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EXPLORING THE INTEGRATION OF UNIVERSAL DESIGN FOR LEARNING IN ETHNOMATHEMATICS TEACHING: A SYSTEMATIC LITERATURE REVIEW OF THE SOUTH AFRICAN CONTEXT

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ABSTRACT

This review examines the application of Universal Design for Learning (UDL) in supporting ethnomathematics teaching in South African schools. Using a PRISMA-aligned systematic review, we analysed peer-reviewed studies published between January 2015 and July 2025. Of 520 records screened, 21 met the inclusion criteria and were synthesised qualitatively. Six clear findings emerged: (1) national policies and CAPS create a supportive environment for UDL-informed, context-rich mathematics; (2) culturally relevant tasks (e.g., indigenous games) improve learner engagement; (3) local artefacts (e.g., beadwork) provide multiple representations that enhance understanding; (4) teacher knowledge and sustained professional development are critical. A purposeful UDL integration can make ethnomathematics more accessible, meaningful, and inclusive in diverse South African classrooms. The review concludes that purposeful integration of UDL with ethnomathematics provides both pedagogical and cultural legitimacy, advancing inclusive mathematics education in South Africa. However, policy frameworks alone are insufficient; teachers require ongoing training, contextual resources, and support to translate inclusive principles into practice. The study recommends embedding UDL principles into teacher education programmes, designing continuous professional

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development focused on culturally responsive pedagogy, and leveraging community knowledge systems to create more inclusive and engaging mathematics classrooms.

KEYWORDS: Universal Design for Learning; Ethnomathematics; Inclusive Education; Mathematics Education; South Africa; PRISMA; Systematic Review.

1. BACKGROUND

Despite policy commitments to inclusion, mathematics classrooms in South Africa continue to face barriers related to language diversity, resource constraints, and curricula that do not reflect the local culture (DBE, 2001, 2011, 2014). These challenges contribute to ongoing achievement gaps, particularly for learners from disadvantaged communities, and raise urgent questions about how to make mathematics teaching more accessible, equitable, and culturally responsive. Mathematics education is not merely about transmitting abstract knowledge; it also reflects societal inequities while having the potential to transform them by creating learning environments where all learners can meaningfully participate (Bakker et al., 2021; Yolcu, 2019). Internationally, research focused on equity has increasingly shown that traditional approaches to mathematics often alienate learners from disadvantaged backgrounds (Crespo et al., 2022; Matthews et al., 2022). In South Africa, large-scale assessments such as TIMSS reveal stark inequalities in mathematics achievement that span socio-economic, linguistic, and geographic divides (Reddy et al., 2019). These findings underscore the necessity for more transformative pedagogical approaches, such as ethnomathematics and Universal Design for Learning (UDL).

Ethnomathematics emphasises how mathematical concepts are intertwined with cultural practices, artefacts, and games, providing students with familiar and meaningful methods to engage with mathematics (D'Ambrosio, 2001; Gerdes, 1998; Chahine, 2016). In South Africa, for example, beadwork patterns illustrate symmetry and geometry, while weaving demonstrates number patterns. Indigenous games like Morabaraba encourage counting, logic, and strategic thinking (Meeran, Kodisang, Moila, Davids, & Makokotlela, 2024). These methods make mathematics more relatable and affirm learners' cultural identities. However, although ethnomathematics has been widely recognised as a tool for inclusive education (Kabuye Batiibwe, 2024), its implementation remains inconsistent in developing regions. South African teachers often creatively adapt cultural resources, but they encounter challenges aligning these practices with the CAPS curriculum due to a lack of structured training and clear guidelines (Meeran & Van Wyk, 2022; Meeran et al., 2024). Beyond pedagogy, ethnomathematics plays a vital role in decolonising mathematics education by challenging Eurocentric traditions and grounding mathematics learning in students' lived experiences (Msila & Gumbo, 2016; Bhuda & Pudi, 2020; Mosimege & Egara, 2023).

