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Synchronising English Second Language Proficiency and Mathematical Understanding Through Plurilingualism in Correctional Centre Classrooms: Empirical Perspectives

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Abstract: Several scholars have outlined the existence of a direct proportionality relationship between mathematics understanding and learners' second language proficiency. Nonetheless, the role of plurilingualism in realising the synchronous development of mathematics understanding and second language proficiency within the context of adult correctional centre classrooms has received minimal scholarly attention, particularly given the expansion of multilingualism. This paper sought to probe into how the correlation between mathematics understanding and English second language proficiency is realised through plurilingual pedagogical strategies. In this research endeavour, we employed a pragmatic epistemological stance and framed the study within the QUANT-QUAL explanatory sequential mixed methods research design. We collected quantitative data through mathematics and L2 tests from 150 conveniently sampled adult offenders. We further collected qualitative data through semi-structured interviews from 5 purposively sampled educationists. We analysed data thematically and by SPSS data analysis tool, through Pearson Correlation. The study was underpinned by the Socio-Cultural Learning theoretical stance. Amongst our findings is that L2 proficiency correlates positively with adult offenders' mathematics understanding. We further identified plurilingualism as the prominent pedagogical strategy through which the synchronisation between L2 and mathematics understanding is realised. Based on findings, we acclaimed the use of plurilingual strategies in the synchronisation of L2 proficiency and mathematics understanding in the context of multilingual adult offender education.

Keywords: Mathematics understanding, English L2 proficiency, plurilingualism, educationists, adult offenders.

1. Introduction

Multilingual proficiencies within mathematics teaching and learning trajectories have been swinging like a pendulum between opposite viewpoints. The initial contestation was grounded in the view that multilingualism in mathematics classrooms impedes learning (Spolsky, 1974). The conceptualisation of multilingualism as a resource for and towards the advancement of mathematics understanding that followed gave rise to a plethora of multilingual pedagogies, which include translanguaging (García, 2017), code-mixing (Thara & Poornachandran, 2018), code-switching (Moschkovich, 2015; Phakeng, 2018; Planas & Setati-Phakeng, 2014; Setati et al., 2002), plurilingualism (Piccardo, 2013; Rosa & Flores, 2021), and translation (Laviosa, 2014). Furthermore, several scholars have featured second language proficiency within multilingual mathematics learning discourses, thereby arguing for learners' proficiency in the language through which mathematics is taught (Essien, 2010; Henry et al., 2014). Worth noting is that there have been noticeable scholarly contestations, even among the latter scholars, which gyrate around the polarized arguments on whether language diversity should be embraced or whether learners should be solely

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developed in their language of instruction and in their home language. Furthermore, occupying the central focus of the preceding scholarship have been the contestations for the use of multilingual pedagogies within the context of children's mathematics learning (McLachlan & Essien, 2022; Sharma & Sharma, 2023). The body of scholarship on how second language proficiency and multilingualism correlate with the performance of adults in mathematics is limited. Furthermore, the confluence of multilingualism and second language proficiency with the performance of adult offenders in mathematics has been explored to a limited extent, particularly because of the salience of adult offenders' poor performance in mathematics in standardised examinations, which has been reported for over two decades (Farrington et al., 2016; Grigorenko, 2006; Mbatha, 2024b; Park & Kim, 2021; Verma, 1997).

Increased language and cultural diversity in the mathematics teaching and learning landscapes has given rise to the contemporary scholarly viewpoint that is grounded in the idea that multiplicity and diversity can increase chances of social and mathematical progress (Agbata et al., 2024; de Abreu, 2020). That is where the advocacy for the use of plurilingualism seems to feature within the mathematics teaching and learning trajectories. While advocating for plurilingualism within mathematics learning and teaching trajectories is worthwhile, the question of how it [plurilingualism] hallmarks and catalyses the comprehension of mathematics understanding and second language proficiency has been minimally addressed.

For over seven decades, scholars have engaged in various research endeavours to describe the correlation between second language fluency and mathematical understanding. Durkin and Shire (1991), for instance, outlined the centrality of language in mathematics learning by asserting that it [mathematics learning] commences and advances in language, gets hindered because of language, and its outcomes are often assessed through language. While these scholars present a legitimate argument, the nature of language use (whether L1 or L2) deemed central to the learning of mathematics remains obscure. Reinforcing this scholarly claim is Planas and Setati-Phakeng's (2014) assertion that language steers the communication of mathematical skills, procedures, and facts. Without a doubt, mathematics and language are conceptually inseparable. In fact, mathematics itself is a language of symbols (Mainali, 2021; Xu et al., 2022), with unique terminology whose meaning is not transferable to other disciplines (Ulusoy, 2021), and it has its own unique register (Straehler-Pohl et al., 2014; Wilkinson, 2018). The conceptualisation of mathematics as the "worldwide symbolic language" that encompasses "important language" (Rozgonjuk et al., 2020) reiterates the interweaving of language and mathematics. Therefore, the centrality and role of language cannot be isolated in discourses pertaining to mathematical understanding. Of paramount importance is probing into the synchronic development of the two (mathematics and second language proficiency), because while mathematics cannot develop without language (and vice versa), many mathematics learners acquire it through the medium of their second language. Due to the acceleration of social mobility and the consequent rise in linguistic and cultural diversity (Davis & Sumara, 2005; Freeman & Cameron, 2008; Piccardo & Aden, 2014; Verspoor et al., 2011), the role of plurilingualism in the realisation of the synchronic development of second language proficiency and mathematical understanding is a legitimate area of concern.

