or pragmatic approach, which in most studies, increases learners' mathematics achievement. Furthermore, teaching approaches such as the 7E Learning Cycle and Visual Thinking Learning are also considered vehicles for ethnomathematics integration and are seen to enhance learners' mathematical literacy.

### 3.2 Content Areas for Ethnomathematics Integration

Table 1 presents the different mathematical content areas where ethnomathematics is integrated into secondary-level education. As observed in the table, 67.5% identified geometry as the area of ethnomathematics integration. For example, studies conducted by Imswatama & Lukma (2018) and Ma'Rifah et al. (2021) investigated learners' critical thinking and conceptual understanding by integrating traditional building design in the context of teaching properties of 2-dimensional shapes. Findings reveal that geometry is the area most susceptible to ethnomathematics integration, with "Properties of 2-Dimensional Shapes" being the most frequent topic of integration.

A significant 24.3% of the studies were conducted in the context of algebra. Most of the studies conducted in algebra delved into improving learners' problem solving, including concepts such as linear equations, and word problem-solving (e.g., Sari et al., 2023 Sunzuma et al., 2021; Widada et al., 2020b). It is worth noting that "linear equation" is most frequently integrated with ethnomathematics, as this is a topic that caters to a wide range of applications in real-life situations (Wardono, 2021).

Statistics, however, is the least considered content area for ethnomathematics integration. Combinatorial and probabilistic reasoning can be potentially integrated with the culture of gambling, which is less considered as a teaching material for secondary teachers (Ambarwati, 2020).

Table 1 Identified Mathematical Content Areas where Ethnomathematics is Integrated

Content Area	Topic	Frequency	Percentage
Algebra	Arithmetic	2	5.4%
	Linear Equation	6	16.2%
	Word Problem Solving	1	2.7%
Geometry	Inductive and Deductive Reasoning	1	2.7%
	Properties of 2D Shapes	13	35.1%
	Pythagorean Theorem	2	5.4%
	Locus	1	2.7%
	Transformation Geometry	2	5.4%
	Congruence	1	2.7%
	Object Configuration	2	5.4%
	3D Objects	1	2.7%
	Parallel Axiom	1	2.7%
	Vectors	1	2.7%
Calculus	Function	1	2.7%
	Solid Mensuration	1	2.7%
Statistics	Probabilistic and Combinatorial Reasoning	1	2.7%

### 3.3 Learning Outcomes of Ethnomathematics Integration in Secondary Level Education

Table 2 presents the themes generated on the learning outcomes obtained through ethnomathematics-integrated instruction on learners' conceptual understanding. Two themes emerged as learning outcomes of integrating ethnomathematics in secondary education across literature.

Implementing ethnomathematics in the classroom caters to the improvement of learners' mathematical performance. First, ethnomathematics-based instruction is presented to have a better learning outcome in terms of learners' mathematics achievement. It can be observed that in all studies comparing ethnomathematics-based instruction to traditional instruction, learners taught with the former exhibit increased learning through significantly higher achievement test scores than learners in the traditional approach. This result is highly evident in learners' increased retention of mathematical concepts (Terungwa & Tertsea, 2021).

Second, improvement in mathematical performance is evident in learners' conceptual understanding. Based on the reviewed literature, it has been found that incorporating a culturally relevant approach in teaching mathematics stimulates learners' comprehension of different mathematical topics such as triangles and angles, linear equations, and functions. This conceptual understanding of various mathematics concepts is characterized by learners' ability to demonstrate understanding of mathematics concepts and properties through their application (Herawaty et al., 2020b; Marleny et al., 2020). The integration of ethnomathematics in secondary mathematics has been shown to address learners' difficulties in understanding math concepts (Nursyahidah et al., 2018; Sari et al., 2023).

The development of secondary learners' higher order thinking skills (HOTS) is also a clear manifestation of how ethnomathematics-integrated lessons can improve their mathematical performance. The process of efficient learning in mathematics requires HOTS to solve relevant problems (Imswatama & Lukman, 2018). The emphasis on problem solving abilities and critical thinking in various forms, such as the ability to make conjectures, is widely acknowledged as significant aspects of learning mathematics. Moreover, the ability of learners to communicate mathematically projects a deeper understanding of a subject matter and is a predictive aspect of a learner's performance in the subject (Wardono et al., 2021). Hence, ethnomathematics could be considered an effective approach to teaching mathematics to improve learners' mathematical performance (Matang, 2001).