The Universal Design Learning recognises that learners differ in how they are motivated, how they perceive and process information, and how they demonstrate what they know. Its three principles, namely: multiple means of engagement, representation, and action/expression, are closely related to brain networks associated with affective, recognition, and strategic learning processes (Boothe, Lohmann, Donnell, & Hall, 2018; Rose & Strangman, 2007). These principles correspond to affective, recognition, and strategic learning processes in the brain (Boothe, Lohmann, Donnell, & Hall, 2018; Rose & Strangman, 2007). UDL emphasises flexible and varied instructional approaches that challenge and support all learners (Hitchcock, Meyer, Rose, & Jackson, 2002; Rose, Gravel, & Domings, 2010). In the South African context, where learners come from diverse linguistic, cultural, and socio-economic backgrounds, UDL holds relevance because it enables teachers to anticipate learner variability and design lessons that are accessible, inclusive, and meaningful.

Integrating UDL with ethnomathematics presents a powerful synergy. Ethnomathematics provides culturally relevant and real-life entry points into mathematics, while UDL ensures these are presented in ways that engage all learners, offer conceptual access, and create equitable assessment opportunities (CAST, 2018, 2024; D'Ambrosio, 2001). This integration makes mathematics both inclusive and rigorous, aligning with South African policy priorities. The national policy environment, as outlined in White Paper 6, SIAS, and CAPS, emphasises barrier reduction, contextualised learning, and differentiated support, creating clear entry points for UDL-informed ethnomathematics (DBE, 2001, 2011, 2014).

While promising studies demonstrate the value of using cultural artefacts and indigenous games in mathematics teaching, systematic evidence on UDL-guided instructional design, assessment practices, and teacher professional development in South Africa remains fragmented (Nkopodi & Mosimege, 2009; Chahine, 2016). Small-scale case studies highlight teacher creativity and learner engagement, but they lack consistent frameworks for integration. This gap justifies a systematic literature review (SLR) to synthesise available evidence, identify barriers and enablers, and chart pathways for more structured integration of UDL and ethnomathematics.

This review synthesises evidence on how UDL principles are enacted within ethnomathematics teaching in South Africa. It asks: (1) How are UDL

principles operationalised in ethnomathematics-based mathematics lessons? (2) What barriers and enablers influence the integration of UDL with ethnomathematics? and (3) What learner outcomes are reported in terms of access, engagement, and achievement? The review focuses on peer-reviewed studies conducted in South African school contexts where cultural artefacts, games, and community knowledge intersect with mathematics, and analyses how these practices align with UDL principles to promote equity and inclusion. Findings will inform teacher planning templates, guide professional development priorities, and surface policy-aligned strategies for inclusive, culturally grounded mathematics teaching. They will also contribute to research by highlighting knowledge gaps and offering frameworks for systematically integrating UDL with ethnomathematics in South African classrooms.

2. THEORETICAL FRAMEWORK

A theoretical framework provides the conceptual lens through which a study is viewed, interpreted, and analysed. It underpins the study by linking theory with practice, guiding the research questions, data interpretation, and overall scholarly contribution (Anfara & Mertz, 2015). In this study, the theoretical framework combines Vygotsky's Sociocultural Theory and Universal Design for Learning (UDL) to provide an understanding of how mathematics education can be transformed to promote inclusion, equity, and cultural relevance in the South African context.

The Sociocultural Theory posits that learning is inherently social and shaped by cultural tools, language, and interaction (Vygotsky, 1978; Lave & Wenger, 1991). Key principles include the Zone of Proximal Development (ZPD) and the role of the More Knowledgeable Other (MKO), which highlight that knowledge is co-constructed through guided interaction and scaffolding. In mathematics education, this means that learners construct understanding by engaging with peers, teachers, and culturally relevant artefacts. The strength of Sociocultural Theory lies in its emphasis on collaboration and contextualisation, which resonates with ethnomathematics and inclusive pedagogies (Wertsch, 1991).