Linguistic and cultural diversity are quotidian across adults' and children's mathematics learning situations, and across "normal" and incarcerated communities. Furthermore, while substandard performance in mathematics perturbs scholars whose research interests focus on children's mathematics learning trajectories as much as it perturbs those who concentrate on adult learning trajectories, there is limited scholarship whose central focus is on the interrelationship between second language proficiency and mathematics understanding in adult correctional centre classrooms. Hence, in this study, we sought to address the following research questions, which served as guidelines for this research endeavour:

- How does mathematical understanding correlate with English L2 proficiency in the context of adult correctional centre classrooms?
- What are the perceptions of educationists on the factor(s) that are an impetus for the synchronisation of mathematics understanding and English L2 proficiency?

The study's focus on plurilingualism in an attempt to describe the correlation between mathematical understanding and second language proficiency within the context of correctional centre classrooms distinguishes it [the study] from the preceding scholarship, whose focus has been either on discussing the correlation between mathematics and language with other multilingual pedagogies occupying the central focus, or on how mathematics performance relates to second language proficiency within the context of children's learning.

2. **Literature Review**

In this study, we arranged the review of literature as illustrated in Figure 1 below

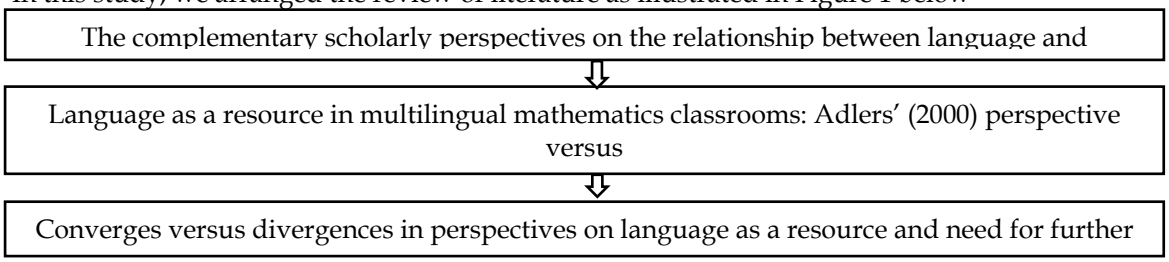

Figure 1: *Literature review layout*

2.1 Scholarly perspectives on the relationship between language and mathematics

The literature that merges language proficiency and mathematics predominantly orients the readership towards the notion of language as a resource. Planas and Civil (2013); Planas and Setati-Phakeng (2014); Planas and Setati-Phakeng (2014); and Barwell et al. (2016), in their attempts to designate language as a resource, argue that embracing and developing multilingualism overcomes deficit perspectives that view learners' home languages as inferior to dominant languages. In fact, substantial scholarly work conducted in a range of multilingual settings, including bilingual mathematics classrooms (Khisty & Chval, 2002; Krause et al., 2022; Malaki et al., 2022; Moschkovich, 1999, 2009; Moschkovich, 2008; Scherzinger & Brahm, 2023); second language mathematics classrooms (Barwell, 2005a, 2005b; Erath et al., 2021; Prediger & Wessel, 2013; Stovner & Klette, 2022); and plurilingual mathematics classrooms (Adler, 2001; Cutrim Schmid, 2023; Prediger & Uribe, 2021; Setati, 2005) converges towards the argument that the use of more than one language is more resourceful and mitigates the perception of bilingual or multilingual learners as less capable of learning mathematics. Drawn from these scholarly contentions is the conceptualisation of "language as a resource," to which we believe a two-fold conceptualisation is attached (this two-fold conceptualisation will be discussed in depth in the subsequent section). Furthermore, due to this two-fold conceptualisation, we argue that the view of "language as a resource" converges and diverges in various ways, particularly within multilingual and bilingual mathematics teaching and learning contexts.

The phrase "language as a resource" has been prominently used within the discourses of mathematics cognitive development and social interaction. For example, Perlovsky (2009) presented a study that illuminated the role of language as a resource in contexts where other cognitive factors influencing mathematics learning are disregarded, while Horn and Garner (2022) have employed Socio-Cultural Learning Theory to demonstrate the use of language as a cultural tool to facilitate the development of mathematical cognition.

