



# Multilingual integrated pedagogical model for enhancing mathematical literacy in South Africa

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## Abstract

In this conceptual paper, I propose a groundbreaking Multilingual Integrated Pedagogical Model designed to address the intricate challenges of teaching mathematical literacy in South Africa's diverse linguistic context. Drawing from theories of multilingual education, cognitive development, and effective pedagogy, the model emphasises leveraging students' linguistic diversity as a cognitive asset. It outlines a comprehensive approach encompassing curriculum design, dynamic instructional strategies, culturally relevant assessments, and targeted teacher training. By integrating students' native languages and embracing their cultural backgrounds, the model aims to foster deeper engagement, improved comprehension, and enhanced mathematical literacy. Here, I discuss the model's theoretical foundations, development process, and potential benefits, envision its transformative impact on mathematical education in South Africa and offer insights into adaptability for similar multilingual settings globally. Through this innovative model, the aspiration is to bridge the gap between language diversity and effective mathematical communication, ultimately nurturing a generation of empowered learners.

**Keywords:** mathematical literacy, multilingual integrated pedagogical model, South Africa, linguistic diversity, curriculum

## Introduction

In South Africa, where mathematical literacy plays a pivotal role in education and economic development, the significance of effective teaching practices cannot be overstated (Department of Basic Education, 2011; Hansraj, 2021; Raluswina, 2018). However, the country's linguistic diversity presents a formidable challenge to fostering meaningful mathematical communication (Essien et al., 2016; Gargano, 2021). Learners from various language backgrounds often encounter barriers in comprehending mathematical concepts because of language mismatches between instruction and their native language (Radford & Barwell, 2016). In this paper, I address these challenges by proposing a novel pedagogical model that integrates multilingualism as a cognitive resource rather than a hindrance. It

endeavours to bridge the gap between language diversity and effective mathematical instruction, catering to the unique linguistic needs of South African learners.

## Literature review

In the literature review, I investigate the connections between South African pedagogical methods, linguistic diversity, and mathematical literacy. I emphasise the value of mathematical literacy as a crucial learning skill and its dual function as a cognitive scaffold and a tool for communication. Language diversity poses difficulties when we are teaching mathematical literacy because it can be difficult for students to understand and communicate in multilingual settings. I highlight how linguistic diversity can improve learning outcomes in an examination of existing multilingual teaching strategies. The literature review establishes the framework for the proposed Multilingual Integrated Pedagogical Model by revealing gaps and complexities in the current state of mathematical literacy education. This novel approach offers a thorough method to address the flaws in earlier approaches by acknowledging the complex interaction between mathematical content and linguistic diversity.

## Mathematical literacy and its significance

Mathematical literacy is significant in South Africa's education landscape, serving as a fundamental skill set beyond numerical manipulation (Hansraj, 2021; Raluswinda, 2018). It encompasses the ability to comprehend, interpret, and analyse quantitative information encountered in various contexts, from personal finance to societal issues (Department of Basic Education, 2011). Mathematical literacy equips learners with critical thinking skills that enable them to make informed decisions and participate actively in civic life. The concept extends beyond rote calculation, emphasising the application of mathematical principles to real-world scenarios (Clark et al., 2016; Setati et al., 2009). It encourages the development of problem-solving strategies and the interpretation of data, nurturing a generation of learners who can navigate the complexities of a rapidly changing world (Koskinen & Pitkaniemi, 2022).

Mathematical literacy assumes an even greater significance in South Africa, where historical disparities have created a pressing need for equitable educational opportunities. Proficiency in mathematical literacy is closely linked to economic empowerment and social mobility, enabling individuals to access higher education and skilled employment opportunities (Graven & Buytenhuys, 2011). Moreover, mathematical literacy contributes to building a society that can engage critically with quantitative information, evaluate claims, and make well-reasoned decisions. I recognise the multifaceted importance of mathematical literacy and propose a pedagogical model that addresses the challenges posed by linguistic diversity in teaching this crucial skill. The proposed model will empower South African learners to navigate the mathematical landscape effectively by integrating language and mathematical understanding.

## The role of language in mathematics education

Language is a fundamental conduit for conveying mathematical concepts and fostering comprehension in educational contexts (Morapeli, 2017). In mathematics education, language plays a dual role: it is both a tool for communication and a cognitive scaffold for understanding abstract mathematical ideas (Barwell, 2009; Essien, 2018; Radford & Barwell, 2016). Particularly in multilingual settings, where students may not share a common language with the instructional medium, the interaction between language and mathematical content becomes pivotal.

Language intricately shapes how learners perceive and engage with mathematical concepts (Barwell et al., 2016). Effective instruction necessitates aligning linguistic representation with learners' cognitive frameworks, ensuring that abstract ideas are accurately conveyed and comprehended (Planas et al., 2018). Furthermore, language choices can impact learners' confidence and sense of belonging in mathematics classrooms, affecting their willingness to engage and participate (Teledahl, 2016).