On the other hand, in complementing Sociocultural Theory, we employ the Universal Design for Learning (UDL), a framework developed by Meyer, Rose, and Gordon (2014) and advanced by CAST (2018, 2024). UDL is based on three principles:

1. Multiple Means of Engagement, which addresses learners' interests and motivation.
2. Multiple Means of Representation providing diverse ways of accessing and understanding information.
3. Multiple Means of Action and Expression that allow learners to demonstrate knowledge in varied ways.

These principles are supported by practical checkpoints that guide teachers in designing lessons, assessing student progress, and developing instructional materials. UDL's strength lies in proactively removing barriers to participation, making it applicable to diverse South African classrooms where learners differ in language, socio-economic background, and learning styles (Black et al., 2019).

These two frameworks are also informed by design-justice (Costanza-Chock, 2020) and decolonial theory (Smith, 1999), which highlight structural inequalities and power asymmetries in knowledge production and curriculum design. These perspectives question whose knowledge is privileged in mathematics classrooms and emphasise the need to value Indigenous knowledge as mathematically rigorous. They complement UDL by extending inclusion beyond pedagogy to broader systemic and policy considerations, such as assessment and resource allocation. The concept of ethnomathematics, introduced by D'Ambrosio (2001) and expanded by Gerdes (1998), positions mathematics as embedded in cultural practices, artefacts, games, and problem-solving in daily life. It emphasises that mathematics is not a universal, culture-free discipline but is expressed through traditions, crafts, and languages of different communities. In South Africa, ethnomathematics plays a key role in multilingual and multicultural classrooms, as it validates learners' lived experiences and connects mathematics learning to their identities and communities (Chahine, 2016). This makes ethnomathematics a natural ally of UDL, especially in advancing Engagement and Representation.

In South Africa, the Education White Paper 6 and the Screening, Identification, Assessment and Support (SIAS) Policy mandate the removal of learning barriers and provision of support (DBE, 2001, 2014). Furthermore, the Curriculum and Assessment Policy Statement (CAPS) encourage the use of contextualised, real-world mathematics applications (DBE, 2011). These align closely with UDL principles and ethnomathematics by promoting accessibility, inclusivity, and contextual relevance.

Taken together, these theories and perspectives create a comprehensive framework for analysing the

integration of UDL in ethnomathematics teaching. The framework highlights how inclusive design (UDL), cultural grounding (ethnomathematics), and attention to systemic inequalities (design-justice/decolonial theory) combine to support meaningful, accessible, and empowering mathematics education. The study demonstrates how inclusive, culturally responsive pedagogies can address persistent inequities in mathematics education and provide pathways for transformation in the South African context by applying this theoretical lens.

3. RESEARCH METHODOLOGY

This study employed a Systematic Literature Review (SLR) to explore the integration of Universal Design for Learning (UDL) in ethnomathematics teaching within the South African context. A systematic review was chosen because it provides a structured and transparent process for synthesising available evidence, thereby minimising bias and enhancing reliability (Kitchenham & Charters, 2007, 2016). The review highlights patterns, identifies gaps, and offers insights into how inclusive and culturally responsive pedagogies can strengthen mathematics education by consolidating findings across multiple studies. The methodology followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines; 2020, which promote rigour, transparency, and reproducibility in systematic reviews (Page et al., 2021). Although PRISMA was initially designed for health-related reviews, it has been widely applied in social sciences and educational research to ensure methodological consistency (Wittorski, 2012). The review was conducted in three phases: searching, screening, and analysis.