Laying out the conceptual framework through which the phrase "language as a resource" can be perceived was not the primary aim of the study. However, by drawing on and building upon Adler's (2000) and Planas and Setati-Phakeng's (2014) differing viewpoints on the conceptualisation and contextualisation of the term, particularly in the post-apartheid multilingual mathematics teaching and learning context, it was deemed necessary to create the framework through which the use of language as a resource can be understood to investigate and postulate the relationship between mathematics and second language proficiency in the development of plurilingual pedagogical strategies.

2.2 **Language as a resource in multilingual mathematics classrooms**

The use of the term "resource" within the multilingual mathematics teaching and learning context, even though it gained traction in 1990, has not anachronised. By contrast, different perspectives have sprouted out of it. In this study, two significant perspectives on language as a resource were drawn deliberately from the scholarly work of Adler (2000) and Planas and Setati-Phakeng (2014).

2.2.1 Adler's perspective of language as a resource

Adler (1997, 1998, 1999, 2001) attempted to perceive language as a resource in mathematics teaching and learning practices by exploring how learners' and teachers' engagement in social interaction correlates with the development of mathematical understanding. By framing her work within Vygotsky's (1978) Socio-Cultural Learning Theory, Adler (2000, 2001) explicitly argued for the use of language as a cultural tool and maintained that the role of teachers is to reconcile learners' everyday language and culture with formal mathematical concepts (Adler, 2021; Essien, 2023). Although her conceptualisation of language as a resource was initially challenging, her proposed framework of different kinds of resources (i.e. basic resources such as buildings and teachers; material resources such as books and calculators; social and cultural resources such as language; and other resources such as teachers' knowledge) illustrated the significance of language and its use in developing mathematical understanding. Furthermore, her coupling of social and cultural resources, we argue, strengthens the notion that the combination of language and culture advances mathematical understanding. In her subsequent scholarly work, she explicitly stated that the alignment and combination of language and culture guide and organise mathematical thinking in ways that align with developed practices, particularly within multilingual mathematics teaching and learning contexts (Adler et al., 2022). In our view, Adler's (2000) interlinking of language and culture within mathematics teaching and learning discourses positions plurilingualism—as a catalyst for advancing mathematical understanding—even if not overtly stated, as scholars define it.:

- Model for interconnection and interdependence between language and culture (Cross et al., 2022; Piccardo & Aden, 2014).
- Variety of perspectives that situate language and culture within the same continuum (Canagarajah & Liyanage, 2012; Galante & Dela Cruz, 2024) and as the
- Practice of integrating culturally and linguistically exclusive states (Moore & Gajo, 2009; Trenchs-Parera & Pastena, 2024).

In Figure 2, we diagrammatically illustrate how we have discerned the role of plurilingualism in the development of mathematical knowledge by building upon Adler's (2000) perspective of language as a resource.

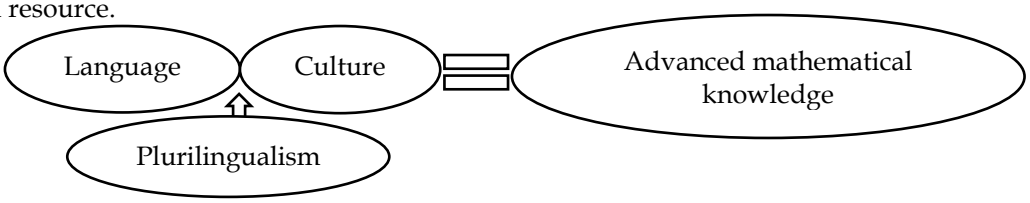

Figure 2: *The role of language and culture (plurilingualism) in the advancement of mathematical knowledge*

Figure 2 illustrates how plurilingualism advances mathematical knowledge. Adler's (2000) scholarly work, even though it clarifies how language proficiency relates to mathematics understanding (Mwadzaangati & Adler, 2023), illustrates the correlation of mathematics to language (that is, whether and how mathematics understanding hallways towards language proficiency) to a minimal extent.

2.2.2 Planas and Setati-Phakeng's (2014) perspective of language as a resource

As a means of strengthening and critiquing Adler's (2000) perspective of language as a resource, we drew on the second body of research that utilises the notion of language as a resource in multilingual mathematics teaching and learning contexts, developed by Planas and Setati-Phakeng (2014), as evidenced in Romera-Paredes et al. (2024); Setati (2005, 2008); Planas (2014); and Planas & Civil (2013).

