

International Journal of Learning, Teaching and Educational Research
Vol. 24, No. 10, pp. 587-606, October 2025
<https://doi.org/10.26803/ijlter.24.10.28>
Received Jul 29, 2025; Revised Aug 23, 2025; Accepted Oct 6, 2025

The Thin End of the Wedge: South African Adult Offenders' Empirically Calibrated Mathematics Learning Trajectories

Xolani Khohliso 

Central University of Technology
Bloemfontein, South Africa

Siphelele Mbatha* 

University of the Free State
Qwaqwa Campus, Phuthaditjhaba, South Africa

Abstract. The substandard performance of children and adults in mathematics is a global conundrum. Studies identified large cohort of South African children who could not benchmark against their counterparts in standardized international tests. Similarly, an analysis of adults' performance in mathematics reveals that mathematics understanding in adults' learning contexts is direful. By assembling upon Gagne's (1962) theorization of mathematics as a subject with a strong vertical demarcation and integration of concepts, the paper sought to explore adult offenders' mathematics learning trajectories, with the context of Correctional Education Adult Education (AET) Level One to Adult Education and Training Level Four occupying the central focus. The phenomenon was viewed from the pragmatic epistemological stance. The study was framed within the QUANT-QUAL explanatory sequential mixed methods research design. For quantitative data, 150 adult offenders' mathematics scores from standardized AET tests across four levels were analysed by SPSS, while qualitative data, inferred from 10 stratified sampled adult offenders through semi-structured interviews were analysed thematically. Based on empirical evidence, it was discovered that the combination of language barriers, prison contextual factors and AET curriculum structure inhibited adult offenders' mathematics cognitive development. Furthermore, the findings were that language barriers, prison contextual factors and AET curriculum structure created a low ceiling, beyond which the progress in mathematics, across AET levels was improbable. Based on the findings, the model for flattening adult offenders' mathematics learning trajectory is proposed, with implications on the use of multilingual pedagogies, Correctional Services Policy reform, and adult curriculum policy framework.

*Corresponding author: Siphelele Mbatha; MbathaST@ufs.ac.za

Keywords: Mathematics performance; mathematics learning trajectories; educationists; correctional centre classrooms; adult offenders

1. Introduction

The antecedent body of scholarship gestures towards children's substandard understanding and performance in mathematics. For instance, according to Spaul and Hoadley (2018), only the top 16% of South African grade 3 children were performing at an appropriate grade 3 level. This notion is supported by a host of scholarly literature, that extends back to 1998 (Fleisch, 2008; Howie & Hughes, 1998; Reddy, 2007; Spaul & Taylor, 2022; Taylor, 2021; Venkat & Spaul, 2015). Worth noting is that the similar findings transverse to adult mathematics learning situations. According to Neri and Retelsdorf (2022), all countries that participated in the Program for International Assessment of Adult Competencies study of 2018 have a considerable number of adults with mathematical deficits. These deficits arguably hallway substandard performance in mathematics (Rodrigues et al., 2023).

The studies whose focus is on children's performance in mathematics and those whose focus is on adults' performance in mathematics intersect in identifying that learners acquire learning deficits and cognitive challenges across their mathematics schooling expeditions. These cognitive challenges affect their mathematics learning trajectories and subsequently inhibit mathematics understanding progression(s). Amongst the plethora of aspects that contribute to the curvature of mathematics trajectories is the language through which mathematics is taught, learnt, and assessed (Azerbaiyev et al., 2023; Erath et al., 2021a, 2021b).

Mathematics and language are conceptually inseparable (Planas et al., 2021); therefore, identifying language as both the catalyst in the development and the controlling variable for the stagnation of mathematics understanding is the logical proposition. Augmenting the latter claim is Sharma and Sharma (2023)'s identification of children's lack of proficiency in English as the controlling variable for the elevation of mathematics learning deficiencies and subsequently the curvature of children's mathematics trajectories. On the other hand, the findings from different scholarly works have designated the role of Home Language instruction in elevating mathematics conceptual understanding, procedural fluency, and factual knowledge (Greisen et al., 2021).

As an attempt to crystallize the understanding of the extent to which language impedes and promotes mathematics learning (particularly for learners that learn mathematics in the language that is not their own), several scholars have intersected the curvature of mathematics trajectories with the lack of understanding of mathematical register (Mainali, 2021; Wilkinson, 2019), thereby arguing for the use of multilingual pedagogies in the contemporary multilingual teaching and learning situations. Worth noting is that scholarly discourses on language use, lack of understanding of mathematics register, and the combination thereof have been contextualized within children's mathematics learning situations. The question of how the intersection of and between the latter

translates to the curvature of adults' mathematics trajectories has been bedevilling scholars for some time.

According to the body of scholarship, language and mathematics are intertwined (Moschkovich, 2012), therefore, is a need to explore the adult offenders' mathematics learning trajectories, particularly given the contemporary expansion of multilingualism in mathematics classrooms. Again, the body of scholarship has identified the similarity between children's and adults' performance in mathematics. As an extension of the quantification of adults' performance in mathematics, the excavation of factors attributed to adults' poor mathematics performance and the exploration of factors attributed to the curvature of adults' mathematics learning trajectories is a worthwhile scholarly endeavour. Again, the focus on adult offenders' mathematics trajectories is arguably an efficacious scholarly exercise, particularly since offender education receives minimal scholarly attention, especially in the South African context.

As an attempt to explore adult offenders' mathematics learning trajectories, the following research questions were operationalized as guidelines for the present research endeavour:

1. Based on standardized test scores, what is the mean difference in adult offenders' mathematics performance along the AET Level One and AET Level Four learning trajectory?
2. What does the mean difference in mathematics performance along adult offenders' AET Level One and AET Level Four learning trajectory denote about the nature of the mathematics trajectory within correctional centre classrooms?
3. How do adult offenders' perspectives of mathematics learning experiences define mathematics performance and mathematics trajectories?
4. How (according to adult offenders) does language, context and curriculum inform mathematics learning trajectories?

The study's unfamiliar focus on adult offenders' mathematics trajectories and the antecedents thereof distinguishes it [the present study] from the preceding scholarly bodies, whose central foci have been predominantly on children's mathematics learning experiences and trajectories. Furthermore, the study's endeavour to emphasize the significant role of mathematics learning (i.e. critical thinking and problem solving) in the rehabilitation process distinguishes it from the studies whose foci are mainly on the functioning of education (in general) within the context of the offender rehabilitation cycle.

