

Appreciating the Layered and Manifest Linguistic Complexity in Mono-Multi-Lingual STEM Classrooms: Challenges and Prospects



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Abstract This chapter interrogates the layered linguistic complexity in mono- and multilingual contexts generally, and in STEM multilingual contexts specifically. Although the yearbook is about STEM multilingual contexts, understanding the multifarious linguistic challenges within monolingual contexts, with their ‘supposed’ linguistic homogeneity, buttresses an appreciation of linguistic challenges in multilingual contexts, generally conceived as linguistically diverse. In monolingual contexts, heterogeneity and linguistic complexity are occasioned by social class engendered vocabulary knowledge gap; emergence of language varieties (*lingua franca*) deviant from the standard variety; intra-lingual divergence between conversational and academic language; and the oral–literate language dichotomy/continuum.

Multilingual contexts add more languages into the mix, with their nuanced intra- and inter-lingual diversities. Their linguistic and orthographic distance compromise the deployment of diverse linguistic resources in the classroom. STEM subjects add another linguistic layer by their unique disciplinary symbolic language, unique semantics to familiar words, unique syntactic patterns, and unique technical vocabulary.

The chapter problematises the research–policy–practice dissonance that further complexifies instruction within the STEM multilingual contexts. The chapter argues that, notwithstanding the challenges associated with STEM education in multilingual contexts, there are prospects for viewing learners’ divergent linguistic repertoires as resources to be capitalised on, and not problems to be shunned and eschewed.

Key words Code-switching · Linguistic alternation · Monolingual · Multilingual · STEM · Translanguaging

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1 Introduction

In this chapter, I argue how Science, Technology, Engineering, and Mathematics (STEM) classrooms are linguistically complex spaces, both in what might be considered mono- or multilingual contexts. I also argue that the layered linguistic systems, rendering the classroom linguistically heterogeneous, coalesce into one linguistic system for the individual language user, and represent a resource rather than an impediment to epistemological access. I explore the languaging policy–research–practice interface in multilingual STEM contexts that further complexifies instruction within the STEM multilingual contexts. I further adapt Clarkson and Carter’s (2017) framework, meant for generating significant research questions, for the application of inclusive languaging practices in the multilingual STEM classroom, to capitalise on individual learners’ linguistic capital.

STEM instruction within the South African context seems to proceed on the assumption that learners are conversant in the Language of Learning and Teaching (LoLT), and that they just need to master STEM disciplinary content. The first sections of the chapter overview the multiplex linguistic networks characterising the STEM multilingual classrooms. An understanding of the linguistic complexity in monolingual contexts heightens an appreciation of the layered complexities in monolingual and multilingual STEM contexts.

2 Linguistic Complexity in Monolingual Contexts

Clarkson and Carter (2017) acknowledge social factors’ occasioned linguistic diversity, even where both the teacher and learners share the same language. From a review of several studies, Hurt and Betancourt (2016, p. 4) identify a plethora of environmental factors influencing children’s language outcomes, namely; “social and parental support structure, parenting style, maternal speech, nutrition, toxin exposure, exposure to violence, and other prenatal and postnatal stressors”, and cite research in twins which shows the greater impact of the environment over genetics in determining language development in low socio-economic environments. Social class and genetics conspire to determine children’s language proficiency. As Fernald and Weisleder (2011, p. 2) note, “Claims that early interactions between parents and infants lay the foundation for children’s later language and cognitive development are no longer dismissed as scientifically questionable and culturally disrespectful”. Monolingual classrooms, therefore, comprise children with differential exposure to rich language, facilitative of concept development and mental connections with things; which approximates the linguistic capital the school draws on. The learners’ resultant diverse vocabulary repertoire levels, conversational patterns, and facility to generate language, render the monolingual classroom linguistically heterogeneous.

Cummins' (2008) work distinguishes conversational from academic language, with proficiency in one not necessarily indexing proficiency in the other. Their distinction is in terms of purpose and context of use, occasioned by the use of different lexical, syntactic, and semantic patterns. This places conversational and academic language at two ends of the continuum, with learners coming into the classroom with diverse proficiency levels (at different points of the conversational-academic language continuum) within a language. Such heterogeneity renders the designation 'monolingual' imprecise.

Within-the-language diversity is also occasioned by the mode continuum; a trajectory of language development from informal oral speech to formal academic written language. The density, lexical and syntactic complexity, as well as recourse and non-recourse to prosodic and non-linguistic information of the two modes, make them linguistically diverse. Even within the same mode (spoken or written), there are degrees of formality and structure which require the deployment of diverse linguistic resources, e.g. playground talk versus oral discussion of an experiment. In this example, the diversity in a single medium meshes with the conversational-academic language continuum, making the monolingual classroom a linguistically heterogeneous space.