The two authors have jointly and separately focused on three dimensions relevant to the teaching of mathematics in multilingual classrooms: the political dimensions of language choice (Setati, 2005, 2008); the association between language and identity (Planas, 2011); and the role of language in the emergence or creation of opportunities to learn mathematics (Planas & Setati, 2009). Throughout their discussions of these dimensions, they adhered to the assertion of language as a resource. Due to Planas and Setati-Phakeng's (2014) resonance with the framework developed by Ruiz (1984) in the field of language planning, we argue that these dimensions are anchored in and discussed within the three orientations in language planning research and practice: language as a problem, language as a right, and language as a resource. Although Ruiz's (1984) three orientations were generic, Planas and Setati-Phakeng (2014) translated and situated them within the context of mathematics teaching and learning. The two authors argue that policy documents in South Africa are framed by a language as a right perspective. In other words, South African learners have the right to education in any of the eleven official languages (Docrat, 2012; Kaveh, 2023). Conversely, findings from various scholarly works by Planas and Setati-Phakeng revealed that teachers' perceptions of language use in multilingual classrooms are influenced by the concept of language as a problem (Planas & Setati-Phakeng, 2014). This implies that teachers often perceive language as a barrier that impedes mathematics learning in classrooms with learners who speak different languages. Ultimately, teachers' language choices in practice are shaped by the language as a resource perspective. For instance, Planas and Setati-Phakeng (2014) exemplified how the use of multiple languages appears to enhance mathematics learning. We argue that this phenomenon relates to their conception of language as a resource. In their perspective of language as a resource in multilingual mathematics classrooms, the two authors contend that approaching language from a resource-oriented perspective is a prerequisite for recognising language as a right (Planas & Alfonso, 2023; Ward-Penny & Thomas, 2024). In other words, understanding mathematics, the choice of multilingual pedagogies through which understanding is achieved, and the performance facilitated by language use should be prioritised over policy and political stipulations.

2.3 Converges versus divergences in perspectives on language as a resource and need for further research

Between the two latter perspectives on language as a resource, we identified convergences and divergences. We further discerned the need for research that correlates and intersects mathematics, language proficiency, and plurilingualism.

Adler's (2000) scholarly perspective on language as a resource models the intersectionality between language and culture, and the role they play in the development of advanced mathematical understanding. Based on relevant scholarly literature that focuses on the conceptualisation of plurilingualism, we argue that the intersectionality of language and culture denotes plurilingualism. What differentiates Adler's (2000) perspective from that of Planas and Setati-Phakeng (2014) is that

the latter reveal the role and resourcefulness of language without incorporating cultural aspects. Furthermore, while Adler (2000) argues that language and culture contribute to the development of mathematical understanding, Planas and Setati-Phakeng (2014) diverge by contending that language plays a fundamental role in the emergence of learning opportunities, which, in our view, do not satisfactorily translate to mathematical understanding.

We believe the two perspectives intersect and converge at the point where further research is needed. Both perspectives outline language (or language use) as the controlling variable for both mathematical understanding and learning opportunities. Nonetheless, the question of whether and how mathematics influences the development of language proficiency remains insufficiently discussed. Therefore, we contend that the two perspectives do not satisfactorily model the correlation between mathematics and second language proficiency. Again, the oversight of how second language proficiency and mathematics relate within the context of the adult mathematics teaching-learning process is both a point of convergence and an indication of the need for further research. While several studies have focused on the learning of mathematics within adults' teaching-learning contexts (Mbatha, 2024a, 2024b; Mbatha et al., 2024; Mbatha & Mokoena, 2024), the correlation of mathematics and second language proficiency within the context of adult correctional centre classrooms is arguably a field that has received minimal scholarly attention.

3. Theoretical Framework

We underpinned this study with Vygotsky's (1978) Socio-Cultural Learning Theory Vygotsky's (1978) socio-cultural ideas have been extensively used in scholarly works as a framework and lens for analysing the role of language and culture in the development of cognition. This Socio-Cultural theoretical stance has also been employed to demonstrate the role of language and social interaction in translating everyday understanding into classroom concepts. The role played by language and social interaction in translating and infusing everyday understanding into the learning space is frequently termed "the use of language as a cultural tool."

Among the key subsets of cognitive development, according to Vygotsky (1978), is social interaction, which can occur between children and adults or between children and knowledgeable peers. Social interaction (or language) is perceived as a cultural tool used to systematise learning in ways that align with and reflect collectively developed practices (culture).

The Socio-Cultural Learning Theory posits that the more knowledgeable other (typically a teacher or instructor) possesses a substantial amount of knowledge and skills related to a particular task. Hence, he or she [the knowledgeable other] can help a child learn new concepts and tasks only if the concepts or tasks do not exceed the Zone of Proximal Development. However, learning a new task materialises when it is transmitted in ways that align with and reflect collectively developed practices.

We deemed this theory pertinent for this study because it outlines the relationship between language (proficiency), the development of cognition (which, in this context, is modelled by mathematics understanding), and the realisation of the two through the integration of language and culture (plurilingualism). We used this theoretical stance as the framework through which the correlation between adult offenders' second language proficiency and mathematics understanding can be viewed from a plurilingual standpoint. Additionally, we further utilised this theoretical stance as a lens through which the role of language in the development of cognition can be perceived. Language use, in this context, is modelled by plurilingualism, while the development of cognition refers to the synchronised advancement and understanding of a second language and mathematics. It is through this theoretical stance that we interpreted plurilingualism as the scaffold that facilitates the simultaneous advancement of mathematics understanding and second language proficiency. We also used this theory as the framework upon which the understanding of language use within the language and mathematics learning-teaching context can be underpinned.