2. Literature review

2.1 The conceptualization and the contextualization of adult offenders' formal learning experiences in South Africa

Offender education is amongst the rehabilitation programs offered to actualize the holistic reform of an individual offender's social behaviour (Mokoele, 2016). Frantz (2017), defines offender education as the planned intervention (in the form of learning and teaching), which aims towards transforming offenders' criminal behaviour and alleviating recidivism. While the body of scholarship has identified an inverse proportionality between recidivism and offender formal education

(Carey, 2024; Charles, 2023; Magee, 2021), it is worth noting the discernible decline in offender formal education enrolment and the upsurge in recidivism rate, particularly within the South African context. The decline in offender formal education arguably calls for the scholarly intervention, whose central focus is on probing beneath offenders' formal learning experiences and trajectories, which are (hypothetically) determining factors for offender school dropout, particularly within the South African correctional centre context. The scholarly discourse on the nature of South African offender education curriculum and policy framework will foreground the review of literature on offenders' learning experiences.

The architecture of the offender education curriculum framework was sculpted to meet and develop offenders' intellectual, social, emotional, spiritual, and occupational needs (Badiktsie, 2023). The latter four needs have been maximally discussed in various bodies of scholarship, particularly since they [the four needs] are foundational in the development and rehabilitation of offenders' behaviours (Mbatha, Khohliso, & Nsele, 2025; Mbatha, Khohliso, Zondi, et al., 2025; Mokoele, 2016). On account of the noticeable fundamentality of the four needs and the interrelatedness thereof, we document them [the four needs] as "the quadrants of rehabilitation."

In fact, the latter needs are enshrined in the White Paper on Corrections of 2005, and they were further used to cement the argument for the humanistic approach to imprisonment, which was effectuated after the attainment of democracy in South Africa (Conway, 2022; Vandala & Bendall, 2019). While the inclusion of the "quadrants of rehabilitation" within the offender education curriculum landscape has been theorized, scholars have been establishing offenders' learning experiences along the trajectory towards fulfilling the needs upon which the humanistic approach to offender rehabilitation was assembled. Again, documented in the offender education curriculum are the learning area-specific pedagogical strategies and learning outcomes [which were paralleled with the aims and objectives of the Correctional Services Act of 1998].

Several other scholars have attempted to coordinate the documented pedagogical strategies and learning outcomes with the correctional centre classroom realities to construct the polygon of three sides through which correctional education can be comprehended. For example, Mbatha and Khohliso (2025) attempted to intersect language multiplicity, the development of offenders' understanding across the curriculum, and educationists' andragogic strategies. While an exploration of the triune of pedagogical strategies, learning outcomes, and correctional centre classroom realities is relevant, probing into adult offenders' learning trajectories and/or experiences is paramount, particularly given the critical nature of correctional centre contexts.

In attempting to conceptualize the adult offenders' formal learning experiences in South Africa, the scholarly work from Costelloe and Langelid (2011) was drawn. For the latter scholars, institutional and situational factors instigated by confinement define and inform offenders' learning experiences. Institutional factors refer to documented procedures that govern the practices in correctional

centres (Francis, 2015), for example, offender draft transfers. For Costelloe and Langelid (2011), institutional factors prevent or discourage offenders from participating in education programs and interfere with their learning trajectory (the scholarly works of Moore & Mokhele, 2017 also inferred similar findings). Situational factors, on the other hand, (i.e., the rise of gangsterism, violence, and drug use) also hallway to the curvature of offenders' learning trajectories.

The findings from Mbatha and Khohliso's (2025) study revealed that warfare between offenders' rival gang groups coerces security officials to lock down correctional centres and prohibit offenders' movement to education facilities. In addition to institutional and situational factors, researchers have defined offenders' learning experiences from the cognitive standpoint. For example, Goethals (2024)-documents that up to 60% of male adult offenders have learning difficulties. The latter scholar argues that offenders' learning difficulties inhibit their ability to learn, and subsequently hallway to poor academic performance.

While the body of scholarship reviewed above gestures towards factors contributing to the curvature of adult offenders' learning trajectories, there is a need, we argue, for empirically calibrated findings on adult offenders' mathematics learning trajectories. Our argument is assembled upon the findings that were excavated from the scholarly works of Mbatha (2024b); Mbatha (2024a); Mbatha et al. (2024); Mbatha and Khohliso (2025), which intersect in identifying adult offenders' substandard performance in mathematics across AET levels.

Again, the global studies identify the paramountcy of consistent mathematics formal learning in actualizing offenders' critical and synergistic thinking, which minimizes recidivism rate (Chrysikou et al., 2023; Klein, 2025). This implies that mathematics education for offenders is as important as children's mathematics education. We therefore endeavoured to probe into adult offenders' mathematics trajectories and experiences as a means towards hypothesizing substandard mathematics performance determinants. This, in our view, was also an attempt to draw attention to factor(s) that impede the mastery of mathematics understanding in correctional centre contexts, particularly since it is a minimally researched phenomenon.

Foregrounding the inferred findings from the research endeavour is our attempt to conceptualise adult offenders' mathematics trajectories through the lens of the Gagne's (1962) theorization of mathematics as a subject with a strong vertical demarcation and integration of concepts. We further operationalize this theoretical lens to provide the framework for understanding adult offenders' mathematics learning and presuppose the nature of adult offenders' learning trajectories. In the subsequent section, we, moreover, intersect Gagne's (1962) theory with the theoretical ideas of the Knowlesean (1984) Andragogic theory. This intersection, in our view, is instrumental in understanding, analysing and perhaps theorizing adult offenders' mathematics learning trajectories.

2.1.1 Theorizing adult offenders' mathematics learning trajectories from Gagne's (1962) and Knowles (1984) perspectives: The conceptual framework

Gagne (1962) deliberates that learning processes are to be predicated upon sequential instructional events (i.e. gaining attention, informing learners of the objectives, and stimulating recall of prior knowledge). In our view, these instructional events are not only sequential, but intertwined and interdependent, particularly in mathematics teaching-learning contexts. Subsequent to the deliberation of these instructional events, we will model their interdependence, and the paramountcy thereof in conceptualizing adult offenders' learning trajectories.

Gagne (1962) subsequently provide the framework for designing and delivering instruction in a structured and systematic manner. The scholar further contextualises the applicability of the instructional events within mathematics learning situations, thus presupposing that, since mathematics is a subject with strong vertical demarcation and integration of concepts, the learning processes therein are bound to be characterized with the plethora of trajectories. Therefore, the nature of those learning trajectories should be used as building blocks for pertinent instructional approaches.