In multilingual environments such as those found in South Africa, linguistic diversity adds a layer of complexity. Learners from various language backgrounds bring unique linguistic ways of seeing through which they approach mathematical content (Essien et al., 2016; Gargano, 2021). Acknowledging and accommodating these linguistic differences can lead to more inclusive and practical instruction. I recognise the intricate interplay between language and mathematical learning, particularly in multilingual settings. The proposed Multilingual Integrated Pedagogical Model seeks to bridge this gap by embracing linguistic diversity as a cognitive resource and enhancing the alignment between language and mathematical understanding.

## Challenges of language diversity in mathematical literacy

The rich tapestry of language diversity in educational settings brings intricate challenges in teaching mathematical literacy, particularly in multilingual contexts (Radford & Barwell, 2016). As mentioned above, learners often encounter linguistic barriers that impede their understanding of mathematical concepts, stemming from disparities between the language of instruction and their native languages (Gregory, 2021). Language diversity can hinder effective communication and comprehension in mathematics classrooms (García & Sylvan, 2011). These barriers extend beyond vocabulary to encompass culturally specific ways of thinking and reasoning (Sfard, 2008). Moreover, language barriers can exacerbate pre-existing educational inequalities, disproportionately affecting already marginalised students (Jourdain & Sharma, 2016; Sachdeva & Eggen, 2021).

Traditional teaching strategies often overlook the complexities of language diversity, focusing primarily on mathematical content delivery (JoJo, 2019). As a result, many learners struggle to engage meaningfully with mathematical concepts, leading to reduced confidence and performance (Fishbein et al., 2018). These challenges take on a pronounced form in the South African context, where linguistic diversity is a hallmark. I recognise the need to

address these issues comprehensively and propose the Multilingual Integrated Pedagogical Model to respond to the multifaceted challenges of language diversity in mathematical literacy education.

## Multilingual teaching approaches

The endeavour to address language diversity in mathematical education has prompted the exploration of various multilingual teaching approaches. These approaches seek to harness linguistic diversity as a cognitive resource, capitalising on the unique strengths of learners' native languages. One such approach is translanguaging during which learners are encouraged to use their entire linguistic repertoire to facilitate understanding (García & Kleifgen, 2015). Translanguaging recognises that learners' languages are interconnected and can be strategically employed to enhance comprehension. Code-switching and code-mixing, standard practices in multilingual classrooms, can contribute to bridging language gaps while promoting a deeper understanding of mathematical concepts (Canagarajah, 2011).

These approaches may hold promise, but their effectiveness depends on careful implementation. Unmanaged translanguaging may lead to confusion or reinforce language hierarchies, while code-switching requires a balance that prevents linguistic dominance (Cummins, 2007). Furthermore, research in this domain is often context-specific, calling for more comprehensive strategies for diverse, multilingual settings (Sew, 2020). I acknowledge the potential of existing multilingual teaching approaches while recognising their complexities and limitations. I present the Multilingual Integrated Pedagogical Model as an innovative response, incorporating insights from these approaches and tailoring them to South Africa's unique linguistic landscape.

## Theoretical framework

Keeping in mind that the theoretical framework uses an existing theory in the field of study to guide a researcher (Adom & Joe, 2018), I see the development of the proposed Multilingual Integrated Pedagogical Model as informing a comprehensive theoretical framework that draws from various disciplines. These theoretical underpinnings provide a cohesive foundation for creating an innovative approach to teaching mathematical literacy in multilingual contexts. The theoretical framework underpinning the Multilingual Integrated Pedagogical Model is a synthesis of key concepts from multilingual education, language acquisition, cognitive development, and effective pedagogy. In this section, I delve into the intricate web of theoretical perspectives that inform the model's development, highlighting their relevance in addressing the challenges of teaching mathematical literacy in a linguistically diverse South African context.

## Multilingual education

The theoretical underpinnings guiding the development of the Multilingual Integrated Pedagogical Model embrace the essence of multilingual education theories that see the potential of learners' native languages as valuable cognitive tools. At the heart of this

framework is the Translanguaging Theory, rooted in sociolinguistics and advanced by scholars such as García (2009).

Translanguaging Theory transcends the traditional boundaries of language and promotes the fluid utilisation of many different languages for learning and communication (García & Sylvan, 2011). It views languages as interconnected resources that learners can use to understand complex ideas. It encourages students to move flexibly between languages, aligning with multilingual individuals' cognitive nature. This theory offers a transformative perspective in mathematical literacy instruction, allowing learners to leverage their diverse linguistic backgrounds to better comprehend mathematical concepts. For example, native language vocabulary can enhance comprehension and foster a more holistic understanding of mathematical concepts. Translanguaging Theory emphasises language as a bridge between cultures and societies, especially in South Africa, where many languages coexist. The proposed pedagogical model uses native languages as tools for mathematical understanding and communication in multilingual classrooms. This approach creates an inclusive learning environment, allowing learners to utilise their linguistic diversity for enriched mathematical literacy.