Phase 1: Searching

To ensure comprehensive coverage, the search strategy targeted major academic databases that provide access to educational and social science scholarship: Scopus, Web of Science, ERIC, and Google Scholar. Search terms were constructed around three key concepts: Universal Design for Learning, ethnomathematics, and South Africa, combined using Boolean operators (AND, OR). Example search strings included: "Universal Design for Learning" AND ethnomathematics AND "South Africa" "inclusive mathematics" AND "cultural mathematics" AND UDL "ethnomathematics" AND pedagogy AND "Universal Design for Learning"

The review focused on peer-reviewed empirical studies published between January 2015 and July 2025. This timeframe was selected to capture recent research developments on UDL and inclusive pedagogies in mathematics education. Only studies published in English were considered. Non-empirical works such as book reviews, opinion pieces, and purely theoretical discussions were excluded to maintain methodological rigour (Higgins & Green, 2011). This ensured that the synthesis was based on evidence derived from empirical research.

Phase 2: Screening

The initial database search yielded 520 records. Prior to screening, 50 duplicate records were removed, resulting in 470 unique records. These records were subjected to title and abstract screening. The following inclusion criteria guided screening: (1) the study explicitly addressed UDL, inclusive education, or ethnomathematics in mathematics teaching; (2) the research was conducted in the South African context or in contexts with direct relevance to South African education, (3) the study was empirical (qualitative, quantitative, or mixed-methods) & (4) the study was published in a peer-reviewed journal between 2015–2025.

Exclusion criteria ruled out articles that: did not focus on mathematics education; addressed inclusion or culture in general without reference to UDL or ethnomathematics; were not empirical in nature. Following title and abstract screening, 402 records were excluded, leaving 68 articles for full-text assessment. All 68 full-text articles were successfully retrieved and assessed for eligibility. After full-text evaluation, 47 articles were excluded for the following reasons: not empirical studies (n = 18), wrong population or non-school-based focus (n = 9), not conducted in South Africa or comparable contexts (n = 8), lack of explicit focus on UDL or ethnomathematics (n = 7), and insufficient data for extraction (n = 5). Consequently, 21 studies met all inclusion criteria and were retained for final analysis. The study selection process is summarised in a PRISMA 2020 flow diagram (Figure 1), which visually represents each stage of identification, screening, eligibility assessment, and inclusion.