2.1.2 Gagne's (1962) instructional events

Gaining Attention: This instructional event seeks to capture the learners' attention and engage them in the learning process (Kruse, 2009). The process of engaging learners in a learning process requires intensive understanding of their personal experiences and contextual factors (Purvis et al., 2014). The use and the understanding of personal experiences aligns with Knowles' (1984) postulation that (adult) learners come with voluminous experiences, upon which learning and teaching is assembled. Furthermore, the presumption is that, personal experiences and contextual factors inform learning trajectories (Wong, 2018), thus to alleviate learning challenges and the curvature of learning trajectories, an understanding of contextual factors ought to be taken into consideration (Kohzaki, 2024). The use of relevant stimuli and the posing of questions or problems are to be central in the learning process.

Informing Learners of the Objective: Learners need to be aware of the specific learning objectives or goals they are expected to achieve. Clear communication of these objectives helps to focus their attention and motivate them to learn (Solanki, 2014). The concept of motivation is further documented in Knowles' (1984) Andragogic theory, under the principle on motivation. Of paramount importance is that clear indication of objectives aids in mathematics understanding (particularly for adults), since mathematics is characterised with both vertical demarcation and integration of concepts.

Vertical demarcation refers to mathematics register, which demarcates mathematical content from familiar concepts used in social events. An integration of concepts refers to the incorporation of mathematics register with language used in social events to elicit understanding. Informing learners of objectives, we argue, creates the platform for interacting with them to establish what their experiences

and trajectories are, thereby using those experiences and trajectories in the instructional event.

Stimulate Recall of Prior Knowledge: Activating learners' prior knowledge helps them connect new information to existing mental frameworks (Solanki, 2014). By reviewing relevant concepts or experiences, learners can build upon what they already know. The prior knowledge further aids teachers to understand pre-existing learning experiences and trajectories.

2.1.3 The relevance of Gagne's (1962) instructional events in establishing adult offenders' mathematics learning trajectories

Gaining learners' attention involves an understanding of adult offenders' experiences and contextual factors that influence, in one way or the other, the nature of their learning trajectories. This theoretical perspective is particularly relevant within adult offenders' mathematics learning contexts, particularly because the context within which they learn impacts, in one way or the other, their mathematics learning trajectories. Informing Learners of the objective, on the other hand, helps not only with developing adult offenders' mathematics register, but also with intersecting their experiences and previous trajectories with mathematics learning processes. Stimulating prior knowledge does not only help with establishing content specific knowledge, but also with establishing experiences and trajectories incurred over the years.

3. Methodology

The study was contextualised within one of the correctional centres in the province of KwaZulu-Natal. It [the study] adopted the pragmatic epistemological stance, acknowledging both quantitative and qualitative data as pertinent for probing into the inquiry of examining adult offenders' mathematics learning trajectories. 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 Paired samples t-test (i.e., the analysis that sought to compare the mean differences of nationally standardized mathematics test scores of the same group of adult offenders from their AET Level One to their AET Level Four) to explain and attach meaning to qualitative data (which were analysed thematically from semi-structured interviews with AET Level Four adult offenders). The thematic analysis process was through the manual coding data, identification of patterns within the pieces of data, and observation of the themes that emerged from the patterns.

The mathematics scores were inferred from standardized summative tests, which covered the yearly mathematics content, thereby incorporating all the Bloom's Taxonomy levels. The tests were out of 100, with the sections on mathematics procedural fluency, conceptual understanding and factual knowledge included. The validation of semi-structured interview protocol was ensured through expert review of the interview guide and by conducting a pilot study on a different

correctional centre to ensure that questions are clear, relevant, and effectively elicit the desired information.

150 adult offenders were conveniently sampled for quantitative data, and subsequently, from the population of 150 (n=150) adult offenders, the sample of 5 participants was purposively selected to infer qualitative data. Informing the selection of 5 participants was an attempt to integrate different performances. According to the statistical analysis (which was collected from educationists), adult offenders performed within the range of 5 levels, therefore, each offender was representing the cohort of adult offenders that categorically performed within the specific level.

The adult offenders that were sampled were those who were already in AET Level four, but their mathematics learning trajectory was evaluated by comparing their performance from AET Level one to their present AET Level. The sampling (for the quantitative part of the data) was convenient because, out of the population of 1200 adult offenders enrolled for AET level four, 150 were deemed to be consistently present in mathematics classrooms.

Furthermore, 150 adult offenders that were conveniently sampled were those who had been in the same correctional adult learning centre for the past 4 years. 5 adult offenders that were purposively sampled for the qualitative part of the data were those that were representing various cognitive levels across within the AET Level Four group (hence, we endeavoured to use the maximum variation purposive sampling). As specified latterly, the performance of adult offenders was analysed according to prescribed performance levels (level 1: 0-29; level 2: 30-39; level 3: 40-49; level 4: 50-59; level 5: 60-69). Therefore, there was variation in terms of their performance and cognitive 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, thereby 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 and the trustworthiness of data was ensured by the triangulation of two data collection tools (standardized tests and semi-structured interviews). Furthermore, in our attempt to ensure test reliability, we used standardised mathematics tests. Before the collection of data, we requested to record the proceedings using a tape recorder.

To alleviate language barriers during the process of data collection, semi-structured interview questions were translated into four different languages (i.e. isiZulu, Sotho, English and Afrikaans) and language experts were instrumental in the process of interpretation. The translation of semi-structured interview questions into four languages followed the process of establishing different languages and language use within the adult-offender cohort.

4. Presentation and discussion of findings

4.1 Quantitative results: Test of normality

In their emphasis on the importance of conducting tests of normality for quantitative studies, several scholars argue that when normality assumptions do not hold, it becomes impractical to draw accurate and reliable conclusion(s) about data (Ghasemi & Zahediasl, 2012; Hinton et al., 2014). In this study, we performed the Shapiro-Wilk test to determine whether the data from AET Level One and AET Level Four 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 that is greater than .05 ($p > .05$). The null hypothesis (H_0) posited that the AET Level one and AET Level four mathematics 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 1: The tests of normality table

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
AET Level One Mathematics Test	,156	150	,200*	,978	150	,957
AET Level Four mathematics test	,156	150	,200	,978	150	,957

According to the tests of normality table, for AET Level one and AET Level four mathematics scores, there were no statistically significant values between the scores and normality. In other words, the data were normally distributed (the p -value is 0.957, which is greater than 0.05 for AET level One and AET Level Four test scores).