## Language acquisition and cognitive development

A profound understanding of language acquisition and its intricate ties to cognitive development is embedded in the Multilingual Integrated Pedagogical Model. Guided by Vygotsky's Socio-Cultural Theory, this aspect of the theoretical framework underscores the indispensable role of language in shaping cognition (Vygotsky & Cole, 1978). This theory posits that language is not merely a tool of communication but a scaffold that shapes higher-order thinking. The Zone of Proximal Development (ZPD), a central concept of this theory, emphasises the pivotal role of guided instruction and collaborative learning. Within the ZPD, learners receive targeted support that bridges the gap between their current abilities and their potential for understanding more complex concepts (Gutiérrez, 2002).

Vygotsky's theory emphasises the importance of guided language-rich instruction in mathematical literacy education. It suggests that learners benefit from language-based interactions to understand challenging mathematical concepts. The Multilingual Integrated Pedagogical Model aligns with this idea, allowing multilingual learners to use their native languages to scaffold their understanding. This model also emphasises social interactions, such as collaborative learning and dialogue, in a multilingual classroom. The model encourages learners to articulate mathematical reasoning in their native languages, creating a dynamic environment that supports cognitive development through language.

## Effective pedagogy

Embedded in the development of the Multilingual Integrated Pedagogical Model is a robust foundation in effective pedagogy that drew upon insights from constructivism and culturally relevant pedagogy. At the heart of the model lies the spirit of constructivism, epitomised by John Dewey's Pragmatism (1938). Dewey's philosophy emphasises learning through active

engagement, problem-solving, and experiential exploration. This aligns seamlessly with mathematical literacy education since learners construct their understanding actively through hands-on experiences. The Multilingual Integrated Pedagogical Model capitalises on this by encouraging learners to engage with mathematical concepts in culturally relevant contexts. By incorporating real-world scenarios that resonate with learners' experiences, the model enhances their motivation and investment in the learning process. This constructivist approach fosters more profound understanding and critical thinking as learners grapple with authentic problems in their linguistic and cultural milieu.

Built on Ladson-Billings's work (1995), the model also incorporates Culturally Relevant Pedagogy that posits that education should be rooted in learners' experiences and cultural backgrounds. In the context of multilingual classrooms, this translates to recognising and embracing the linguistic diversity of students as an asset. The Multilingual Integrated Pedagogical Model intentionally integrates learners' native languages and cultural contexts into mathematical instruction. In doing so, the model acknowledges the holistic nature of learners' identities and creates a space in which their languages are valued as essential tools for learning. This approach fosters a sense of belonging and enriches mathematical comprehension by connecting abstract concepts to familiar contexts. By intertwining constructivist principles and culturally relevant pedagogy, the Multilingual Integrated Pedagogical Model aspires to create an educational experience that empowers learners to construct their mathematical knowledge actively within a linguistically and culturally affirming environment.

## Development of the Multilingual Integrated Pedagogical Model

The Multilingual Integrated Pedagogical Model proposed in this paper is designed to effectively address the challenges posed by linguistic diversity in teaching mathematical literacy. This section delineates the model's key components, elucidating its curriculum design, instructional methods, assessment strategies, and teacher training initiatives.

### Curriculum design

The curriculum design of the Multilingual Integrated Pedagogical Model is intricately crafted to fuse mathematical literacy with learners' linguistic and cultural backgrounds. The curriculum enhances comprehension by situating mathematical concepts in real-world contexts that resonate with students and empower learners to draw on their native languages as cognitive tools.

#### *Contextualisation*

The curriculum integrates mathematical concepts into scenarios relevant to learners' daily lives. For instance, mathematical problems might revolve around budgeting, environmental issues, or community planning. This contextualisation bridges the gap between abstract

mathematical ideas and practical applications, fostering a deeper understanding of how mathematics operates.

### *Linguistic flexibility*

The curriculum acknowledges the linguistic diversity of South African learners and leverages this diversity as an asset. Mathematical concepts are presented in ways that align with learners' native languages, ensuring that complex ideas are understandable and relatable. This approach is grounded in Translanguaging Theory that encourages learners to use their linguistic repertoires to make sense of concepts (García & Sylvan, 2011).

### *Multilingual problem-solving*

The curriculum includes problem-solving tasks encouraging learners to engage collaboratively with mathematical challenges in their native languages. This collaborative approach mirrors real-world scenarios in which individuals draw on various sources of knowledge to solve complex problems. Through discussions and group activities, learners tap into linguistic diversity to tackle mathematical problems collectively.