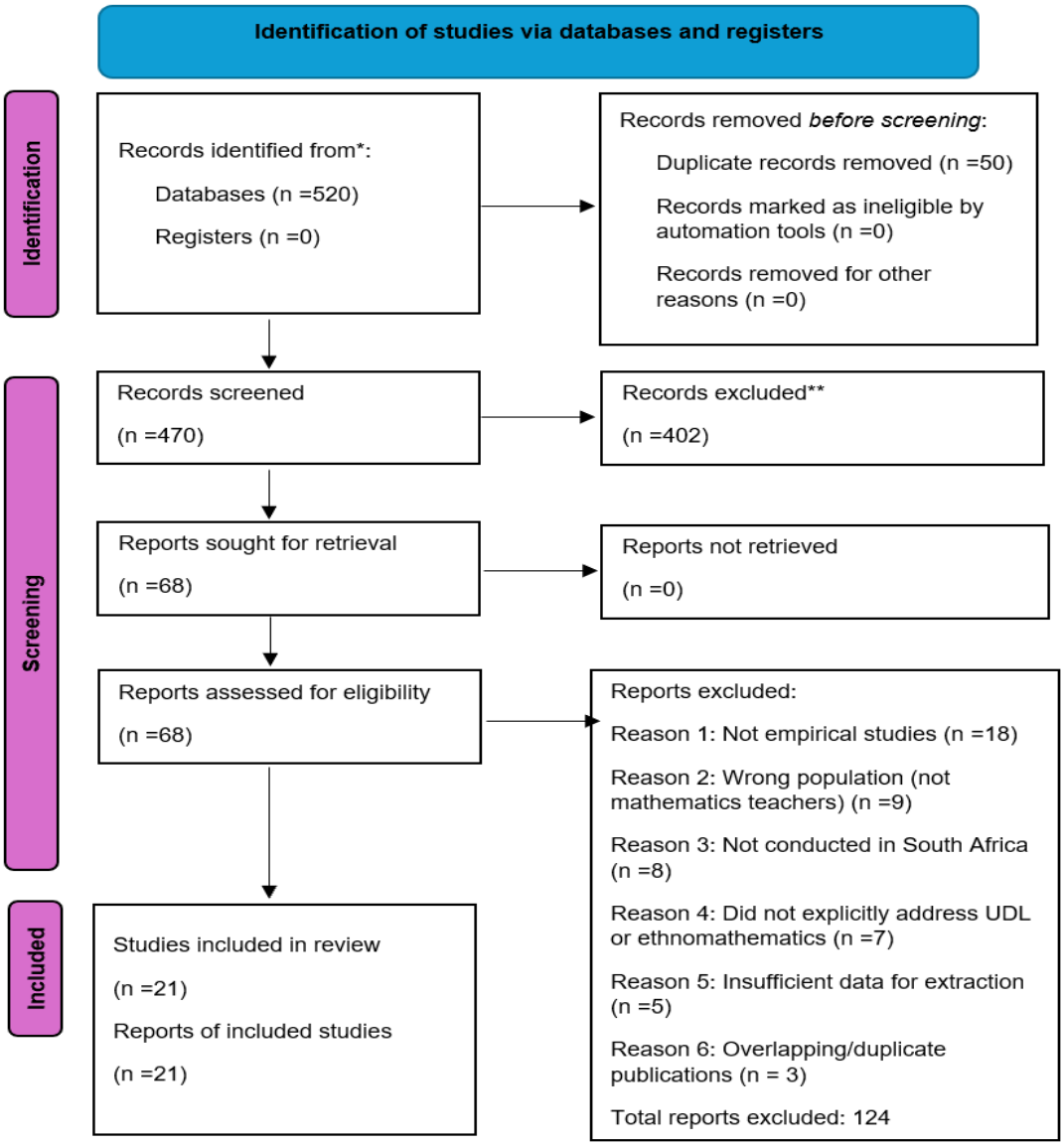
Phase 3: Analysis

The 21 selected studies were subjected to detailed examination using a structured data extraction form. Information was collected on: (1) research aims and methodologies (qualitative, quantitative, mixed methods); (2) contextual focus (classroom practices, teacher professional development, policy alignment, learner experiences); (3) UDL principles applied

(engagement, representation, action/expression); (4) integration with ethnomathematics (use of cultural artefacts, indigenous games, multilingual teaching practices); (5) key findings and implications for inclusive mathematics education.

The review process was documented through a PRISMA flow diagram (Liberati et al., 2009) (see Figure 1), which visually represented the stages of article identification, screening, eligibility, and inclusion.

Figure 1. PRISMA 2020 Flow Diagram for Study Selection



A thematic analysis was applied to synthesise findings across the reviewed studies (Braun & Clarke, 2006). Through iterative coding and categorisation, four themes emerged:

(1) National policies and CAPS create a supportive environment for UDL-informed, context-rich mathematics.

(2) Culturally relevant tasks (e.g., indigenous games) improve learner engagement.

(3) Local artefacts (e.g., beadwork) provide multiple representations that enhance understanding.

(4) Teacher knowledge and sustained professional development are critical, and These themes highlight the potential of integrating UDL and ethnomathematics as a dual framework for fostering inclusion, equity, and cultural relevance in mathematics education in South Africa.

4. FINDINGS

Theme 1: Policy And Curriculum Alignment as an Enabler of Integration

South Africa's education policies strongly support inclusive mathematics teaching. *White Paper 6* (DBE, 2001) and the *SIAS Policy* (DBE, 2014) emphasise the removal of barriers to learning, which aligns with UDL's inclusive approach. CAPS (DBE, 2011) further promote contextualised learning that values diversity and encourages awareness of mathematics in social and cultural contexts. This creates space for ethnomathematics, where cultural games and practices enrich mathematics learning (Forbes, 2018; Machaba, 2019; D'Ambrosio & Rosa, 2017). Scholars argue that addressing cultural, linguistic, and social issues is key to equitable mathematics education (Favilli, 2004; Gasteiger et al., 2015; Naidoo, 2021). UDL guidelines (CAST, 2018, 2024) provide teachers with practical tools to implement these policies, ensuring that inclusive frameworks translate into culturally responsive classroom practices.