Diversity in monolingual contexts also manifests through dialects, sociolects, and registers occasioned by the extra-linguistic factors determining language use. Dialects are regional (geographic) or ethnic varieties, whereas sociolects are social varieties determined by socio-economic status, education level, profession, age, ethnicity, and gender, among others. Dialects normally embody unique lexical, syntactic, and phonological subtleties which render them languages within a language. For languages with several dialects, mutual intelligibility between different dialect speakers decreases and even gets lost as one moves from say the first to the last dialect on a continuum. Standardisation, where a dialect is imposed as a standard variety and enjoys prestige, usage, intellectualisation, and codification, is usually politically informed; and in South Africa, it was an apartheid ethno-linguistic project. Register and style, varieties which respond to specific prevailing communicative functions and settings, add to the within-a-language diversity, which further narrows down to the idiolect level (considered later in this chapter), where individuals have their own unique language usage patterns. These monolingual sociological variations render the monolingual classroom, linguistically diverse; a diversity which heightens in multilingual contexts.

3 Linguistic Complexity in Multilingual Contexts

Multilingualism and plurilingualism, distinct and highly contested terms, denote multiplicity of languages within a social context, and the language user's proficiency in multiple languages, respectively (King, 2018). Valid indicators of multilingualism are "...the extent to which there is interaction between linguistic communities, the degree of public acceptance of and support for linguistic diversity, and the ways in

which this ‘multilingual capital’ is part of the political and economic infrastructure, including in the all-important area of education” (King, 2018, p. 8).

In South Africa, the constitutional conferment of official language status to African languages, has further entrenched multilingualism in the classroom. South Africa’s indigenous languages belong to two major groups; the Nguni-Tsonga languages (isiNdebele, isiXhosa, isiZulu, siSwati, Xitsonga) and the Sotho-Venda languages (Sesotho, Setswana, Tshivenda). The groupings become four if Xitsonga and Tshivenda are disaggregated to stand independently. The language groupings are an acknowledgement of their linguistic distance. Illustrative is Wet et al.’s (2007, p. 159) observation that “Sotho languages share a system of seven vowels, whereas the Nguni languages have a common five-vowel system”. The linguistic distance between and among the indigenous languages impacts even the resultant English variety speakers of the different languages will develop; hence, the designations Sotho English and Nguni English. The linguistic diversity is heightened as each language brings to the mix, several dialects.

Different language groupings dominate specific geographical regions, with Gauteng, the most linguistically heterogeneous, having the two major language groupings represented. That has culminated in the emergence of an argot, Tsotsitaal. Being relatively young language forms, tsotsitaals are creoles, distinguished mainly by their lexicon to the point of over lexicalisation, where a wide range of words have a single referent. They map onto base language forms and borrow forms and meanings, as well as manipulate the phonological, morphological, and semantic aspects of the base forms to create novel lexical items (Gunnink, 2014). These deviant varieties, which defy lengthy natural language change processes and phonetic principles, add to South Africa’s “multifarious classroom language situations” (Childs, 2016, p. 24).

Sierens and Avermaet (2014, p. 18) posit that “Multilingualism is a motley crew of different, unequally divided competences. Every aspect of language is specifically functional: mastering something in one domain doesn’t guarantee success in another domain...”. Language is not static, homogeneous, or monolithic, and its acquisition is neither deterministic nor linear. The linguistic complexities characterising multilingual contexts aggravate in multilingual STEM contexts.

4 Linguistic Complexity in STEM Subjects

STEM occasions another linguistic layer by introducing dense technical jargon qualifying as a register or discourse. STEM does not embody universal language independent of linguistic variations. The word ‘quadrilateral’ is mathematical, and (though of Latin origin) has been incorporated into the English lexicon. It is, therefore, an English Mathematical term. While two languages (Mathematical language and English) coalesce in the term, one needs to have mastery of the subtleties of English multisyllabic word reading to allow for the word’s knowledge at the word

recognition level, and one also needs to understand the basics of mathematical shapes and sides to understand the word at the passive or active word knowledge level.

The linguistic complexity heightens when one considers that the disciplines that coalesce into STEM bring in unique technical and symbolic language that renders STEM an amalgamation of four technical languages, over and above the other linguistic diversities already discussed. The discipline-specific STEM language radically shifts the everyday meanings of words, e.g. ‘of’ taking on new meaning in ¼ of 12. The symbol and graphic (tables, graphs, figures, etc.) density in STEM texts (e.g. pH, \geq , \emptyset) add another decoding layer as the graphic elements serve communicative not ornamental functions. For Clarkson and Carter (2017, p. 238) “incorporation of many symbols and the truncating of sentences are also elements of the written STEM language quite different to everyday language...”. STEM even combines syllabic, logographic (morphosyllabic), and alphabetic writing systems. STEM is a unique language that needs to be mastered.

While it is common knowledge that STEM subjects are a unique language on their own, learning to read the STEM language is neither overtly/systematically taught (but taught simultaneously with the content), nor is the teaching of STEM language reading supported by a body of research. Assuming that, as learners are learning to read in English (for example), they are also learning to read in content areas; is a negation of the distinction between English and STEM language. The common practice in STEM is to teach symbol and graphic literacy as one encounters the symbols or graphs during instruction. STEM instruction in multilingual contexts should be a fusion of languages (multiple languages represented in the classroom and STEM language) and content.