4.1.1 Paired Samples t -test, which sought to excavate the mean difference(s) between AET Level one and AET Level four Mathematics scores

The tables below indicate the mean difference between AET Level One and AET Level Four mathematics scores.

Table 2: The means and standard deviations for AET Level One and AET Level Four mathematics test scores

		Paired Samples Statistics			
		Mean	N	Std. Deviation	Error
Pair 1	AET Level One Mathematics Test	59,11435	150	8,94461	,89641
	AET Level four mathematics test	37,78191	150	9,18546	,87290

Table 3: The paired samples *t*-test results

	Paired Differences					t	Df	Significance	
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				One-Sided p	Two-Sided p
				Lower	Upper				
AET L1 test scores' - AET L4 test scores	+21,332	-0,24085	,0936	-15,26494	-12,85506	9,051	150	<.001	<.001

According to the means and standard deviations table above, the difference between AET Level One mathematics test scores' mean and AET Level Four mathematics test scores' mean is +21,33244 [59,11435-37,78191]. The positive difference between the two test scores' means denotes that adult offenders' performance in the standardized AET Level One mathematics test was greater than their performance in the standardized AET Level Four mathematics test. The formula that was used to calculate the mean difference was:

$$X_1 - X_4 = \text{Mean difference}$$

$$59,11435 - 37,78191 = +21,33244$$

N.B.: X_1 denotes AET Level one mathematics test score mean, and X_4 denotes AET Level four mathematics test score mean.

To establish if the mean difference is statistically significant, the *t*-value has to be greater than the critical value of 2,045. For this study, the *t*-value is 9,051, which is greater than the critical value of 2,045. Therefore, the difference was statistically significant.

5. Qualitative findings and discussion

During the process of thematically analysing qualitative data, three prevalent themes emerged. Although the themes appear to be discrete, we discovered overlapping pieces of data that subsequently caused them [the themes] to converge and intertwine (see Figure 1 below). Furthermore, we deliberately intersected and coordinated pieces of data to address the following research questions:

1. Based on standardized test scores, what is the mean difference in adult offenders' mathematics performance along the AET Level One and AET Level Four learning trajectory?
2. What does the mean difference in mathematics performance along adult offenders' AET Level One and AET Level Four learning trajectory denote about the nature of the mathematics trajectory within correctional centre classrooms?
3. AET Level One and AET Level Four learning trajectory denote about the nature of the mathematics trajectory within correctional centre classrooms?
4. How do adult offenders' perspectives of mathematics learning experiences define mathematics performance and mathematics trajectories?
5. How (according to adult offenders) does language, context and curriculum inform mathematics learning trajectories?

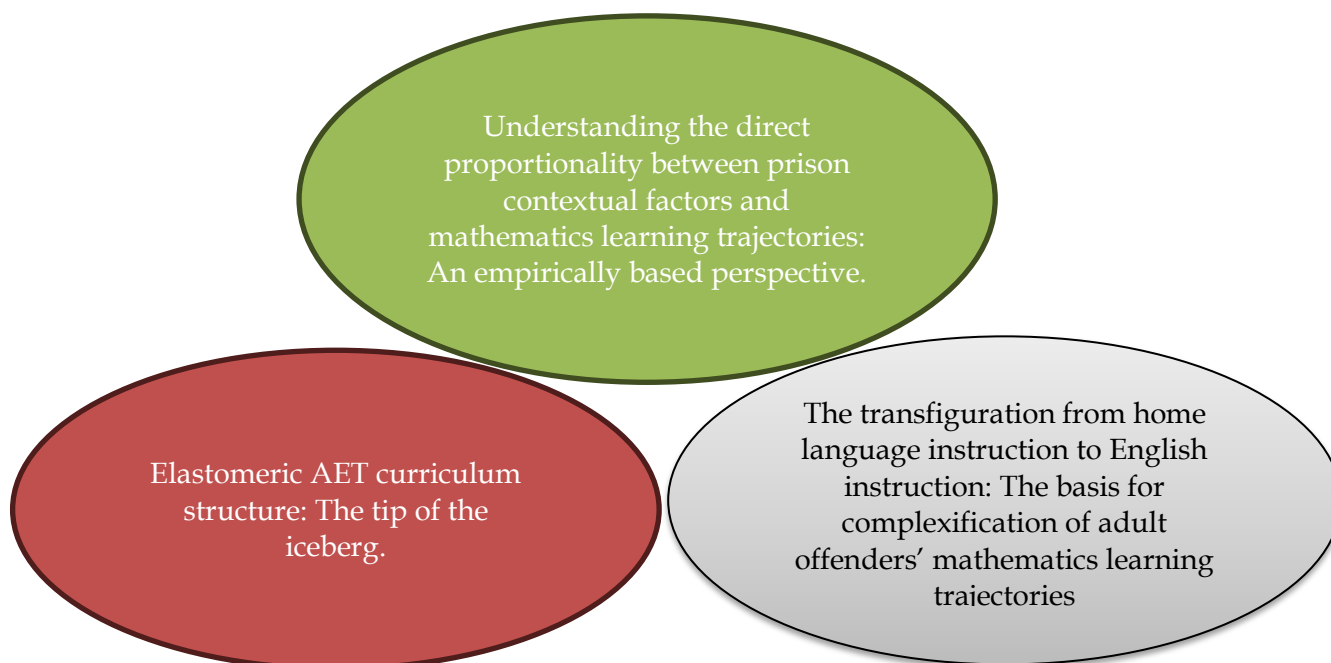


Figure 3: The interweave between the three prevalent themes

5.1 The transfiguration from home language instruction to English instruction: the basis for complexification of adult offenders' mathematics learning trajectories

According to Morgan and Del Fabbro (2018), language and mathematics are conceptually inseparable. In fact, several studies identify that the language through which mathematics is taught regulates the nature of learners' performance and determines the nature of their mathematics learning trajectory (Peng et al., 2020; Wilkinson, 2019). This research endeavour excavated data, which gestured towards the impact of switching from home language to English mathematics instruction on adult offenders' mathematics learning trajectories. The verbatim words of **adult offender A** indicated that mathematics is taught through the medium of isiZulu from AET Level one to AET Level two. After AET Level two, adult offenders are taught and assessed mathematics content knowledge through the medium of English.