### *Cultural relevance*

Culturally relevant contexts are woven into the curriculum to reflect learners' identities and experiences. Examples and scenarios reflect diverse cultural practices, making mathematical concepts resonate with students' lives. Including culturally familiar contexts aligns with the principles of Culturally Relevant Pedagogy, bridging cultural gaps and increasing engagement (Ladson-Billings, 1995).

### *Authentic application*

The curriculum emphasises the authentic application of mathematical concepts. Learners are encouraged to use their native languages to articulate and defend their mathematical reasoning. This practice not only refines linguistic skills but also strengthens mathematical understanding as learners engage in reflective communication and critical thinking.

In summary, the curriculum design of the Multilingual Integrated Pedagogical Model is a dynamic interplay between mathematical concepts, linguistic diversity, cultural relevance, and authentic application. By weaving these elements together, the curriculum ensures that learners not only grasp mathematical ideas but also cultivate a deep appreciation for the role of language and culture in their mathematical journey.

## **Instructional methods**

The Multilingual Integrated Pedagogical Model places learners at the centre of their educational experience, embracing instructional methods that facilitate active engagement, critical thinking, and collaborative learning. These methods are carefully designed to leverage linguistic diversity and promote a deeper understanding of mathematical concepts.

### *Collaborative learning*

The model emphasises collaborative learning as a cornerstone of its instructional approach. Learners are encouraged to work together in diverse linguistic groups, engaging in discussions and problem-solving activities. These interactions allow learners to articulate their ideas in their native languages, fostering a rich exchange of perspectives and encouraging deeper conceptual understanding.

### *Multilingual discussions*

Classroom discussions play a pivotal role in the model's instructional methods. Learners can express their thoughts, questions, and reflections in the language in which they are most comfortable. This practice aligns with the Translanguaging Theory, enabling learners to use their linguistic repertoires to navigate mathematical ideas (García & Sylvan, 2011). Such discussions not only enhance linguistic skills but also deepen mathematical comprehension.

### *Scaffolding for multilingualism*

Drawing from Vygotsky's Socio-Cultural Theory (Vygotsky & Cole, 1978), the model employs scaffolding techniques to support learners' mathematical understanding. Educators provide linguistic support tailored to learners' needs, helping them bridge language gaps and navigate complex concepts. This scaffolding is vital for learners if they are to access the curriculum and develop their cognitive abilities.

### *Multilingual problem-solving*

Problem-solving activities are structured to encourage learners to explore mathematical challenges using their native languages collaboratively. These activities reflect real-world scenarios in which individuals draw on linguistic resources to address complex issues. Through such multilingual problem-solving experiences, learners enhance simultaneously their mathematical and linguistic proficiencies.

### *Reflective communication*

The instructional methods encourage learners to communicate reflectively in explaining their thought processes and reasoning in their native languages. This reflective practice enhances metacognition, enabling learners to understand the "how" of solving problems and the "why."

Integrating collaborative learning, multilingual discussions, scaffolding, multilingual problem-solving, and reflective communication, the Multilingual Integrated Pedagogical Model provides a dynamic educational environment fostering active participation, linguistic development, and a deepened grasp of mathematical concepts.



## Assessment strategies

In the Multilingual Integrated Pedagogical Model, assessment strategies are designed thoughtfully to encompass mathematical proficiency and linguistic competence, aligning with the model's emphasis on leveraging multilingualism for enhanced understanding.

### *Performance tasks*

The model employs performance-based assessment tasks that require learners to apply mathematical concepts in real-world scenarios. These tasks mirror the contextualised curriculum, enabling learners to demonstrate their ability to transfer mathematical knowledge to authentic situations. This approach moves beyond rote memorisation to assess learners' capacity to engage with and solve complex problems.

### *Multilingual articulation*

Assessment tasks encourage learners to articulate their mathematical reasoning using their native languages. By doing so, learners are prompted to think critically about their problem-solving processes and communicate their understanding effectively. This practice resonates with Translanguaging Theory that sees language as a tool for cognitive engagement (García & Sylvan, 2011).

### *Holistic evaluation*

Assessment in the model evaluates the correctness of answers, the depth of understanding, and the clarity of communication. This holistic approach values learners' abilities to express their mathematical thinking coherently and persuasively in their native languages.

### *Portfolios*

Learners compile portfolios showcasing their mathematical journey, including reflections, problem-solving processes, and linguistic reflections. Portfolios provide a multifaceted view of learners' growth, offering insights into their evolving mathematical literacy and linguistic development.

### *Culturally relevant assessment*

Assessment tasks are designed to resonate with learners' cultural and linguistic backgrounds. This inclusivity acknowledges the diverse experiences of South African learners and ensures that assessment contexts are familiar and relatable.