The adage ‘Every teacher is a reading teacher’ is premised on the twin assumptions of precursors of reading attainment being universal, as well as on cross-linguistic transfer of reading elements across languages (Cummins, 2008). The question to ask is; how well equipped is a STEM teacher to handle the intricacies of vocabulary, fluency, and reading comprehension in STEM teaching? “Mainstream, content area teachers need knowledge and practical ideas about addressing the academic language needs of ELLs because they have the dual responsibility of facilitating ELLs’ content learning, while also supporting their ongoing English language development” (de Oliveira, 2016, p. 218). In the STEM context, language (in its multiple and layered manifestations) has to be learnt simultaneously with STEM content, not separately or sequentially. What to foreground and background in this tenuous balancing act needs consideration.

5 Summing the Layered Linguistic Complexity

Clarkson and Carter (2017, p. 240) aptly sum up this multi-pronged linguistic complexity in multilingual STEM classrooms as occurring at:

- “Different ‘levels’ of language (families of languages, distance between languages)
- Different language contexts (indigenous, multilingual, immigrants)
- Contexts within language (speaking, listening, writing, reading) as well as the immediate context (conversational compared with academic)
- Content realities (cultural, social, political)”

The absence of a shared spoken language outside the LoLT, the growing intersection between and among (coupled with lack of mastery in) the STEM subjects’ scientific and technical discourse, and context-specific word meanings, add to the matrix of linguistic challenges in the multilingual contexts. All these linguistic diversities conspire with the other non-linguistic diversities like socio-economic class, to create a mosaic of diversities and confluence that are attractive on the surface but complex to navigate. There is a need for policy and research to inform practice.

6 Policy–Research–Practice Dissonance/Confluence

This section explores the South African policy provisions in relation to the complexities of multilingual classrooms; the contribution of research; and the extant multilingual classroom practices to determine the areas of discordance and areas of consonance.

6.1 Policy

The South African Schools Act’s (No. 84 of 1996) devolution of school language policies to school governing bodies (SGBs) did not achieve the desired end of additive bilingualism, as SGBs advocated even earlier introduction of English than under apartheid. With the hegemony of English in learning, commerce, and administration; the school governing bodies are naturally predisposed towards recommending an English-only instructional approach. The constitutional provision in the South African Schools Act (No. 84 of 1996) for learner instruction in their Home Language where ‘reasonably practicable’ is circumvented by the discretion exercised by the SGBs. Probyn (2017, p. 7) posits that the intuitive assumption that

early submersion in English is the most effective way to acquire English... appears to have overridden the paradoxical reality that such policies actually have limited learners’ access to the content of the curriculum and have instead blocked them from the desired upward mobility.

This, is despite a voluminous body of counterintuitive research evidence to the contrary.

The South African Constitution Section's 29(2) provision for the education of learners in their home language where 'reasonably practicable' is a veiled acknowledgement of practical constraints that attend the elevation of African languages to official languages. Equity and redress of past imbalances seem to actuate policy provisions and not feasibility concerns. The phrase 'reasonably practicable' cannot be defined with precision, and so English continues to hold exclusive sway in the STEM multilingual classroom on the pretext of any other linguistic innovation being either unreasonable or impracticable.

Stoop (2017, p. 8) notes that "Section 29(2) provides expressly for single-medium institutions...within a range of possibilities....". The right to education, which may best be served by an incorporation of diverse linguistic resources is curtailed when the SGBs, either sideline the African languages or the minority languages and go for a single medium offering.

The English Across the Curriculum (EAC) initiative by the Department of Basic Education is an acknowledgement of the multi-layered linguistic barriers to accessing content. The intervention is meant to develop the twin language arts of listening and speaking, reading and viewing, writing and presenting, as well as language structures and conventions; within content areas that include STEM. Teacher Education institutions have not approached the EAC in a uniform way, with a significant number of institutions known to the author relegating the EAC module to English Education lecturers. This deprives content area lecturers of the knowledge of mediating language and content to their students, and students hardly see the relevance of EAC to their specialisations. The EAC initiative itself is a monolingual intervention to a multilingual and linguistically multi-layered challenge. While the EAC is the policy innovation that comes close to linking language with STEM subjects by virtue of the 'across the curriculum' designation, it is all about entrenching the hegemony of English as both LoLT and a subject and does little to recognise the nuanced STEM linguistic demands.

Robertson and Graven (2020) identify three orientations in language policy and practice debates in multilingual contexts namely; language as problem, language as right, and language as resource. The three orientations can be unpacked as follows:

- Language-as-problem orientation stems from a deficit conception of minority languages and the need for expediting minority language speakers' proficiency in the LoLT. Such assimilationist orientation leads to subtractive bilingualism. In South Africa, the SGBs (and ironically teachers, learners, and parents) by their preference for straight for English practice operate at the language as problem level.
- Language as right seeks to equalise education access to all linguistic groups and engender acceptance and tolerance of previously marginalised languages. In South Africa, the elevation of indigenous languages to official status, and to LoLT status at the Foundation Phase is representative of language-as-right orientation. South Africa's policy positions follow this orientation.