Adult offender A:

"I also have noticed that I was very good at mathematics in AET Level one. I could understand different operations and procedural skills because they were taught in my home language. From AET Level three, my marks dropped because I could not understand English [the language through which mathematics is taught]. I even leave the examination room without getting an understanding of what the question(s) required of me."

"Adult offender B also identified that the sudden shift from home language instruction to English instruction negatively impacted his mathematics performance."

Adult offender B:

"I do not know English. This practice of learning mathematics in the medium of English causes me to have difficulties in understanding mathematics instructions. I remember that I could understand, relate to and enjoy mathematics when it was taught through isiZulu in AET level one. Now I am faced with the task to first get to understand English before I can understand what the instructions require of me."

For latter two adult offenders, the cause for the curvature of their mathematics learning trajectories is the fact that they learn mathematics in a language that is not their own. In fact, **adult offender B** indicated that he is faced with the dual task of learning English and mathematics register simultaneously. The difficulties brought about by the dual task of learning the language through which mathematics is taught, and mathematics register concurrently, are further documented in the scholarly work of Park et al. (2020). Although the central focus of Park et al. (2020) was on children aged 9-10 years, we argue that transitioning from home language instruction to English instruction causes the curvature of adult offenders' mathematics learning trajectories as well.

We therefore argue that, owing to the expansion of multilingualism within mathematics classrooms, and because the majority of adult offenders learn mathematics in a language that is not their own, implementing multilingual pedagogies within mathematics teaching-learning contexts might be a legitimate strategy for and towards soundly developing English proficiency and mathematics register concurrently. In fact, several scholars have argued for the use of multilingual pedagogies, particularly in the contemporary dispensation where multilingualism is perceived as a resource rather than a barrier to mathematics learning (Adler et al., 2022; Phakeng, 2018; Phakeng et al., 2018).

Although **adult offender A's** perspective divulges the prevalence of monolingual ideologies and the reiteration of developing mathematics learners in the language of instruction, we postulate the embracement of multilingualism (i.e., learners' home language and the language through which mathematics is taught) across the AET levels. The idea of the embracement of multilingualism emanates from the fact that, according to Gagne (1962), mathematics is characterized with the integration of concepts, and those concepts are predominantly drawn from social settings, and the meaning thereof can be soundly integrated with mathematics register to advance understanding.

We argue against the use of monolingual pedagogies, since it has been greatly opposed for causing linguistic setbacks while disadvantaging English non-home language learners from reaching their full mathematical potential. Although adult offenders deem home language mathematics instruction resourceful (in fact, several other scholars have also argued that home language instruction catalyses mathematics concept development in the brain), we deem the integration of English and offenders' home language useful for the synchronic development of mathematics conceptual understanding, skill application and factual knowledge (this postulation is supported by the findings inferred from the scholarly work of Mbatha, 2024b and strengthened by Gagne's, 1962 theory).

We identified that the curvature of adult offenders' mathematics learning trajectories emanates from the abrupt shift from home language to English mathematics instruction. This abrupt shift, we argue, is caused by the lack of attempts to operationalize pre-existing language knowledge and experiences with mathematical content. Therefore, this curvature can be mitigated by drawing from adult offenders' experiences and language knowledge (as Gagne, 1962 and Knowles, 1984 posit). This finding explains why the mathematics scores' mean of adult offenders at AET Level Four is significantly lower than their mean score at AET Level one. Nonetheless, because of our strong belief in developing language multiplicity within correctional centre mathematics classrooms, we propose the use of translanguaging over the excessive emphasis on developing adult offenders' proficiency in the language of English.

5.2 Understanding the direct proportionality between prison contextual factors and mathematics learning trajectories: An empirically based perspective

Prison contextual factors have been previously intersected with the decline in offender school enrolment and amplified recidivism rate, particularly within the South African context (Bello, 2017; Khwela, 2015; Mbatha & Khohliso, 2025). The present study discovered the direct proportionality between prison contextual factors and offenders' mathematics learning trajectories. **Adult offender C**, for example, identified that the decline in his mathematics performance from AET Level one to AET Level four has been (significantly) caused by some prison contextual factors, which affected him both mentally and psychologically.

Adult offender C:

"When I was in AET Level One, the rivalry between the two dominant gang affiliations was not as prevalent as they are now. In fact, there was a forum of offenders that was against any gangsterism. Now that the forum is no longer operational, the 28s and the 26s are constantly fighting, thus causing a prison lockdown. Sometimes we do not attend educational programs for over a month. As you know, mathematics needs consistency. By not attending mathematics classes, we find ourselves getting substandard results in standardized mathematics tests. Sometimes, that which is assessed is what we have not even seen or heard of."

Adult offender D also indicated that prison contextual factors had a significant impact on his psychological well-being, thus leading to the curvature of his mathematics learning trajectory.

Adult offender D

“A lot is happening here. Unfortunately, I cannot share much about the things that are done by abafowethu (fellow inmates) to us. But what I can tell you is that a lot of the things done by abafowethu affect us psychologically. I have experienced and endured a lot of psychological abuse, which was inflicted by abafowethu, particularly on those who are not affiliated with gangsterism. That is why my marks in mathematics have dropped in AET level four.”

Mathematics performance is not only affected by extrinsic factors, but also by intrinsic factors. In fact, studies have shown that psychological well-being manifests externally through mathematics performance (Onyango et al., 2021). This highlights the importance of using experiences and contexts within which mathematics is taught as building blocks for sound mathematics instruction and for excavating adult offenders’ learning trajectories (as Gagne, 1962 posits). **Adult offender D** gestures towards the impact of psychological well-being on the curvature of mathematics learning trajectories.

From the latter verbatim words, we identify prison contextual factors as contributory to the curvature of adult offenders’ mathematics learning trajectories. We further argue that prison contextual factors go as far as causing adult offenders to drop out of school (thus, we intersect the impact of prison contextual factors with the curvature of mathematics learning trajectories and offenders’ school dropouts). Furthermore, these findings underscore the critical need for understanding contextual factors for sound mathematics instruction (1962). Understanding contextual factors can be used as prior knowledge, which directs the manner in which mathematics is to be taught (see Knowles, 1984 and Gagne, 1962).

5.3 Elastomeric AET curriculum structure: The tip of the iceberg

The study discovered that the Adult Education and Training curriculum structure is non-static and continuously changing. In fact, documented in the Policy Document on Adult Basic Education and Training of 2003 is the preamble that identifies that the adult curriculum framework ought to be continuously changed, owing to the non-linear educational needs of adults. While taking into cognizance that non-linear nature of adults’ educational needs is paramount, worth noting is that, within the context of correctional centre facilities, education is offered to actualize the single vision, i.e. rehabilitating offenders for the sound societal reintegration (Mokoele, 2016; Vandala & Bendall, 2019; Vandala, 2017).