4. **Contextualising the Study**

The study was contextualised within one of the correctional centres in the province of KwaZulu-Natal. While conducting an intervention study on the use of a three-dimensional approach in teaching addition and subtraction through the medium of isiZulu, we noted that adult offenders are multilingual, culturally diverse, and frequently moved from one correctional centre to another due to the stipulations of the Department of Correctional Services Draft Transfer Policy of 2009. We subsequently identified the relevance of plurilingualism in both correctional and non-correctional settings, owing to the expansion of cultural and linguistic diversity that has characterised and shaped learning and teaching practices in "normal" societal contexts. We were further drawn to the fact that these adult offenders, like children and adults in non-correctional settings, learn English as a second language, while mathematical content is taught, learned, and assessed in English. Offender education policies stipulate the use of English as the Language of Learning and Teaching (see Correctional Services Act 111 of 1998, for instance), despite the growing multilingualism and cultural diversity in correctional centre facilities. In this regard, we endeavoured to observe language use during the learning and teaching of mathematics in multilingual, bilingual, and multicultural contexts within correctional centres. We aimed to investigate how mathematical understanding informs and correlates with second language proficiency (and vice versa). As the study sought to focus on both learning and teaching processes, we deliberately selected both adult offenders and educators to participate in the research.

5. **Methodology**

In this study, we adopted a pragmatic epistemological stance, acknowledging both quantitative and qualitative data as pertinent for probing into the inquiry of examining the correlation between second language proficiency and mathematical understanding. We framed the study within the QUANT-QUAL explanatory sequential mixed methods research design, which is a design that uses quantitative data to explain qualitative findings. We used quantitative data that were analysed by SPSS through Pearson Correlation (i.e. the analysis that sought to observe how mathematical understanding and second language proficiency correlate) to explain and attach meaning to qualitative data (which were analysed thematically from semi-structured interviews with educationists). 150 adult offenders were conveniently sampled, and 5 educationists were purposively sampled. The population of adult offenders was 1200 (n=1200) across AET levels one, two, three, and four. The total population of educationists was 10 (n=10). The adult offenders that were sampled were those representing AET levels one, two, three, and four respectively, and the sampling was convenient because, out of 1200, 150 were deemed to be consistently present during mathematics and language classes. Educationists that were purposively sampled were those who teach languages and those who teach mathematics across the AET levels.

Participants were informed of anonymity and confidentiality. We also indicated to the participants that their participation was purely voluntary and that they were not deprived of their right to withdraw their participation at any given time should they wish to do so. Likewise, all participants signed forms indicating their consent to participate in the study. In line with the Correctional Services Act, we acknowledged adult offenders as liberated South African citizens, who cannot be coerced into participating in any study or programme without their consent. We sought and acquired the gatekeepers' permission from the South African National Commissioner of the Department of Correctional Services. We further applied for and acquired ethical clearance to conduct the study. The validity of the data was ensured by the triangulation of two data collection tools (testing and semi-structured interviews). Furthermore, in our attempt to ensure test reliability, we used standardised mathematics and English tests. Prior to the collection of data, we requested to record the proceedings using a tape recorder. In our attempt to ensure the accuracy of the translation of data (from isiZulu to English), we used the expertise of a language expert, who evaluated cultural

appropriateness, tone, and style in the translated text. Permission to record semi-structured interview proceedings and English L2 language and mathematics test scores was obtained from participants.

6. Presentation and Discussion of Findings

6.1 Quantitative results: Test of normality

In their reiteration of the importance of conducting tests of normality for quantitative studies, several scholars assert that when normality assumptions do not hold, it becomes impractical to draw accurate and reliable conclusions about the data (Ghasemi & Zahediasl, 2012; Hinton et al., 2014). In this study, we performed the Shapiro-Wilk test to determine whether the data from English L2 and mathematics test scores were normally distributed. Furthermore, we conducted the Shapiro-Wilk test to ascertain whether comparisons should be made using a parametric or non-parametric test. For the Shapiro-Wilk test, the criterion for data normality is an alpha value greater than .05 ($p > .05$). The null hypothesis (H0) posited that the English L2 test scores and the mathematics proficiency test scores were normally distributed. The p-value in the normality table below was used to assess the normality of the data and to decide whether to accept or reject the null hypothesis.

Table 4: *The tests of normality table*

	Kolmogorov-Smirnov[a]			**Shapiro-Wilk**		
	Statistic	Df	Sig.	Statistic	Df	Sig.
English L2 proficiency test	,149	150	,200*	,975	150	,947
Mathematics test	,149	150	,200	,975	150	,947

According to the tests of normality table, for mathematics and English L2 proficiency scores, there were no statistically significant values between the scores and normality; in other words, the data were normally distributed (the p-value is 0.947, which is greater than 0.05 for English L2 proficiency and mathematics test).