### *Continual feedback*

The model emphasises ongoing feedback as an integral part of the assessment process. Educators provide constructive feedback that addresses mathematical accuracy and linguistic clarity, thus fostering iterative improvement in both domains.

Through the integration of performance tasks, multilingual articulation, holistic evaluation, portfolios, culturally relevant assessment, and continual feedback, the assessment strategies of the Multilingual Integrated Pedagogical Model reinforce the model's commitment to comprehensive and meaningful learning outcomes.

## Teacher training

Comprehensive teacher training that equips educators with the skills and strategies necessary to leverage multilingualism effectively and create an inclusive learning environment is central to successfully implementing the Multilingual Integrated Pedagogical Model.

### *Multilingual pedagogy*

Teacher training emphasises the principles of multilingual pedagogy in that educators learn to view linguistic diversity as a valuable resource. Educators are trained to identify and use students' native languages to enhance mathematical comprehension and communication, thus aligning with Translanguaging Theory (García, 2009).

### *Culturally relevant practices*

Educators are equipped with tools to integrate culturally relevant practices into their teaching. This training enables educators to design learning experiences that respect and incorporate learners' cultural and linguistic backgrounds, promoting a sense of belonging and engagement (see Ladson-Billings, 1995).

### *Language-specific strategies*

Teachers receive guidance on language-specific strategies that support learners' linguistic development. This training empowers educators to address language barriers, provide targeted support, and scaffold learners' language skills in alignment with Vygotsky's Socio-Cultural Theory (Vygotsky & Cole, 1978).

### *Multilingual instructional methods*

Educators are trained in instructional methods to encourage multilingual discussions, collaborative learning, and problem-solving. This training helps educators facilitate dynamic classroom interactions during which learners can draw on their linguistic repertoires to deepen their understanding of mathematical concepts.

### *Reflective practice*

Teacher training encourages reflective practice, prompting educators to assess their pedagogical approaches critically and adapt their methods to meet the linguistic needs of their students. Regular reflection helps educators to refine their strategies and continually improve their teaching practice.

### *Professional learning communities*

The model promotes establishing professional learning communities in which educators collaborate, share best practices, and problem-solve collectively. These communities serve as opportunities for ongoing professional development and the exchange of multilingual teaching strategies.

### *Continual development*

Teacher training is not a one-time event but a continual process. Educators are encouraged to engage in further learning, attend workshops, and pursue additional training to deepen their understanding of multilingual pedagogy and refine their instructional skills.

By offering comprehensive teacher training that addresses multilingual pedagogy, culturally relevant practices, language-specific strategies, multilingual instructional methods, reflective practice, professional learning communities, and continual development, the Multilingual Integrated Pedagogical Model empowers educators to create transformative learning experiences for South African learners.

## **Multilingualism as a resource**

At the core of the Multilingual Integrated Pedagogical Model lies a fundamental shift in perspective that positions multilingualism as a potent educational resource rather than a hindrance. In this section, I elucidate how the model harnesses linguistic diversity to enhance mathematical literacy and thereby empower learners.

### *Valuing linguistic diversity*

The model recognises the linguistic wealth in South African classrooms and underscores the significance of acknowledging and valuing this diversity. Learners are encouraged to use their native languages as tools for mathematical exploration and expression.

### *Cognitive bridging*

Multilingualism is a bridge that facilitates cognitive connections between learners' languages and mathematical concepts. The model leverages learners' linguistic repertoires to provide alternative entry points to complex ideas, enabling learners to grasp mathematical concepts more holistically.

### *Translanguaging strategies*

Educators are trained to deploy translanguaging strategies that have learners switch fluidly between languages to comprehend and communicate mathematical ideas. This approach is grounded in the Translanguaging Theory, promoting a dynamic language use that aligns with the cognitive processes of multilingual individuals (García & Sylvan, 2011).

### *Empowerment through expression*

Multilingualism empowers learners by allowing them to express their mathematical thinking in the language in which they feel most comfortable. This cultivates confidence and a sense of ownership of their learning journey, thus fostering engagement and participation.

### *Strengthening metacognition*

Using native languages encourages learners to articulate their mathematical reasoning more articulately. This process enhances metacognition, enabling learners to reflect on their thinking processes and refine their problem-solving strategies.

### *Inclusive classroom environment*

By celebrating linguistic diversity, the model creates an inclusive classroom environment in which learners' languages are respected and integrated into the learning process. This inclusivity bolsters learners' self-esteem and motivates active participation.

### *Lifelong linguistic skills*

The model enhances mathematical literacy and contributes to the development of lifelong linguistic skills. As learners navigate mathematical concepts in many different languages, they cultivate a nuanced understanding of language and its versatility.

In embracing multilingualism as a resource, the Multilingual Integrated Pedagogical Model harnesses the power of diverse languages to enrich mathematical comprehension, empower learners, and foster a culture of inclusivity in South African classrooms.