Theme 2: Culturally Relevant Tasks Increase Engagement

The review demonstrates that integrating culturally relevant activities enhances the meaningfulness and engagement of mathematics learning. When instruction reflects learners' cultural backgrounds, motivation, and performance improves (Naidoo, 2021; Moloi, 2013; Offorma, 2016). Studies demonstrate that using indigenous knowledge and traditional games such as *Morabaraba* in Southern Africa, *Alikoto* in Ghana, and *Engklek* in Indonesia supports the teaching of concepts like probability, algebra, geometry, and number operations (Nkopodi & Mosimege, 2009; Mudaly, 2018; Owusu & Obuo-Addo, 2023; Anisa et al., 2023; Asrial et al., 2020; Mania & Alam, 2021; Setiyadi et al., 2018). These games also build critical thinking and problem-solving skills while reinforcing cultural identity (Fouze & Amit, 2018; Pradana et al., 2022; Matsekoleng et al., 2024; Meeran, 2024). This approach aligns with D'Ambrosio's (2001) ethnomathematics, which views mathematics as connected to lived experiences, and with the UDL principle of multiple means of engagement, which emphasises relevance, authenticity, and learner choice (CAST, 2018). Research, therefore, reveals that culturally grounded tasks increase learner engagement, persistence, and inclusion in mathematics classrooms.

Theme 3: Multimodal Representations Support Conceptual Understanding

The review highlights that mathematics learning is enriched when concepts are expressed through multiple cultural and symbolic forms. The benefit of multiple representations in a mathematics classroom is evident when they are used to represent a single mathematical concept in various ways and demonstrate connections across concepts, thereby strengthening mathematical understanding (Courtier et al., 2021). Historically, mathematics has been inseparable from culture, with meanings embedded in art, craft, language, and daily practices (Acharya et al., 2021; Jojo, 2024). Cultural variation can shape mathematical interpretation, for example, in how fractions or geometric shapes are defined across languages and traditions (Sumarto, 2020; Tjahyadi et al., 2019). Language remains a critical resource in classrooms, yet challenges arise when teachers and learners do not share the same home language (Matusov & Marjanovic-Shane, 2017; Jojo, 2024). In such cases, integrating cultural artefacts offers powerful alternatives. Studies show that objects like huts or beadwork contextualise mathematics, reinforce cultural identity, and deepen understanding of geometry, symmetry, and transformation (Kurniawan et al., 2023; Chahine, 2016; Gerdes, 1998). Such practices also promote higher-order skills, such as problem-solving and critical thinking (Hwang & Ham, 2021). These findings align with **UDL's principle of multiple means of representation** (CAST, 2018), ensuring that learners access mathematical ideas in varied ways. Therefore, multimodal and culturally grounded representations both enhance conceptual understanding and affirm learner identity, making mathematics more inclusive and meaningful.

Theme 4: Teacher Knowledge And Professional Learning

The successful integration of Universal Design for Learning (UDL) in ethnomathematics classrooms depends primarily on teachers' knowledge, beliefs, and professional preparation. Evidence from South African initiatives suggests that while workshops and targeted interventions demonstrate promise in raising awareness (Dalton, 2012; Moodley, 2024), many teachers still encounter gaps in both mathematical content knowledge and pedagogical practice, which hinder effective implementation (Adler & Ronda, 2015). This underscores the importance of sustained, contextually responsive professional development that explicitly addresses both UDL principles and ethnomathematical approaches. Teacher education plays a critical role in