The study found that the elastomeric nature of the AET curriculum structure leads to the curvature of adult offenders’ mathematics learning trajectories. **Adult offenders E and F** indicated that in AET level one, the focus was predominantly on skills application and factual knowledge. Nonetheless, owing to the need for a concept-based curriculum, the curriculum focus for the AET Level Four is on the

trium of procedural fluency, skills application and deeper conceptual understanding.

Adult offender E:

"I think the main cause for the decline in my mathematics results is that, in AET Level one, we only focused on skills application and factual understanding. The infusion of curriculum aspects and examination questions that require a deeper conceptual understanding of mathematics has somewhat affected my mathematics learning trajectory. "

Adult offender F

"In AET Level One, we were only taught how to do mathematics in paper. There was no aspect of how to solve real life problems using mathematics. I think mathematics has not changed, what has changed, however, is its application in real-life contexts. For example, we know of numbers and number relations, but we struggle to apply such knowledge when a real-life problem is presented before us in AET Level four."

Since the polarization of the elastomeric nature of the AET curriculum against the concept based curricula seems to be bedeviling, particularly at present where the need for concept-based learning is advocated for (Erickson & Lanning, 2013; Mbatha, 2024a), we argue that the three dimensions of numeracy (i.e. facts, skills and concepts) be enshrined in curriculum policy framework for all the four AET levels. In this regard, we propose the consideration of Erickson and Lanning's (2013) three-dimensional approach in the teaching and learning of mathematics across AET levels, particularly since correctional education is offered not only for offenders to attain quantitative literacy, but also for them to have elicited critical thinking, problem solving and ability of work out solution in the society and within the world of skilled trade (Vandala, 2019).

We observed (based on the verbatim words of adult offenders E and F), that the AET curriculum structure is non-static, particularly since it infuses the concept-based aspect only at the advanced AET Level. This non-static nature of the AET curricula leads to the curvature of adult offenders' learning trajectories. We argue for the emphasis on the three dimensions of numeracy across AET levels, particularly with an intent to elicit the applicability of mathematics outside of mathematics perimeters, which prepares adult offenders for sound societal integration and functionality in the world of skilled trade, post-incarceration.

6. Recommendations

6.1 The model for flattening adult offenders' mathematics learning trajectories

Since adult offenders' mathematics learning and good performance thereof are fundamental for the holistic rehabilitation and sound societal reintegration, we recommend the strategic intervention for flattening and simplifying adult offenders' learning trajectories. Henceforth, based on the findings, we propose the model, which can be operationalized to aid adult offenders to have challenge-eased mathematics learning trajectories. This model, in our view, can be used by mathematics educationists across AET Levels (as indicated by the double-arrowed continuum). It (the model) can be used as a resource in ensuring

consistent sound mathematics performance across AET level education within correctional centre mathematics classrooms.

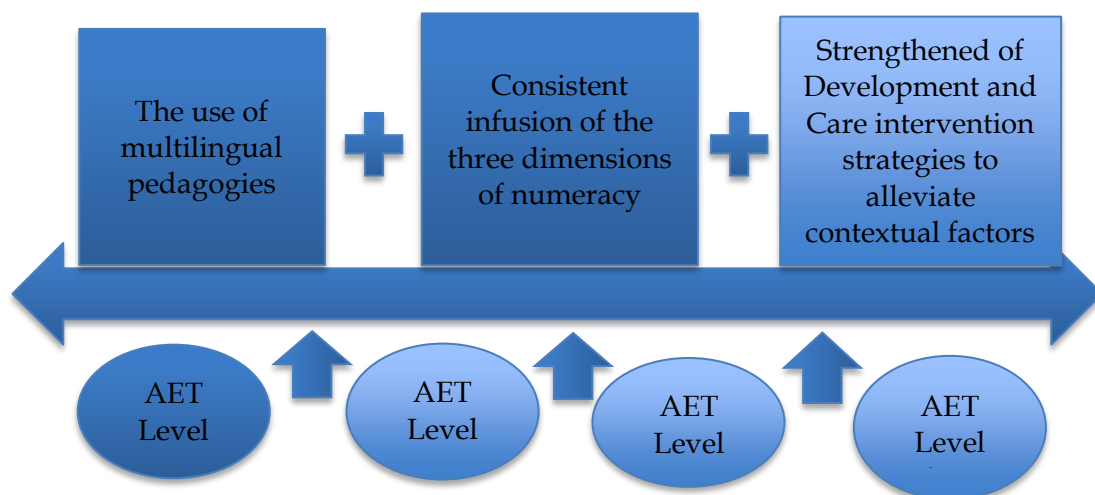


Figure 4: The model for flattening adult offenders' learning trajectories.

We propose the triune of the use of multilingual pedagogies (translanguaging in particular), reform of the AET curriculum such that all three dimensions of numeracy are infused and taught across the four levels as well as strengthening of Development and Care strategies (i.e. social work services, psychological services, and safety measures).

7. Conclusion

The research endeavour sought to delve into factors discernible along adult offenders' mathematics learning trajectories. The findings that were inferred from the study coordinated the quantitative indication of the mean differences in AET Level one and AET Level four adult offenders' results from standardized mathematics tests with offenders' responses from semi-structured interviews.

The qualitative findings identified that the triune of language barriers, prison contextual factors, and the elastomeric nature of the AET curriculum contributes to the curvature of adult offenders' mathematics learning trajectories. As an attempt towards flattening adult offenders' mathematics learning trajectories, we propose the use of multilingual pedagogies implementation and permeation of Erickson and Lanning's (2014) three dimensions of numeracy and innovative strategies to combat prison contextual factors, including the Correctional Services Policy reform and the adult curriculum policy framework restructuring.

The findings gesture towards the infusion of multilingual pedagogies. Because of the current fluid use of languages, the paper has implications for the use of translanguaging, thus aiding adult offenders to make use of their full linguistic repertoires for meaning making in order to flatten adult offenders' mathematics learning trajectories. The findings further have implications on pedagogical practices, thereby gesturing towards the implementation of critical pedagogical strategies for teaching offenders based on their experiences. The latter calls for the

restructuring of the AET curriculum structure and multilingual friendly teacher-training, predicated upon the understanding of prison contextual factors. These implications, we argue, apply even in normal mathematics learning contexts, since poor performance in mathematics and language barriers transverses to children classroom contexts.