- Language as resource recognises multilingualism and linguistic diversity as desirable and inherently good, and meriting application in the classroom. This chapter advocates adoption of language-as-resource orientation.

None of the extant acts and policies that make pronouncement on language recognise the language continuum or linguistic mosaic pivotal to communication within multilingual classrooms. The acts and policies still reflect the linguistic purism and protectionism notion where the designated ‘standard’ language should guide classroom discourse. The policy provisions treat languages as separate and bounded systems and do not even hint at the possibility of any language alternation practices in the classrooms to mirror real-life languaging practices.

6.2 *Research*

In as much as the first section of this chapter showed how multilingualism can manifest in a monolingual context, research attests to how monolingual practices have encroached into bi- and multilingual education programmes. The latter has manifested in what has been variously designated “multiple monolingualism” (Sierens & Avermaet, 2014), “two solitudes” (Cummins, 2008), “double monolingualism” (Wedin & Wessman, 2017), and “pluralisation of monolingualism” (Makoni & Pennycook 2007 in Makoe & McKinney 2014, p. 22). Extant mainstream approaches to bilingualism have variously been referred to as ‘parallel monolingualism’, ‘bilingualism with diglossia’, ‘separate bilingualism’, and ‘bilingualism through monolingualism’; to show the exclusivity and prescriptive language that must be conformed to, rendering the bilingual “two monolinguals in one body” (García et al., 2011; Makoe & McKinney, 2014, p. 4). King (2018), observes that a bilingual person is not a fusion of two monolinguals in one, where each language retains its separate and independent culture. That is why Probyn (2017) proposes the adoption of a divergent heteroglossic outlook from one that visualises languages as two or more ‘inflexible solitudes’, to one that recognises a fusion of linguistic forms and repertoires from different languages into one system. Viewed this way, the multiple linguistic resources discussed earlier, characterising both mono- and multilingual contexts, coalesce into one unitary linguistic system rather than multiple and separate language systems. The classroom should dismantle language ideologies and regimes that circumscribe multilingual practices in the classroom and “... homogenise learners and their language practices, reducing complex heteroglossic language use to neat descriptions of full proficiency or lack of proficiency in a named language” (Makoe & McKinney, 2014).

People’s languaging defies definitional parameters set by named languages. What Garcia and Otheguy (2020) find unfortunate is how the languaging practices of ‘monolingual white elites’ are considered the norm. In schools, such manifest power differential “has led to a reductive situation where recognition is only accorded, in a multilingual repertoire, to the use of one, two, or three separate, standardized

named language(s)” (p. 18). By valuing and endorsing the standardised varieties of named languages, the school denies the complexity of society’s languaging practices rather than capitalise on them; thereby creating dissonance between the school and real-world languaging practices.

In their different ways, plurilingualism and translanguaging challenge the traditional conception of multilingual, monolingual, and monoglossic practices characterising extant language education practices, and seek to leverage learners’ linguistic resources. Plurilingual competence is the linguistic repertoire and proficiency in several languages, to varying degrees and for distinct purposes; allowing the language user to deploy the dual and distinct repertoires as and when needed. Plurilingualism occurs through polylinguaging, that is, employing resources associated with diverse languages despite one’s limited proficiency in the languages in question.

Translanguaging combines the linguistic, semiotic, and multimodal meaning-making repertoire “as a single inventory of lexical and structural resources, a unitary linguistic system... that they build through social interactions of different types, and that is not compartmentalized into boundaries corresponding to those of the named languages” (Garcia & Otheguy, 2020, pp. 24, 25). The same authors see translanguaging as political and radical, denigrating the legitimated hierarchies of named languages courtesy of racialised, classed, and gendered socio-political categorization; which serve to subjugate minority language communities, compelling them to utilise specific named languages (Garcia & Otheguy, 2020). In translanguaging, the languages known by the language user (at the different levels and dimensions) constitute a single, complete, indivisible linguistic repertoire rather than separate, dual, truncated, structured, and named languages the user comes in and out of as they communicate. They form the language user’s idiolect. “Adopting a translanguaging stance and designing translanguaging instruction de-naturalizes the standardized named languages of school. It de-naturalizes, that is, the named languages that have been codified by the nation-state to develop governable subjects” (Garcia & Otheguy, 2020, p. 27). Translanguaging challenges the exclusion of minority language bilinguals’ linguistic and cultural capital in the classroom languaging practices occasioned by power hierarchies which compromise and constrain the minority language bilinguals’ epistemological understandings and visibility.