6.1.1 The Pearson correlation coefficient which sought to measure the correlation between adult offenders' language proficiency and mathematical knowledge

The Pearson correlation coefficient, according to Zhou (2016) and Pallant (2020), is a statistical measure of the intensity of association between any two variables. In other words, the Pearson correlation coefficient aids in observing how the change in the magnitude of one variable is associated with the change in the magnitude of the other variable, either in the same (positive correlation) or opposite (negative correlation) direction (Schober et al., 2018).In the Pearson correlation coefficient, the association is observed through the value of r (which is popularly known as the R-factor), which ranges between -1.0 and +1.0, with a zero (0) denoting that there is no linear association between the variables. The sign of the correlation describes the direction of the relationship. In other words, a positive sign indicates that as one variable increases, the other also increases, while a negative sign indicates that as one variable increases, the other decreases. In the correlation table below, we demonstrate the association between adult offenders' English L2 proficiency and mathematics understanding.

		English L2 proficiency	**Mathematical knowledge**
English L2 proficiency	Pearson Correlation	1	+,87
	Sig. (2-tailed)		,620

	Sum of Squares and Cross-products	8774,762	-1105,524
	Covariance	84,373	-10,630
	N	150	150
Mathematical understanding	Pearson Correlation	-,49	1
	Sig. (2-tailed)	,620	
	Sum of Squares and Cross-products	-1105,524	58046,248
	Covariance	-10,630	558,137
	N	150	150

Table 2: *Pearson correlation between language proficiency and mathematics knowledge*

The Pearson correlation in Table 2 indicates that there was a positive correlation between English L2 proficiency and mathematical knowledge (the R-value was +0.87, which is closer to +1.0). This implies that adult offenders who were found to be proficient in English L2 also demonstrated sound mathematical understanding. On the other hand, there was a negative correlation between mathematical understanding and English L2 proficiency (the R-value was -0.49, which is between 0 and -1.0). This implies that adult offenders who demonstrated sound mathematical knowledge were found to have significantly lower English L2 proficiency. According to the Pearson correlation, English L2 proficiency is directly proportional to mathematical understanding, while mathematical understanding is inversely proportional to English L2 proficiency.

6.2 Qualitative findings and discussion

During the process of thematically analysing the data, two prevalent themes emerged. Although the themes appear to be discrete, we discovered overlapping pieces of data that subsequently caused them to converge and intertwine (see Figure 3 below). Furthermore, we deliberately intersected and coordinated pieces of data to address the following research question:

- What are the perceptions of educationists on the factor(s) that are the impetus for the synchronisation of mathematics understanding and English L2 proficiency?

We further operationalised the data presented and discussed in this context to construct what we termed an "empirical perspective" on the usability of plurilingualism in synchronising English L2 proficiency and mathematics understanding in adult offender correctional centre classrooms.

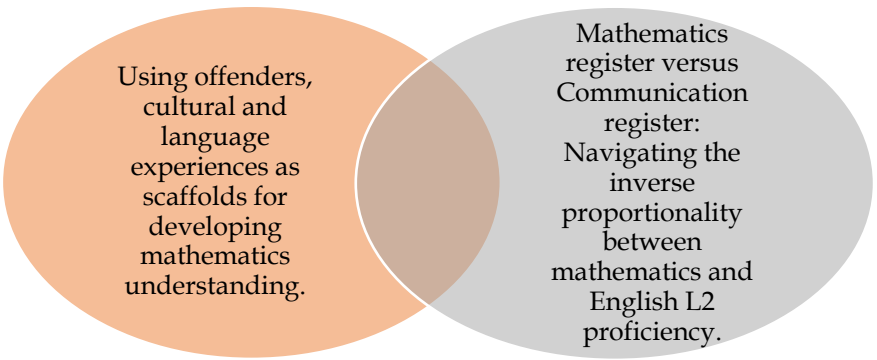

Figure 3: *The interweave between the two themes prevalent themes*

Note: Figure 3 illustrates the interweave between the two themes that emerged during the analysis of data.

6.2.1 Using offenders' prison cultural and language experiences as scaffolds for developing mathematics understanding

According to Adler (2000), language, in multilingual classroom contexts, is used as a resource in positioning mathematical thinking along ways that mirror and align with collectively developed practices (culture). On the other hand, based on Planas and Setati-Phakeng's (2014) perspective, using language as a resource entails (though not limited to) intersecting language with learners' identity (also see Planas 2011). In our quest to probe how the direct proportionality relationship between English L2 proficiency and mathematics understanding was actualised, we discovered that educationists use plurilingual pedagogical strategies in language and mathematics correctional centre classrooms specifically for a two-fold reason. It [plurilingualism] is firstly used unintentionally, in discourses within bilingual and multilingual mathematics classrooms, to coordinate prison cultural practices with mathematical concepts (see the verbatim words of **Educationist A**). Secondly, we located plurilingual pedagogical practices within the English L2 proficiency and mathematics understanding relationship through the analysis of educationists' allusion to linking offenders' language identities with the formal learning of language and mathematics (see the verbatim words of **Educationist B**). Furthermore, **Educationist A** indicated that he initially established the prison culture that is prevalent in his mathematics and language classrooms. He subsequently teaches mathematics and language using examples that relate to the dominant culture within the classroom. This practice, in line with Adler's (2000) perspective of language as a resource for and towards the development of mathematics understanding, was evidently linked with the development of mathematics understanding through language. Furthermore, **Educationists A and B** demonstrated how plurilingualism influences the positive correlation between English L2 proficiency and mathematics understanding.