8. References

- Adler, J., Planas, N., Trouche, L., & Remillard, J. T. (2022). Mathematics teachers' interactions with resources through a language lens.
- Azerbayev, Z., Schoelkopf, H., Paster, K., Santos, M. D., McAleer, S., Jiang, A. Q., Deng, J., Biderman, S., & Welleck, S. (2023). Llemma: An open language model for mathematics. *arXiv preprint arXiv:2310.10631*.
- Badiktsie, M. T. L. (2023). Experiences of Juvenile Offender Learners in Teaching and Learning Support in the Correctional Schools: A Wellness Perspective. *European Journal of Education (EJED)*, 6(1), 17-33. <https://doi.org/10.2478/ejed-2023-0002>
- Bello, M. (2017). Reducing recidivism in Africa and the South African model: A legal and criminological overview. *International Journal of Scientific Research in Humanities, Legal Studies & International Relations*, 2(1), 22-32.
- Carey, L. (2024). *The role of alternate and individualized education in the reduction of juvenile recidivism*. International Specialised Skills Institute.
- Charles, J. (2023). A Literature Review of How Rehabilitation Programs and Education Decreases Recidivism Rate with A Scope to How Public Administrators Can Further Suppress the Recidivism Rate.
- Chrysikou, V., Kitsiou, R., Karazanou, M., Appelbaum, P., & Stathopoulou, C. (2023). Alternative curricular experiences for young prisoners. *Núm. 27 Invierno*, 741. <https://doi.org/10.34024/prometeica.2023.27.15373>
- Conway, P. F. (2022). Andragogy in prison: Higher education in prison and the tenets of adult education. *Adult Education Quarterly*, 72(4), 361-379. <https://doi.org/10.1177/07417136221100481>
- Costelloe, A., & Langelid, T. (2011). Prison education and training in Europe: A review and commentary of existing literature, analysis and evaluation. *Directorate General for Education and Culture, European Commission, EAC*, 19, 06-130. <https://doi.org/10.18546/lre.12.2.03>
- Erath, K., Ingram, J., Moschkovich, J., & Prediger, S. (2021a). Designing and enacting instruction that enhances language for mathematics learning: A review of the state of development and research. *ZDM–Mathematics Education*, 53, 245-262. <https://doi.org/10.1007/s11858-020-01213-2>
- Erath, K., Ingram, J., Moschkovich, J., & Prediger, S. (2021b). Designing and enacting instruction that enhances language for mathematics learning: A review of the state of development and research. *ZDM–Mathematics Education*, 53(2), 245-262. <https://doi.org/10.1007/s11858-020-01213-2>
- Erickson, H. L., & Lanning, L. A. (2013). *Transitioning to concept-based curriculum and instruction: How to bring content and process together*. Corwin Press.
- Fleisch, B. (2008). *Primary education in crisis: Why South African schoolchildren underachieve in reading and mathematics*. Juta and Company Ltd.
- Francis, R. A. (2015). *How should offenders convicted of possession of child pornography be sentenced? Opinions of psychologists and judges*. Alliant International University.
- Frantz, M. J. (2017). Offender reintegration: A challenge to the uniting reformed church in SA, Porterville, in its ministry of reconciliation, restoration and healing to the released offender in the local community. *Unpublished MA thesis*. University of Stellenbosch, Stellenbosch, South Africa.

- Ghasemi, A., & Zahediasl, S. (2012). Normality tests for statistical analysis: a guide for non-statisticians. *International journal of endocrinology and metabolism*, 10(2), 486. <https://doi.org/10.5812/ijem.3505>
- Goethals, K. (2024). Introduction and overview of offenders with intellectual disabilities. *European Psychiatry*, 67(S1), S29-S29. <https://doi.org/10.1192/j.eurpsy.2024.104>
- Greisen, M., Georges, C., Hornung, C., Sonnleitner, P., & Schiltz, C. (2021). Learning mathematics with shackles: How lower reading comprehension in the language of mathematics instruction accounts for lower mathematics achievement in speakers of different home languages. *Acta Psychologica*, 221, 103456. <https://doi.org/10.1016/j.actpsy.2021.103456>
- Hinton, P. R., McMurray, I., & Brownlow, C. (2014). *SPSS explained*. Routledge. <https://doi.org/10.4324/9781315797298>
- Howie, S., & Hughes, C. A. (1998). Mathematics and Science Literacy of Final-Year School Students in South Africa. A Report on the Performance of South African Students in the Third International Mathematics and Science Study (TIMSS).
- Khwela, M. N. (2015). *Ensnarement of prisoners' families to poverty and crime in South Africa: a case of Polokwane Medium B Prison*
- Klein, J. (2025). *Gender, Stereotypes, and Justice: Public Perceptions of Male and Female Violent Offenders' Suitability for Restorative Justice and Rehabilitation* University of Twente].
- Kohzaki, H. (2024). Effects of Gagne's Nine Events of Instruction and online classes about Infectious Diseases Education. *International Journal of ICT Application Research*, 1(1), 1-6.
- Kruse, K. (2009). Gagne's nine events of instruction: An introduction. *Retrieved the*, 10.
- Magee, G. (2021). Education reduces recidivism. *Technium Soc. Sci. J.*, 16, 175. <https://doi.org/10.47577/tssj.v16i1.2668>
- Mainali, B. (2021). Representation in teaching and learning mathematics. *International Journal of Education in Mathematics, Science and Technology*, 9(1), 1-21. <https://doi.org/10.46328/ijemst.1111>
- Mbatha, S. (2024a). Evaluating Educationists' Andragogical Strategies for Teaching Numeracy: A Case Study of the Kwazulu-Natal Adult Correctional Centre Classroom. *E-Journal of Humanities, Arts and Social Sciences*. <https://doi.org/10.38159/ehass.20245813>
- Mbatha, S. (2024b). The Role of Translanguaging in Teaching Mathematics at Adult Correctional Centre Classrooms in South Africa. <https://doi.org/10.38159/ehass.2024563>
- Mbatha, S., & Khohliso, X. (2025). Probing Beneath the Iceberg: An Exploration of Factors Attributed to Offenders' School Dropout in South Africa. *Journal of Culture and Values in Education*, 8(1), 188-207. <https://doi.org/10.46303/jcve.2025.11>
- Mbatha, S., Khohliso, X., & Nsele, S. (2025). The use of isiZulu language as the strategy towards developing numerical literacy in correctional centre classrooms. *Journal for Language Teaching= Ijenali Yekufundzisa Lulwimi= Tydskrif vir Taalonderrig*, 59(1), 1-33. <https://doi.org/10.56285/jltvol59iss1a6660>
- Mbatha, S., Khohliso, X., Zondi, S., & Nzimande, N. (2025). Synchronising English second language proficiency and mathematical understanding through plurilingualism in correctional centre classrooms: Empirical perspectives. *Interdisciplinary Journal of Education Research*, 7(1), a08-a08. <https://doi.org/10.38140/ijer-2025.vol7.1.08>
- Mbatha, S., Mngomezulu, H., Nduku, N., & Mbathu, O. (2024). The Role of Mathematics and Science Education in the Adult Offender Rehabilitation Process. <https://doi.org/10.38159/ehass.20245142>
- Mokoele, M. (2016). Correctional sentence plan: A pathway to adult correctional education. *Adult learning*, 27(2), 87-89. <https://doi.org/10.1177/1045159515596138>