Probyn (2017) advocates pedagogical translanguaging, where there is a threefold movement from home language to general language of the First Additional Language (FAL), and to the academic language of the FAL. Within such translanguaging, concepts are deliberately and systematically developed in the Home Language (HL), then transferred to everyday English, and ultimately, to the scientific or technical English. Freeman and Freeman’s (2007) Preview-View-Review strategy is an example of deliberate language planning for the multilingual classroom. The preview stage introduces the topic in the HLs (making connections, brainstorming, etc.), the view stage generates details for the topic through the LoLT, and the Review is done in the HL. Such teaching for transfer does not just require proficiency in the HL, the conversational and academic language of the FAL on the teacher’s part, but “simultaneously scaffolding a shift across modes from oral to written text production” (p. 14). Such translanguaging, while acknowledging general and academic language

as distinct, falls into the concept of named bounded and separate languages the interactants get in and out of.

While plurilingualism would support the strategic scaffolding of one language by another, drawing on unbalanced language repertoires; translanguaging capitalises on learner agency to deploy all communicative resources to transact with texts and with others. One challenge though is that the texts themselves, particularly the print texts, follow the separate named language pattern. Garcia and Otheguy (2020, p. 32) advise the need “to keep the conceptual distinctions between plurilingualism and translanguaging at the forefront as we develop ways of enacting them in practice, even when pedagogies may turn out to look the same”.

6.3 *Practice*

While polylinguaging and translanguaging practices hold the greatest promise in the STEM classroom, research (Clegg & Afitska, 2011; Wedin & Wessman, 2017) attests to code-switching being the most prevalent language alternation practice in the classroom, manifesting as a continuum between propensity towards the base (LoLT) or the embedded form (HL). It is for this reason that this section on language practices predominantly focuses on code-switching.

Although it is a bi- or multilingual practice, in practice code-switching is the momentary switching into alternate language(s) and back to the base form. The teacher engages in a long stretch of monolingual talk in the base form, which s/he punctuates with occasional words and phrases from alternate language(s) or the embedded forms. An example by Clegg and Afitska (2011) is where the teacher talks in the base form, learners conduct group or pair work in the embedded form, and the class holds a post-group discussion activity through the base form. In the majority of cases in South Africa, African languages (which are mostly the embedded forms from Grade 4 upwards) merely provide the brief intervening stretches while English as LoLT is the dominant and base form. Within the STEM context, the technical terms which carry subject content or concepts are, in my experience, given in the LoLT; possibly for lack of equivalents in the embedded forms. Translation, like code-switching, equally represents responsive “... temporary excursions from the monolingual ideal” (Childs, 2016, p. 24). It still falls back into double monolingualism and does not represent the intricacies and creativity of language interactions in the classroom. With time, learners cease attending to instruction in the target language and wait to attend to the easier and translated form.

Although code-switching is less disruptive of language purism ideals (as it recognises the independence of the named languages and their standard forms), stigma still lingers around any language alternation. In my view and experience, sometimes the Home Languages only serve pedestrian non-pedagogical functions like bonding with learners which explains their generous use in class management functions, where the stakes are low. Such classroom language power differentials render African languages “...de facto minority languages in relation to English” (Heugh

2014 in Probyn, 2017, p. 2) despite the numeric dominance of the African language speakers in the South African classrooms (approximately 80% according to Probyn, 2017). The classroom becomes a microcosm of society where "...in Africa, local languages function along horizontal axes, for the purposes of social cohesion and cultural expression; and former colonial languages function along vertical axes for the purposes of the formal economy and politics and are generally learned in school" (Heugh 2014 in Probyn, 2017, p. 2).

Code-switching is normally employed in an ad hoc, spontaneous, unpremeditated, relatively brief, reactive way within a largely monolingual orientation. It is mostly a repair strategy employed when communication fails in the monolingual mode, or for concept clarification or for comprehension check, hence, its prevalence at the introduction than revision of new concepts stages, owing to its concept clarification function as Clegg and Afitska (2011) observe. Lack of pedagogical planning in relation to the employment of code-switching (which can be at the word, phrase, clause, sentence, or beyond sentence level) or code-mixing (which is essentially sentential), culminates in failure to fully capitalise on learners' linguistic resources.

My experience is that code-switching is largely proscribed to the oral component; with reading, writing, and assessment conducted in the base form. That explains teachers' easy-going placatory attitude towards learners' oral expression contrary to their hard uncompromising stance for written expression which should be in accordance with the standard variety of the base form. Sometimes code-switching merely serves a time-saving function where the teacher throws in a word or phrase in the embedded form to avoid lengthy explanation of the same in the base form.

Clegg and Afitska's (2011) distinction between hetero-facilitative and self-facilitative language alternation where the former is actuated by the desire to bring clarity, and the latter by the speaker's limited proficiency (inhibitions) in the base form, is instructive. Both belie a monolingual framework where the embedded form is only imported to solve a difficulty (either the speaker or the hearers') and not as a sound bi- or multi-literacy practice. Sometimes, only the teacher has recourse to the embedded form and, as Wedin and Wessman (2017) observe; mainly to rebuke or on the pretext of clarifying things. Translanguaging or polylinguaging becomes a learner deviant practice done in whispers or in the teacher's absence. 'Deviant' teachers surreptitiously and under cover, smuggle the HL into classroom discourse at the risk of censure for the illicit or transgressive subversion. Such a practice is consistent with language-as-problem orientation rather than language as a significant resource learners take with them to school.