bridging the gap between perception and practice. Programmes aim to provide pre-service teachers with both theoretical grounding and practical skills to design inclusive, culturally relevant instruction (Syzdykbayeva, Bagitovna, Bakirovna, Evgenievna, Zhangazinovna & Meirkhanovna, 2022; Reid & Reid, 2017). The perception-to-practice framework suggests that teachers' beliefs, attitudes, and values formed during training strongly influence classroom decisions. In ethnomathematics, this includes recognising the value of cultural diversity, understanding how culture shapes mathematical knowledge, and appreciating the pedagogical potential of local practices. However, research shows that translating these perceptions into effective practice is not straightforward. Implementation is mediated by factors such as pedagogical skill, curriculum constraints, and the availability of culturally relevant resources (Juniati & Siswono, 2019; Thornton, 2017).

This challenge is particularly acute in rural South African contexts, where Mbhiza (2021) reports that as many as 60% of teachers lack formal training in mathematics education, creating significant disparities in instructional quality. Without adequate preparation, teachers may struggle to design lessons that integrate UDL strategies with ethnomathematical content in ways that are both inclusive and pedagogically sound.

The findings demonstrate that teacher knowledge and sustained professional learning are indispensable for transforming policy and theoretical commitments into meaningful practice. Equipping teachers with the necessary expertise and confidence ensures that UDL-informed ethnomathematics teaching moves beyond theory to create inclusive, engaging, and culturally responsive mathematics classrooms.

5. DISCUSSION

This review examined how UDL principles are implemented in ethnomathematics-based mathematics teaching in South Africa. Four themes emerged, each shedding light on the enablers, challenges, and learner outcomes in inclusive mathematics education.

The findings show that South Africa's education policies, such as White Paper 6 (DBE, 2001), SIAS (DBE, 2014), and CAPS (DBE, 2011), strongly support inclusive and contextualised mathematics learning. These frameworks create opportunities for ethnomathematics by legitimising cultural knowledge within curriculum delivery (Forbes, 2018; Machaba, 2019; D'Ambrosio & Rosa, 2017). This aligns with UDL's proactive stance on barrier removal (CAST, 2018, 2024). However, as Clarkson notes in Favilli (2004), cultural and linguistic factors have historically been marginalised in mathematics education. Linking policy with practice through UDL and ethnomathematics helps address these inequities, resonating with Vygotsky's Sociocultural Theory, which emphasises contextualised, socially mediated learning (Vygotsky, 1978).

The review highlights that learners engage more deeply when mathematics is contextualised in cultural practices. Indigenous games, such as Morabaraba in South Africa and Alikoto in Ghana, embed probability, geometry, and algebra, while also fostering critical thinking and problem-solving skills (Mudaly, 2018; Owusu & Obuo-Addo, 2023). These findings support D'Ambrosio's (2001) ethnomathematics perspective, which posits that mathematics is inseparable from lived experience. UDL's principle of multiple means of engagement (CAST, 2018) reinforces this by stressing learner motivation, choice, and authenticity. The evidence, therefore, shows that cultural tasks not only enhance performance but also strengthen identity and persistence, consistent with Vygotsky's idea that learning is scaffolded through culturally meaningful tools (Lave & Wenger, 1991).

The findings confirm that multiple representations, linguistic, visual, symbolic, and artefactual, enrich mathematical learning. Historical and cultural forms, such as huts or Zulu beadwork, enhance learners' understanding of geometry, symmetry, and transformation while reinforcing their identities (Gerdes, 1998; Chahine, 2016; Kurniawan et al., 2023). Courtier et al. (2021) further show that such practices allow connections across mathematical concepts. These align with UDL's principle of multiple means of representation, ensuring diverse learners can access ideas (CAST, 2018). However, linguistic diversity remains a barrier, as teachers often cannot code-switch into learners' home languages (Jojo, 2024). From a sociocultural lens, this confirms Vygotsky's emphasis on language as a cultural tool for meaning-making (Vygotsky, 1978).