- Moore, C., & Mokhele, M. (2017). Learning behind bars: the experiences of undergraduate students in a South African prison. *e-Bangi*, 14 (6). In https://doi.org/10.1007/978-3-030-35158-8_3
- Morgan, N., & Del Fabbro, G. (2018). Factors associated with recidivism at a South African forensic psychiatric hospital. *South African journal of psychiatry*, 24. <https://doi.org/10.4102/sajpsychiatry.v24i0.1125>
- Moschkovich, J. (2012). Mathematics, the Common Core, and language: Recommendations for mathematics instruction for ELs aligned with the Common Core. *Commissioned papers on language and literacy issues in the Common Core State Standards and Next Generation Science Standards*, 94, 17.
- Neri, N. C., & Retelsdorf, J. (2022). The role of linguistic features in science and math comprehension and performance: A systematic review and desiderata for future research. *Educational Research Review*, 36, 100460. <https://doi.org/10.1016/j.edurev.2022.100460>
- Onyango, O. C., Nicholas, O. K., & Adama, M. (2021). Influence of gender on rehabilitation and reintegration of recidivists: A study of female inmates in women's prisons in selected counties in Western Kenya. *Public Policy and Administration Research*, 11(8), 50. <https://doi.org/10.7176/ppar/11-8-05>
- Park, J., Yoon, H.-D., Yoo, T., Shin, M., & Jeon, H.-A. (2020). Potential and efficiency of statistical learning closely intertwined with individuals' executive functions: a mathematical modeling study. *Scientific Reports*, 10(1), 18843. <https://doi.org/10.1038/s41598-020-75157-8>
- Peng, P., Lin, X., Ünal, Z. E., Lee, K., Namkung, J., Chow, J., & Sales, A. (2020). Examining the mutual relations between language and mathematics: A meta-analysis. *Psychological Bulletin*, 146(7), 595. <https://doi.org/10.1037/bul0000231>
- Phakeng, M. (2018). One country, many languages: Exploring a multilingual approach to mathematics teaching and learning in South Africa. Proceedings of the IV ERME Topic Conference 'Classroom-based research on mathematics and language' (pp. 8-16),
- Phakeng, M. S., Planas, N., Bose, A., & Njurai, E. (2018). Teaching and learning mathematics in trilingual classrooms: Learning from three different continents. In *Mathematical discourse that breaks barriers and creates space for marginalized learners* (pp. 277-293). Brill Sense. https://doi.org/10.1163/9789004378735_014
- Planas, N., Morgan, C., & Schütte, M. (2021). *Classroom research on mathematics and language*. Routledge. <https://doi.org/10.4324/9780429260889>
- Purvis, C., McNeill, B., & Sutherland, D. (2014). Language, communication, and literacy skills of adolescents with behavioral difficulties in mainstream education. *Speech, Language and Hearing*, 17(4), 225-236. <https://doi.org/10.1179/2050572814y.0000000044>
- Reddy, N. S. (2007). *Problems of teaching secondary school Mathematics*. Discovery Publishing House.
- Rodrigues, B., Cadime, I., & Ribeiro, I. (2023). Cognitive and metacognitive strategy use in poor comprehenders: an exploratory study. *Australian Journal of Learning Difficulties*, 28(2), 139-153. <https://doi.org/10.1080/19404158.2023.2287611>
- Sharma, S., & Sharma, S. (2023). Successful teaching practices for english language learners in multilingual mathematics classrooms: a meta-analysis. *Mathematics Education Research Journal*, 35(4), 821-848. <https://doi.org/10.1007/s13394-022-00414-0>
- Solanki, M. R. (2014). Developing instructional multimedia module incorporating Gagne's Nine Events of Instruction. *The Journal of Education*, 2(1), 1-16.
- Spaull, N., & Hoadley, U. (2018). Getting reading right: Building firm foundations. *ChildGauge*, 201777.

- Spaull, N., & Taylor, S. (2022). Impact or scale? The trade-offs of early grade reading and mathematics interventions in South Africa. *Early grade reading and mathematics in South Africa*, 1-24.
- Taylor, N. (2021). The dream of sisyphus: Mathematics education in South Africa. *South African Journal of Childhood Education*, 11(1), 1-12. <https://doi.org/10.4102/sajce.v11i1.911>
- Vandala, N., & Bendall, M. (2019). The transformative effect of correctional education: A global perspective. *Cogent Social Sciences*, 5, 1-15. In. <https://doi.org/10.1080/23311886.2019.1677122>
- Vandala, N. G. (2017). *The transformative effect of education programmes as perceived by ex-offenders* University of Pretoria (South Africa)].
- Venkat, H., & Spaull, N. (2015). What do we know about primary teachers' mathematical content knowledge in South Africa? An analysis of SACMEQ 2007. *International Journal of Educational Development*, 41, 121-130. <https://doi.org/10.1016/j.ijedudev.2015.02.002>
- Wilkinson, L. C. (2019). Learning language and mathematics: A perspective from Linguistics and Education. *Linguistics and education*, 49, 86-95. <https://doi.org/10.1016/j.linged.2018.03.005>
- Wong, Y. L. (2018). Utilizing the principles of Gagne's nine events of instruction in the teaching of Goldmann Applanation Tonometry. *Advances in Medical education and Practice*, 45-51. <https://doi.org/10.2147/amep.s145498>