Table 2. Generated Themes and Supporting Findings on Learning Outcomes of Ethnomathematics in Secondary Level Education

Supporting Findings	Code	Theme
Students in ethnomathematics class has significantly increased achievement in mathematics than a class in traditional approach (Sunzuma et al., 2021; Achor et al., 2009; Oraneto & Omile, 2021; Kusuma et al., 2019; Terungwa & Tertsea, 2021).	Increased Mathematics Achievement	Improved Mathematical Performance
Students have corrected understanding on the concept of triangles and angles (Sari et al., 2023), system of linear equation (Sowanto & Mulyadin, 2019; Widada et al., 2020a), and modeling using function (Nursyahidah et al., 2018; Herawaty et al., 2020a).	Conceptual Understanding	
Ethnomathematics improved students' problem-solving abilities (Nur et al., 2020; Widada et al., 2020b; Nursyahidah et al., 2018), conjecturing abilities (Dwi Hastuti et al., 2021), critical thinking (Imswatama & Lukman, 2018), and communication skills (Wardono et al., 2021)	Enhanced Higher Order Thinking Skills	
Ethnomathematics increased students' interest in Mathematics (Oraneto & Omile, 2021, Suryonegoro & Hidayah, 2023)	Increased Students' Interest	Enhanced Positive Attitude
Students in Ethnomathematics class has increased motivation in learning Math through understanding culture (Indriati et al., 2022; Achor et al., 2009; Terungwa & Tertsea, 2021)	Increased Students' Motivation	

On the other hand, integrating ethnomathematics at the secondary level results in enhanced positive attitudes of learners towards mathematics. Specifically, learners exhibit increased interest in the subject since they are able to understand its relevance to the daily lives they have (Indriati et al., 2022). When learners are taught using materials that are indigenous to them, it enhances their interest, which brings about curiosity, creativity, and critical thinking that support their ability to achieve their learning goals (Oraneto & Omile, 2021). Teaching approaches that enhance learners' interest eventually increase their participation in the class, lessen self-doubt, and eliminate their fears of learning mathematics (Suryonegoro & Hidayah, 2023).

In addition, learners' motivation to learn mathematics is significantly increased in an ethnomathematics-integrated class. Introducing both culture and mathematics to learners is an interesting way to maintain and appreciate culture while developing knowledge in mathematics (Indriati et al., 2022). Also, Davidson (2010) claims that the interaction of native culture and mathematical ideas can be mutually reinforcing. Hence, in an ethnomathematics classroom, learners' negative perceptions about mathematics are effectively directed towards a positive attitude on the subject, knowing that this is closely connected with the way they live their lives (Terungwa & Tertsea, 2021).

#### 4. Conclusion

Following a systematic literature review procedure, the study found that local daily activities, farming, and weaving are the most prevalent community contexts in which ethnomathematics instruction is integrated in a secondary classroom. In this regard, the contextual learning approach is widely considered across literature as an instructional approach to bringing ethnomathematics into the formal secondary school curriculum. This strengthens the linkage between community culture and mathematics learning competencies (Kusuma et al., 2019).

Across different secondary mathematics content areas, ethnomathematics integration happens in geometry most of the time, and "properties of 2-dimensional shapes" is selected as the most common topic. In addition, this study found that the majority of the studies conducted integrating ethnomathematics in geometry were aimed at improving learners' geometric conceptual understanding, while studies conducted in algebra were focused on

learners' problem solving skill development.

Moreover, two themes emerged as the prevalent learning outcomes of integrating ethnomathematics into the formal secondary school curriculum. Ethnomathematics-based integrated instruction is seen to improve learners' mathematical performance, which is characterized by their increased mathematics achievement, better conceptual understanding, and enhanced higher order thinking skills. Also, ethnomathematics effectively fosters the positive attitude of learners towards mathematics, demonstrated by increasing interest and motivation in the subject. Literature consistently regards ethnomathematics as an effective approach to teaching mathematics in secondary level education (Herawaty et al., 2020a).

However, this review study is limited to determining the reach of ethnomathematics in the formal secondary curriculum and providing descriptive analysis on how ethnomathematics is implemented, including the learning outcomes it is capable of eliciting. Hence, the study recommends future researchers to conduct study analyzing the extent of the effects of ethnomathematics on different learning outcomes.

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