A recurring challenge is teacher preparedness. While short-term interventions raise awareness (Dalton, 2012; Moodley, 2024), many teachers lack strong content knowledge and pedagogical training in mathematics (Adler & Ronda, 2015; Mbhiza, 2021). Teacher education programmes influence beliefs and attitudes, but translating these into culturally responsive practice is mediated by curriculum pressures and resource constraints (Juniati &

Siswono, 2019; Thornton, 2017; Syzdykbayeva et al., 2022). This confirms Vygotsky's notion of the More Knowledgeable Other (MKO): teachers require both expertise and structured professional support to effectively scaffold learners' growth. For UDL-informed ethnomathematics to succeed, continuous professional learning is essential.

6. LIMITATIONS OF THE STUDY

This systematic literature review has several limitations that should be considered when interpreting the findings. First, the review relied on peer-reviewed, published studies. This may introduce publication bias, as studies with non-significant or less favourable results are less likely to appear in journals. Second, it only included studies published in English. Therefore, relevant research in other languages may have been overlooked. Third, the review intentionally focused on the South African school context to provide background and policy context, including CAPS, SIAS, and White Paper 6. While this improves contextual relevance, it may limit the applicability of findings to other countries or education systems with different curricula and inclusion guidelines. Methodologically, the included studies varied widely in design (qualitative, quantitative, or mixed methods) and in participant groups and outcome measures. This variety limited direct comparisons across studies and made statistical meta-analysis impossible. In addition, although the review searched multiple databases, including Scopus, Web of Science, ERIC, and Google Scholar, and followed PRISMA guidelines, differences in database coverage and indexing may have resulted in missing some relevant studies. Finally, the synthesis relies on the quality and reporting of the included studies. When reporting was limited, the extraction of detailed evidence on UDL operationalisation and student outcomes may have been restricted.

7. CONCLUSION

This review concludes that integrating UDL principles with ethnomathematics offers a useful framework for inclusive mathematics teaching in South Africa. Policies such as White Paper 6, SIAS, and CAPS align well with this approach, but successful implementation requires sustained teacher professional development and resource support. Learners benefit when mathematics is connected to cultural practices, represented in multiple ways, and delivered through inclusive strategies. Theoretically, the findings support Vygotsky's sociocultural theory, demonstrating that learning is socially and culturally situated, and they confirm the effectiveness of UDL in proactively removing barriers and broadening access. These frameworks provide a pathway to transform mathematics education into a more inclusive, equitable, and culturally relevant experience.

The review concludes that while South Africa's education policies provide an enabling environment for inclusive practice, policy frameworks alone do not guarantee implementation. Teachers require targeted support and resources to effectively implement these commitments in the classroom. Culturally relevant tasks, such as indigenous games and artefacts, alongside multimodal representations, emerge as central to fostering learner engagement and deepening conceptual understanding. At the same time, teacher knowledge and sustained professional development are vital to ensuring that inclusive practices are effectively applied and sustained over time. The findings also highlight the importance of drawing on community knowledge, which enriches mathematics classrooms, strengthens equity, and affirms learners' cultural identities. Ultimately, integrating Universal Design for Learning with ethnomathematics provides both pedagogical and cultural legitimacy, offering a transformative pathway to advance inclusive mathematics education in South Africa.

Future research should focus on classroom-based and intervention studies that combine Universal Design for Learning (UDL) with ethnomathematics in South African mathematics classrooms. We need design-based and quasi-experimental studies to assess UDL-informed ethnomathematics lesson sequences and their effects on learners' access, engagement, understanding, and achievement, particularly for students facing learning barriers. Further research should also examine teacher training programs that enhance UDL skills and knowledge of culturally relevant teaching. This should track changes in teacher beliefs and planning as they implement lessons in the classroom. Studies focusing on practical implementation across different settings, such as rural and urban areas, school phases and income levels are essential for identifying the support and barriers to learning. These studies will also help develop scalable, sustainable tools to support inclusive math practices.

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