> **Educationist A:** *I initially acquaint and familiarise myself with the collectively developed practices within the correctional centre. I also try to establish the dominant prison culture. After that, I use examples, create educational resources, converse with, and sometimes assess adult offenders using examples that intersect prison cultural practices with either mathematical knowledge or language content. Once offenders observe you the correlation between their culture and mathematics or language, they get fascinated to learn more. What I have observed is that, situating the culture within the learning context is resourceful mainly for adult offenders who are good in language. Again, those who are good at language tend to be good at understanding word-based problems. In our 2024 analysis, we found that language-proficient offenders could make sense of quantitative literacy and text-based mathematical problems.* (Verbatim words were translated from isiZulu).

For **Educationist A**, culture is central to the learning of mathematics and language. Furthermore, **Educationist A** indicated that the interweaving between language and culture yields mathematical understanding. Congruent with Vygotsky's (1978) Socio-Cultural perspective, **Educationist A** perceives learning as a social activity, by outlining that conversations are predominantly based on the intersection of culture and language. We argue that **educationist A** resonates with Adler's (2000) view of language as a resource because he perceives the learning and teaching of mathematics as a fundamentally social activity, while he uses language (interaction) as a cultural tool (see Adler, 2000; Adler, 2001). We further conclude that, for **Educationist A**, plurilingualism (that is, the combination of language and culture) catalyses the positive correlation between English L2 proficiency and mathematics understanding. This postulation explains why, according to the Pearson Correlation, there was an R-value of +0.87 between English L2 proficiency and mathematics understanding.

In our attempt to position plurilingual strategies within the correlation between English L2 proficiency and mathematics understanding, we draw on **Educationist B**'s discussion on the use of language and identity as the reagent for mathematical understanding. This indication is not only

parallel to Planas and Setati-Phakeng's (2014) perspective on language and identity, but it also models how plurilingual strategies arise from the combination of language and identity. As a matter of fact, Khohliso and Mbatha (2025) demonstrated the role of offenders' language identities (the use of the *sabela* dialect) in the advancement of mathematics understanding. Even though Mbatha and Khohliso (2025) did not explicitly use plurilingualism to model the language-identity combination, we argue that plurilingualism is resourceful in advancing both English L2 proficiency and mathematical understanding.

> **Educationist B:** *I use sabela language. These offenders are affiliated with different gangs, and in each gang, there is a certain cultural practice. If you want to get them to understand language and mathematics, you have to firstly establish their identity within the prison gang and also understand the language which they use to communicate within that particular gang. Subsequently, you have to use the sabela language (that caters for all gang members) as some sort of a tool to get them to understand mathematics and even formal language. I have not given myself time to observe whether offenders who are good in mathematics tend to have proficient language skills, but what I have observed is that those that understand the language through which mathematics is taught, which is English in particular, tend to perform better in mathematics.* (Verbatim words were translated from isiZulu).

From the words of **Educationist B**, we argue that language and identity hallways to advanced mathematical understanding. In fact, amongst the variety of topics relevant to the teaching and learning of mathematics in multilingual classrooms, Planas and Setati-Phakeng (2014) focused on the political dimensions of language choice and the link between language and identity. Again, several scholars, in their attempt to conceptualise plurilingualism, gesture towards the dynamic use of multiple languages and cultural knowledge, awareness and (or) experience in social situations (Corsi, 2019; Eren, 2024; Voyer, 2020). Therefore, we argue that it is through plurilingualism that English L2 proficiency and mathematical understanding were found to be positively correlated.

Based on the latter empirical evidence, and by building upon Planas and Setati-Phakeng (2014) and Adler's (2000) perspective of language as a resource, we subsequently architect the four-fold conception, and that is:

- The use of language both as a cultural tool (Adler, 2000) and as a resource based on Ruiz's (1984) three orientations in language planning (discussed by Planas and Setati-Phakeng, 2014) is central to the development of mathematical understanding in bilingual and multilingual correctional centre classrooms.
- Language and mathematics, although predominantly discussed as being conceptually inseparable, have a direct proportionality relationship, which can be observed through the lens of plurilingualism.
- The discussion and the argument for the use of multilingual and/or bilingual pedagogies for children's mathematics learning translate satisfactorily to the adult bilingual and multilingual correctional centre classrooms.