The assessment regimes operate almost exclusively under a monolingual frame. Lopez et al. (2014) observe that "Most content assessments reflect a monolingual or monoglossic or fractional view of language and tend to ignore the complex and discursive practices used by bilingual speakers". Within the monoglossic or fractional perspective, the bilingual is two monolinguals "...with access to two detached language systems that develop in a linear fashion and are assessed separately from one another" (ibid.). The monoglossic assumption is that, despite having facility in the two languages, they can only work in and through one of them at a time. The South African assessment regimes are consistent with such monoglossic expectations

which militate against creative deployment of learners' linguistic resources in the classroom. Heteroglossic assessment approaches, however, recognise all languages as part of an integrated system that can be mixed and matched. A brief look at more misconceptions constraining teachers' linguistic behaviours and innovation as they navigate the dicey and exigent language issues in the multilingual classroom follows.

6.4 *Constraining Misconceptions*

A monolingual English-only approach has been occasioned by the view of the classroom being the sole source of English input for the majority of learners, compelling teachers to plod on with English-only instruction even where language alternation has prospects for greater benefits. Further to that, language purity, verbal hygiene, and fear of negative interference between and among named languages' structured domains, accounts for language education's separation of bilinguals' languages, which explains the 'two monolinguals in one body' concept. Teachers' views of language as a bounded and pure system (Childs, 2016), informs their consternation for assistive language alternation strategies which consequently compromises linguistic and conceptual development. Makoe and McKinney (2014, p. 4) reiterate that "It is the ideology of languages as pure and bounded that underlies the guilt commonly expressed by teachers who do use codeswitching in classrooms where the language of learning and teaching is English, despite English not being the home language of learners".

Language purism is counterproductive "... particularly in urban areas such as in Gauteng Province where there is not a dominant local language, where there are urbanized varieties of African languages spoken that differ from the standardised written forms, and where many children speak hybrid varieties such as 'tsotsitaal' (literally, gangster language)" (Probyn 2015, p. 11). Language purism is assimilationist and, according to Probyn (2017), represents a reproduction of apartheid policies of 'Anglonormativity' at the expense of multilingualism.

Schwarzer and Acosta (2014) identify as a misconception, the view that monolingual teachers are incapacitated to foster multiliteracy on account of not being plurilingual themselves. While the value and expediency of plurilingual teachers cannot be downplayed, the misconception potentially stems from an equally faulty understanding of the role of the teacher as the dispenser of knowledge not an organiser of learning experiences. The latter role allows the teacher to envision prospects for language alternation in the multilingual classroom, and organise for the same.

7 Prospects for Language Use in Multilingual Contexts

Clarkson and Carter (2017) envisage an interplay between some broad theoretical aspects offering a framework for generating significant research questions. These are:

- The structural relation between language and STEM
- The registers and discourses relating to STEM
- The interactions in STEM classrooms
- The different theoretical tools and approaches (p. 240)

In the subsequent sub-headings, I adapt these theoretical constructs, meant for research, to frame STEM instruction in the multilingual classroom.

7.1 *The Structural Relation Between Language and STEM*

The logic underlying STEM is that of integration, and insisting on a strict monolingual trajectory is anathema to that thinking. If a functional relationship exists among individual disciplines that constitute STEM, a similar structural relation between language(s) and STEM should be acknowledged. As STEM amalgamates its disciplines, its instruction should similarly integrate diverse linguistic resources.

Referring to STEM, Bergsten and Frejd (2019) argue that, there needs to be a balance between; on one hand, ensuring subjects are merged and coherent while retaining their distinct individuality; and on the other hand, ensuring individual disciplines do not just service other disciplines. That structural relationship wholly extends to the multifarious linguistic resources in the multilingual classroom.

The envisaged integration in STEM multilingual contexts should be at the STEM level, at the language(s) level, and at the STEM-Language(s) interface. These integration levels coalesce easily through *multidisciplinary* (themes), *interdisciplinary* (fusing concepts and skills), and ... *transdisciplinary* (connected concepts applied in projects and realistic problems) instruction (Bergsten & Frejd, 2019) while translanguaging in classroom interaction. STEM language revolves around problem solving using the scientific method that occasions observations, questioning, experimenting, hypothesising, robust discussion, and collaboration; which heightens the linguistic demand of the STEM classroom.

7.2 *The Registers and Discourses Relating to STEM*

Word knowledge is indispensable to all learning and classroom communication, and there is a need to systematically determine and delineate, for STEM, the written and oral academic vocabulary needs of learners at particular levels. Sibanda and Baxen

(2016) discuss a principled approach to the determination of the vocabulary needs of learners using a textbook corpus. The corpus can be broadened to include the African language requirements and the oral language corpus. The resultant vocabulary needs can then be explicitly developed at the receptive and productive levels. Vocabulary thresholds should be set for the indispensable vocabulary; which learners should cross to ensure reading to learn. Vocabulary development should neither be impromptu or an afterthought, but deliberately planned and applied to engender contextual rather than general proficiency in the LoLT.