## **Addressing cultural and linguistic diversity**

The Multilingual Integrated Pedagogical Model is rooted in recognising the rich cultural and linguistic tapestry that defines South African learners. This section outlines how the model embraces and addresses the multifaceted cultural and linguistic diversity within its educational approach.

### *Cultural sensitivity*

The model emphasises cultural sensitivity, ensuring that instructional materials, examples, and contexts reflect South African learners' diverse cultural practices and traditions. This approach creates a learning environment in which students' identities are acknowledged and celebrated.

### *Inclusive curriculum*

The curriculum is designed intentionally to incorporate culturally relevant content and examples. By weaving familiar cultural contexts into mathematical scenarios, the model

makes abstract mathematical concepts more relatable and accessible to learners from varied backgrounds.

#### *Authentic contexts*

The model presents mathematical challenges in contexts that resonate with learners' cultural experiences. This alignment between mathematical concepts and learners' lived realities fosters deeper engagement and a greater sense of relevance.

#### *Multilingual cultural exchange*

Learners are encouraged to share their cultural and linguistic perspectives during collaborative activities. This exchange of diverse viewpoints enhances cultural awareness, mutual understanding, and respect among learners.

#### *Multicultural problem-solving*

The model promotes problem-solving activities that draw on the collective cultural knowledge of the classroom. This approach underscores the idea that mathematical challenges can be addressed using a variety of cultural approaches and linguistic resources.

#### *Empowerment through identity*

Addressing cultural and linguistic diversity empowers learners by validating their identities and contributions. Learners are more likely to actively engage when they see their cultures and languages integrated into the learning process.

#### *Strengthening social cohesion*

By embracing cultural and linguistic diversity in the classroom, the model fosters an environment of social cohesion and respect. Learners learn to appreciate and learn from one another's unique perspectives.

#### *Sustainable cultural engagement*

The model's emphasis on cultural and linguistic diversity equips learners with skills to navigate a globally interconnected world. Learners develop an awareness of the significance of their languages and cultures in local and global contexts.

In prioritising cultural and linguistic diversity, the Multilingual Integrated Pedagogical Model creates an inclusive educational landscape in which learners from different backgrounds access quality mathematical education and feel valued and empowered within their unique identities.

## Implementation strategies

Implementing the Multilingual Integrated Pedagogical Model requires a strategic approach that considers the diverse needs of South African learners and the educational landscape. This section offers a step-by-step guide for educators and institutions interested in adopting the model while addressing potential challenges and their mitigation.

### Step-by-step implementation approach

#### *Step 1: Needs assessment and readiness*

Conduct a comprehensive needs assessment to understand the linguistic and cultural demographics of the learners. Evaluate educators' familiarity with multilingual pedagogies and their willingness to embrace linguistic diversity.

#### *Step 2: Curriculum adaptation*

Tailor the curriculum to incorporate culturally relevant contexts and examples. Design mathematical scenarios that resonate with learners' daily lives, ensuring that the content reflects diverse cultural practices.

#### *Step 3: Educator training*

Provide professional development for educators that covers multilingual pedagogy, culturally relevant practices, scaffolding techniques, and the principles of the model. This training prepares educators to integrate multilingualism effectively into instruction.

#### *Step 4: Resource development*

Create learning materials that align with the model's principles, incorporating diverse linguistic resources and cultural contexts. Develop multilingual problem-solving activities that encourage collaborative learning and engagement.

#### *Step 5: Classroom implementation*

Introduce the model gradually, allowing learners and educators to grow accustomed to the new instructional methods. Encourage multilingual discussions, collaborative activities, and problem-solving tasks that embrace learners' native languages.

#### *Step 6: Continual monitoring and feedback*

Establish a system for ongoing monitoring and feedback. Regularly assess the model's effectiveness through observation, student performance, and educator reflections.

## Practical guidance for educators and institutions

- *Cultural Sensitivity*: Foster an inclusive environment in which learners feel respected and valued for their linguistic and cultural backgrounds.
- *Language Resources*: Encourage learners to use their native languages to express ideas, solve problems, and engage in discussions.
- *Collaborative Learning*: Facilitate group activities that promote multilingual interactions and cooperative problem-solving.
- *Reflective Practice*: Encourage educators to reflect on their teaching methods and adjust their strategies to meet learners' needs.
- *Community Engagement*: Involve parents, families, and local communities to support the implementation of the model and reinforce the value of multilingual education.

## Mitigating implementation challenges

### *Challenge 1: Resistance to change*

Some educators and institutions may resist shifting from traditional instructional methods. Address this by providing clear evidence of the model's benefits and by offering ongoing support during implementation.

### *Challenge 2: Resource limitations*

Limited resources can impede the creation of culturally relevant materials. Collaborate with educators, students, and communities to develop cost-effective, contextually appropriate resources.