The language-mathematics relationship cannot be viewed from a unidimensional lens. In other words, while English L2 proficiency correlates positively with mathematical understanding, mathematical understanding does not correlate positively with English L2 proficiency.

$$English\ L2\ proficiency \propto \frac{Mathematical\ understanding}{1}$$

BUT

$$Mathematical\ understanding \propto \frac{1}{English\ L2\ proficiency}$$

6.2.2 Mathematics register versus communication register: Navigating the inverse proportionality between mathematics understanding and English L2 proficiency

The Pearson correlation between adult offenders' mathematics understanding and English L2 proficiency revealed a negative association between the two variables. While the perspectives of educationists on the positive correlation between English L2 proficiency and mathematical understanding align with Adler's (2000) and Planas and Setati-Phakeng's (2014) perspectives of language as a resource, data that can be used to explain the inverse proportionality of mathematical understanding to English L2 proficiency has not been discussed. Under this theme, we seek to co-ordinate pieces of data inferred from educationists' perspectives to explain the inverse proportionality of mathematical understanding to English L2 proficiency. In our attempt to foreground the presentation and the discussion of data on mathematics understanding-English L2 proficiency inverse proportionality, we operationalise literature whose concentration has been on the distinction between the communication register and the mathematics register. We subsequently use these distinctions to underpin educationists' perspectives on the inverse proportionality between mathematics understanding and English L2 proficiency within bilingual and multilingual adult correctional centre classrooms.

Wilkinson (2018) conceptualises the register as any language variation, whether in speaking or writing, that participants shape through their social interaction with one another. While registers are discipline-specific (Uptegrove, 2015), there is usually a co-occurrence thereof across different disciplines (Herbel-Eisenmann et al., 2015). In other words, similar words and phrases can be used across English language contexts and mathematics contexts but have different connotations. In mathematics' own language (referred to as mathematics register), certain English words can be used to distinctly denote non-linguistic representations of mathematical ideas (e.g. symbols, operations) (Halliday, 1975; Nagy & Townsend, 2012). The communication proficiency (in oral discussion) and generic language proficiency (i.e. reading and writing with comprehension) is, however, fundamental for the translation of generic language to mathematics register (Schleppegrell, 2007), hence the positive correlation between English L2 proficiency and mathematics understanding (see 6.1.2). Mathematics is the combination of both the application of procedures and the translation of texts to mathematical representations (Lane et al., 2019). Therefore, it is a logical supposition to make that learners who are proficient only in the application of procedures (that require minimal language understanding) might not always be proficient in language.

Educationist C indicated that the disjunction between mathematical register and communication register is mostly attributed to the inverse proportionality of mathematics understanding to English L2 proficiency. He further indicated that, in some instances, adult offenders with advanced non-linguistic mathematical application skills lack reading and writing cognition. Furthermore, in his view, adult offenders like "to apply" rather than "to read for understanding."

> **Educationist C:** *Maths and language are related, but there are some mathematical words that mean the total opposite within the language context. For example, I taught functions to AET level four adult offenders and also taught (the same group) English First Additional language. The text in English had words like "functions," but connoting a difference. My observation was that adult offenders, whom I know are very good with math, were struggling to understand the text. In my view, the languages (maths language and English language) are spelt the same, but their meanings are totally different. Again, I have noticed that adult offenders who like playing around with mathematics procedures are not always interested in anything that is related to reading and writing. That is why I think your mathematics test and your language test did not speak to each other.* (Verbatim words were translated from isiZulu).

According to Dooly and Vallejo (2020), plurilingualism fosters cognitive development, improved cultural awareness, increased social inclusion, better language learning outcomes, and greater

preparedness for a globalised world. By drawing from the latter scholars' postulation, we argue that using plurilingual strategies in both English L2 and mathematics classrooms might:

- Aid adult offenders in differentiating between the mathematics register and the communication register.
- Advance, hone and better reading and writing skills, which are fundamental within the context of language learning.

7. Conclusion and Recommendations

In this paper, we sought to establish the correlation between adult offenders' English L2 proficiency and mathematics understanding. According to the findings of the study, English L2 proficiency correlates positively with adult offenders' mathematics understanding. In contrast, we established the inverse proportion of mathematical understanding to English L2 proficiency. In our attempt to probe beneath the rationale behind the two relationships, we discovered that educationists' use of plurilingualism within mathematics classrooms develops both mathematics understanding and English L2 proficiency synchronically. The educationists' use of plurilingualism was observed through the use of and the salient switching between multiple languages (i.e. isiZulu, prison *sabela*, and English) in the teaching of both English L2 and mathematics. Based on educationists' perspectives, we established that the disconnection between mathematics and communication register leads to the inverse proportionality of mathematics understanding to English L2 proficiency. We then recommend the use of plurilingual pedagogies in bilingual and multilingual adult offender classrooms in both language and mathematics for three reasons. Firstly, because most adult offenders learn English as a second language; secondly, because most offenders learn mathematics in a language that is not their own; and thirdly, because of the expansion of multilingualism, bilingualism, and multiculturalism in correctional centre classrooms. We further recommend longitudinal studies tracking the English L2 proficiency and mathematics performance in correctional centre classrooms over time. Since the focus of the study was on correctional education, we recommend correctional education policy changes that support plurilingual learning.

8. Declarations

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