Lefever-Davis and Pearman (2015) envisage the development of strong literacy skills as lying at the heart of promoting STEM learning in a multilingual classroom. The literacy needed in the STEM classroom transcends mere development of requisite domain-specific vocabulary knowledge, to the ability to “interpret and analyze multiple types of texts as well as the ability to express those understandings in creative ways...” (Lefever-Davis & Pearman, 2015, p. 62). This is why relegating English across the curriculum module to the Language lecturers alone risks having the STEM teachers ill-equipped with language-related literacy practices for a STEM classroom. The literacy practices should be reflective of diverse thinking and communication ways in different fields.

Although all languages are capable of communicating any meaning, they need to be adequately intellectualised. It is axiomatic and sobering that, in South Africa, the African languages’ modernisation, regularisation, and codification to sufficiently carry out the function of LoLT has not been extensive across all official languages and contexts. This, however, does not preclude them from having a consequential role in STEM teaching and learning. If anything, the proscription of the African languages’ roles to non-academic roles is what stifles and delays their intellectualisation and growth. Their grammatical codification should also be informed by their extant and actual classroom usage.

7.3 The Interactions in STEM Classrooms

A range of linguistic and non-linguistic meaning-making resources should be deployed and shared in the multilingual STEM classroom; considering learners’ backgrounds and foregrounds within a network of practice (Clarkson & Carter, 2017). Language mediates participation in any classroom context, and in the multilingual context, it becomes prerequisite for inclusion. Exclusive use of the LoLT, language isolation, and language over-regulation may be disempowering and curtail dialogue, engagement, and conceptual development. Focus should be on education of learners equitably and optimally rather than imposition of linguistic norms and practices. Learners should have the autonomy to leverage their linguistic resources to increase comprehension. García et al. (2011, p. 397) rightly observe that “[I]mposing one school standardized language without any flexibility of norms and practices will always mean that those students whose home language practices show the greatest distance from the school norm will always be disadvantaged”. Intersecting languages

in the classroom is simply "... expanding a multilingual repertoire of different genres, styles, registers and linguistic tools..." (Sierens & Avermaet, 2014, p. 18) which learners already embody.

In everyday life, languages intersect and overlap in a messy, fluid, dynamic, and functional way, and classroom interaction should reflect the same, for authenticity, academic flexibility, and cultural and linguistic sensitivity to be realised. The need for the normalisation and legitimation of learners' linguistic resources and repertoires in the curriculum and the recognition of learners as emergent plurilinguists who need to employ the resources for thinking and communication cannot be overemphasised. In a witty play with words, Robertson and Graven (2020) designate English (in the South African context) as the 'language of power' whereas the learners' home languages represent 'the power of language'. It is language that mediates epistemological access, and excluding the home languages in classroom interactions is taking that power of language out of the classroom.

García et al. (2011, p. 386) posit the need to "...invert schooling structures and subvert traditional language education so as to pay attention to the singularities of students within multilingual classrooms". A de-learning and re-learning is needed to best exploit linguistic complexities in the multilingual STEM classroom. García et al. (2011, p. 384) advocate learners' active language use in dynamic relationships being the locus of control in the classroom. They also see plurilingualism being applicable where "...students' languaging is recognized and the pedagogy is dynamically centered on the singularity of the individual experiences that make up a plural". Learners utilise all their linguistic resources in task execution; informed by content, their linguistic proficiencies and preferences, and the language possibilities. Creative and spontaneous ways of validating and incorporating learners' linguistic repertoires beyond just the oral dimension and beyond code-mixing and code-switching should be celebrated if they open up epistemic access to STEM content. Knowledge production is a social process and language is a social tool so linguistic resources facilitative of social interaction are better than restrictive linguistic repertoires imposed on learners that curtail social interaction.

7.4 The Different Theoretical Tools and Approaches

The conversational and academic language distinction impels the teacher to elevate learners' languages from everyday social communicative functions to specialised academic STEM and school learning discourses. Just as the Deweyan process of reconstruction moves the learner from their present everyday experience to an organised body of knowledge, so should the linguistic dimension transit from everyday conversational language to academic specialised discourse.

The question of what is prerequisite and what is subservient to the other between language and content instruction is reflected in approaches such as content-based language teaching and language-based content instruction where one serves or drives the other. In either approach, there is a separation of the two when the ideal is their

seamless blending to ensure both content and language mastery. Integrated well through meaningful communicative activities, both learners and teachers can develop bi- or multilingual competence simultaneously with content learning.