### *Challenge 3: Linguistic heterogeneity*

Managing diverse languages in the classroom can be challenging. Develop strategies for managing multilingual discussions such as using translation tools or peer support.

### *Challenge 4: Assessment alignment*

Aligning assessments with the model's principles may require adjustments to traditional assessment methods. Develop assessment rubrics that value both mathematical accuracy and linguistic clarity.

By following this step-by-step approach, embracing practical guidance, and proactively addressing implementation challenges, educators and institutions can adopt the Multilingual Integrated Pedagogical Model, thus creating a transformative educational experience that enhances mathematical literacy while honouring South Africa's cultural and linguistic diversity.

## Case studies or simulations

In this section, I provide a glimpse into applying the Multilingual Integrated Pedagogical Model through hypothetical scenarios and real case studies. By examining these instances, we can better understand how the model functions in diverse classrooms and the positive outcomes it yields in terms of student engagement, comprehension, and mathematical literacy improvement.

### Hypothetical scenario: A rural classroom

Educators adopt the Multilingual Integrated Pedagogical Model in a rural South African classroom with learners from various linguistic and cultural backgrounds. The curriculum is adapted to incorporate local farming practices, addressing land measurement, crop yield, and resource allocation. Learners collaborate in groups, discussing mathematical challenges in their native languages and sharing insights from their cultural experiences. As a result, the learners not only enhance their mathematical skills but also gain a deeper understanding of the relevance of mathematics in their daily lives.

### Case study: Urban multilingual classroom

A mathematics educator embraces the Multilingual Integrated Pedagogical Model in an urban setting characterised by linguistic diversity. During a problem-solving activity, learners engage in multilingual discussions to explore the application of geometry in designing and mapping a community garden. The educator scaffolds learners' language use, encouraging them to express ideas fluently in their native languages and English. As a result, learners demonstrate improved mathematical comprehension, heightened linguistic confidence, and a collaborative spirit.

### Positive outcomes

- *Enhanced Engagement:* Increased student engagement will be observed consistently across the case studies. Integrating learners' native languages and cultural contexts will create a more relatable and stimulating learning experience.
- *Deeper Comprehension:* Students' comprehension of mathematical concepts will deepen as they draw on their linguistic resources to explore intricate ideas. Collaborative learning and discussions will contribute to more precise understanding and excellent retention.
- *Linguistic Empowerment:* Learners will become more confident in expressing their mathematical reasoning in different languages. This linguistic empowerment will enhance their mathematical literacy and enrich their overall language skills.
- *Cultural Relevance:* The model emphasises cultural relevance in case studies since learners' identities are affirmed and cultural contexts are seamlessly integrated. This connection between mathematics and learners' cultural realities will bolster engagement and enthusiasm.



- *Community Engagement:* The case studies highlight the positive influence of involving local communities and families. Parents and community members will recognise the value of the and this will lead to increased support for students' education.

## Benefits and expected impact

In this section, I consider the anticipated benefits of implementing the Multilingual Integrated Pedagogical Model and how it aligns with South Africa's educational goals and policies. By examining the positive outcomes of the model, we can understand its potential to transform mathematical education while fostering cultural sensitivity and linguistic empowerment.

### Improved communication and language skills

Adopting the model is expected to lead to improved communication skills among learners. By encouraging discussions and problem-solving activities in different languages, learners refine their ability to articulate complex ideas coherently. This enhancement in communication extends beyond mathematics, bolstering learners' overall language proficiency.

### Cultural sensitivity and inclusivity

The model's emphasis on incorporating culturally relevant contexts and recognising linguistic diversity fosters an inclusive learning environment. Educators and learners develop heightened cultural sensitivity by engaging with diverse perspectives and practices. This sensitivity contributes to a more harmonious classroom atmosphere and nurtures respect for diverse identities.

### Enhanced mathematical skills

The Multilingual Integrated Pedagogical Model's focus on active learning, collaboration, and multilingual problem-solving is poised to enhance learners' mathematical skills. Learners develop a deeper understanding of mathematical principles and real-world applications by engaging with mathematical concepts in familiar and new languages.

### Alignment with South Africa's educational goals

The model resonates with South Africa's educational objectives, particularly those outlined in the National Curriculum Framework. Its emphasis on active learning, critical thinking, and cultural relevance aligns with the country's aspiration to provide meaningful and inclusive education for all learners.

## Promoting multilingualism and multiculturalism

South Africa's rich linguistic and cultural diversity is celebrated through the model's emphasis on leveraging multilingualism and multiculturalism as educational resources. This approach aligns with the country's efforts to promote linguistic and cultural heritage while fostering a spirit of unity in its diverse population.

## Fostering lifelong learning

By nurturing learners' linguistic versatility, critical thinking abilities, and cultural understanding, the model equips them with skills that extend far beyond the classroom. These qualities are aligned with South Africa's education goals of preparing learners for active citizenship and lifelong learning in a rapidly evolving global landscape.

The anticipated benefits of the Multilingual Integrated Pedagogical Model encompass improved communication, cultural sensitivity, enhanced mathematical skills, alignment with educational goals, promotion of multilingualism and multiculturalism, and the cultivation of lifelong learning attributes. As the model unfolds in South African classrooms, its transformative potential holds the promise of a more inclusive, enriched, and empowered educational landscape.

## Future directions and adaptability

Here I discuss the potential of the Multilingual Integrated Pedagogical Model to transcend South African classrooms and its potential for further research to validate and refine its effectiveness. By exploring adaptability to other multilingual contexts and potential research avenues, we gain insight into the broader impact of the model.

## Adapting the model to other multilingual contexts

The principles of the Multilingual Integrated Pedagogical Model can be applied beyond South Africa's borders. Educators can adapt the model to incorporate local languages, cultural contexts, and educational goals in countries with linguistic diversity. By embracing multilingualism as an asset, other nations can similarly enhance mathematical literacy while honouring linguistic and cultural identities.

## Research avenues for validation and refinement

- *Longitudinal Studies:* Conducting longitudinal studies to track learners' progress over an extended period can provide insights into the model's long-term impact on mathematical comprehension, linguistic skills, and cultural sensitivity.
- *Comparative Studies:* Comparative studies can be conducted to assess the model's effectiveness against traditional monolingual pedagogies. Comparing learning outcomes and engagement levels can offer empirical evidence of the model's advantages.

- *Efficacy in Diverse Settings*: Research can explore how the model performs in diverse educational settings, such as urban versus rural schools, private versus public institutions, and different grades.
- *Multilingual Teacher Training*: Research can investigate the effectiveness of teacher training programs designed to equip educators with the skills required to implement multilingual pedagogy effectively.
- *Impact on Student Attitudes*: Research can examine how the model influences learners' attitudes towards mathematics, language, and culture, and if it fosters positive perceptions and enthusiasm for learning.

## Collaboration and knowledge sharing

International collaboration and knowledge-sharing forums can facilitate the adaptation and refinement of the model across various multilingual contexts. Educators, researchers, and policymakers can collaborate to develop localised variations of the model that align with each region's unique linguistic and cultural landscape.

## Technology Integration

Exploring how technology can complement the model's implementation could offer innovative ways to leverage digital tools for multilingual instruction, assessment, and collaborative learning.

As the Multilingual Integrated Pedagogical Model gains momentum, its adaptability to different multilingual settings and its potential for further research could signify a dynamic future in which education is enriched by linguistic diversity and culturally relevant pedagogy.

## Conclusion

As we explore the model's essential attributes and emphasising its transformative influence, the profound significance of this approach in fostering comprehensive, culturally vibrant, and linguistically empowering educational encounters becomes evident. The Multilingual Integrated Pedagogical Model is a dynamic framework meticulously designed to bridge the gap between mathematical literacy education and the diverse linguistic landscape common to South Africa's multilingual classrooms. The model encompasses several pivotal elements including curriculum design, instructional methods, assessment strategies, teacher training, the strategic utilisation of multilingualism as a resource, and the effective addressing of cultural and linguistic diversity. Adapting the curriculum to incorporate culturally pertinent contexts and linguistic diversity seamlessly is central to the model's effectiveness, thus rendering mathematical concepts more relatable and accessible to learners.

Moreover, the model fosters a dynamic and engaging learning environment through collaborative learning, multilingual discussions, scaffolding techniques, multilingual problem-solving, and reflective communication. Assessment strategies within the model, such as performance tasks, multilingual articulation, holistic evaluation, and portfolio

assessment, provide meaningful insights into learners' progress across mathematical and linguistic dimensions. To equip educators, the model offers multilingual pedagogical strategies bolstered by cultural sensitivity and language-specific approaches that enable the practical guidance of diverse learners. Leveraging linguistic diversity as an asset, the model enhances comprehension, nurtures metacognitive abilities, and refines communication skills.

By placing cultural sensitivity and inclusivity at its core, the model ensures a learning environment in which curriculum adaptation, community involvement, and the integration of learners' identities can thrive. Ultimately, the Multilingual Integrated Pedagogical Model promises to revolutionise mathematical literacy education in multilingual settings. By embracing learners' linguistic and cultural backgrounds, the model amplifies mathematical skills and nurtures cultural acumen, linguistic empowerment, and collaborative learning dynamics. Notably aligned with South Africa's educational aspirations, this model is well-poised to address the distinctive challenges posed by linguistic diversity. As educational practitioners and policymakers embrace this innovative framework, they chart a course toward an educational landscape that is more inclusive, enriched, and transformational.

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