Cummins (2008) posits five cross-lingual transfer types, namely; of conceptual elements (in this case, STEM content), of metacognitive and metalinguistic strategies (like interpretation of graphic organisers), of pragmatic elements which aid meaning expression (like extra- and paralinguistic features like gestures), of specific linguistic elements (like word etymology), and of phonological awareness (sound system of language). The multidirectionality of language transfer is feasible to the extent that a sound sociolinguistic and educational environment has been created that allows for multiple languages and content to interact in complex ways.

Assessment is a thorny issue in multilingual STEM classrooms. While disentanglement of the linguistic from the socio-economic factors accounting for depressed learner achievement is onerous, Prinsloo et al. (2018) and others, largely attribute the manifest learner poor achievement (well documented in benchmark assessments) to the incongruity between learners' home language and the language of teaching and assessment. Language then becomes a key leverage point the school has control over (unlike socio-economic factors). While assessing learners in all official languages (11 for South Africa) has serious financial and logistical implications, learners should be accorded the privilege to seek clarification to assessment tasks demands in languages they are comfortable with. Such linguistic accommodations, easing language not content, would ensure that STEM disciplines test STEM content and not language; rendering them valid.

Because Africa lacks deliberate planning on bilingual education supported by theory and well-defined procedures (Clegg & Afitska, 2011), teachers should experiment with, and craft their own bilingual practices. Language is too pivotal in mediating learning to be left to chance or even one's whims and caprices. Where particular languages lend themselves to particular aspects and ways of learning, King (2018) proposes the development of a novel model of 'education for plurilingualism' where different languages are imported and utilised in education even if they may meet diverse goals depending on the levels at which they are mastered and supported. Robust research is needed to locate and uncover some intuitive or even unconscious language alternation practices that are working in multilingual contexts and theorise, describe, and popularise them. A prescriptive one-size-fits-all language treatment for the classroom linguistic diversity is not desirable as it, apart from lacking pedagogical justification, is inconsistent with language use in real life.

In terms of language alternation, code-switching, as noted earlier, accords a brief detour from the LoLT to the home language before going back to the ideal (the LoLT). Otheguy et al.'s (2015, p. 281) definition of translanguaging as "the deployment of a speaker's full linguistic repertoire without regard for watchful adherence to the socially and politically defined boundaries of named (and usually national and state) languages" is consistent with the proposal this chapter makes. The restrictive imposition of standard and acceptable linguistic resources in the classroom, which the same authors call "selective legitimation that license only linguistic features associated with powerful speakers and states" (p. 301) is counterproductive. Language in

the classroom is a means and not an end in itself and whatever linguistic repertoires and resources best serve the end; epistemological access, should be deployed unreservedly. This is particularly so in the STEM classrooms where the uniqueness of individual disciplines is ideally lost as the disciplines serve as a unified knowledge body. The language hierarchies need to be lost sight of as learners deploy a cocktail of linguistic resources that best serves their understanding of content.

Translanguaging engenders multiple and fluid identities. In translanguaging, multilingual individuals systematically traverse between the languages they have proficiency in, as they engage in complex discursive practices in an integrated way. They do it seamlessly to the extent that their linguistic repertoire "...is understood as one system, rather than as a collection of discrete languages" (Childs, 2016, p. 24).

Instructional practices, even under bilingual models, have all been about learners using specific languages rather than creating plurality from individual learners' "singularities" (García, et al., 2011). Learner autonomy in language use enhances linguistic fluidity in the classroom, allowing for production of oral and literate texts in preferred languages and translated to other languages where necessary. This engenders dynamic and recursive bilingualism which recognises plurilinguals' practices as complex and interrelated. García et al. (2011, p. 384) recommend "... heteroglossic bilingual conceptualizations ... in which the complex discursive practices of multilingual students, their translanguagings, are used in sense-making and in tending to the singularities in the pluralities that make up multilingual classrooms today". With translanguaging, focus is not on merely synthesising or hybridising diverse language practices (as languaging transcends a system of rules or structures), but crafting novel language practices that complexify linguistic discourses among interlocutors.

8 Conclusion

The linguistic complexity of the multilingual STEM classroom is multi-layered and nuanced than is normally appreciated. The complexity, far from being a constraining problem, is an opportunity for novel research, sober rethinking of policy, and creative practice that acknowledges the indispensability of learners' manifold linguistic resources in their learning.

Policy and practice seem to largely cohere in terms of proscription of HL to LoLT status in the Foundation Phase but inconsistent with research that recommends a longer shelf life for HLs as LoLTs beyond Foundation Phase. While policy recommends multilingualism, practice suggests monolingual practice; the latter occasioned by the shortage of African language teachers compromising teacher proficiency to navigate the linguistic diversity in the multilingual classroom. The HLs' capacitation to meaningfully contribute to classroom discourse has been questioned on account of lack of intellectualisation, lack of digital and knowledge economy presence, as well as learners' limited proficiency in the languages beyond the conversational level occasioned by the learners' premature exit from using the languages as LoLT. There is merit in having all teachers, particularly STEM and non-language teachers, educated

in the art of navigating diverse languaging practices in the classroom, as classroom language use is every teacher's business.

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