Disinventing and reconstituting language for learning in school Science

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Abstract

This paper proceeds from an acknowledgement of the profound ways in which language ideologies shape and constrain the use of language as a resource for learning in 'multilingual' or linguistically diverse classrooms. We draw attention in particular to the ideology of languages as stable, boundaried objects and to the colonial invention of African languages. Against this backdrop, we analyse an example of pedagogical practice which was designed in response to a linguistic ethnography of Year 9 Science learning in a South African high school. The aim of this intervention is to move beyond the constraints of current language ideologies and to enable bilingual isiXhosa/English students to use a wide range of resources from their semiotic repertoires (Kusters et al, 2017) for learning Science. We will argue that debates about language of instruction in post-colonial contexts which pit one named language against another, misdirect our attention away from how the resources of language and other semiotic modes are or are not being used for learning in classroom discourse and learning materials. We aim to show how pedagogical translanguaging and trans-semiotising can be taken up as strategies of disinvention and reconstitution of 'language' for learning Science. (195)

Key words: language ideologies, translanguaging, trans-semiotising, disinvention, Science, semiotic repertoires

Introduction

> Facilitator: Can you mix Science in...can you speak Science with a mix? isiXhosa ngesiNgesi? (isiXhosa and English)
>
> Thandile[1] (student): (nods) Mhm. (rotates hand at wrist) Only explanations.
>
> Khethiwe (student): Ja.
>
> Thandile: I'm speaking isiXhosa.
>
> Facilitator: Only with the explanations.
>
> Thandile: (nods)
>
> Facilitator: What's an explanation?
>
> Khethiwe: Like when you're explaining something.
>
> Facilitator: So what's not an explanation in Science? Give me an example of when you're not explaining something in Science?

[1] All students have been given pseudonyms.

> Thandile: It's a statement, like saying something, saying something then you are confident, sure. But when I'm trying to explain to the whole class, like it gets difficult to explain it in English. So…
>
> Facilitator: Then you change. I would have thought you have to really know the Science to explain it. So if you're explaining something, you really know what you're saying. So the words that you use have to be right.

The exchange above takes place between the facilitator (author) and Year 9 students Thandile and Khethiwe in a Cape Town high school in the predominantly isiXhosa speaking township of Khayelitsha, South Africa. It highlights the contestation over using local language resources (in this case isiXhosa and bilingual isiXhosa/English) to 'speak' Science in a high school which follows an official policy of monolingual English language of learning and teaching. We begin with this exchange because it goes to the heart of the concerns that we take up in this paper: the language ideologies that inform what are seen to be legitimate language practices for 'doing' Science as well as our understanding of what it means to 'do' Science successfully in Year 9.

The exchange takes place in a learning context that is fairly typical of urban schooling in South Africa. Despite the recognition of eleven official languages, the constitutional right to receive education in one's own language and the fact that English is home language to less than 10% of the population, African language speaking students typically undergo an early exit from 'home language' medium of instruction after three years of schooling. They then begin to follow an English only curriculum using monolingual English textbooks and assessments from the beginning of Year 4 until their final year in Grade 12. The student Thandile is thus used to reading and writing about Science in English only. If we use Barnes' (1992) distinction between 'exploratory' and 'presentational' talk[2] , Thandile has been exposed exclusively to 'presentational' language use in English while learning Science at school. However, (author) has frequently observed Thandile and his peers using isiXhosa/English bilingual language practices in order to solve Science problems and to complete tasks collaboratively in their classroom. In doing so Thandile and peers defy the English-only language policy of the school in their 'exploratory talk', a practice that is not uncommon in Western Cape schools (see Banda, 2010). While she asks Thandile whether it's possible to 'speak' Science using mixed language resources, (author) already knows from her classroom observation that the students can and do 'mix' the language resources in their repertoires in order to do Science. However, Thandile clearly asserts that one can only 'mix' isiNgesi nesiXhosa while providing *explanations* in Science lessons. For (author), providing explanations is an essential indicator of successful languaging for learning in Science; however, for Thandile successful Science is about providing 'statements' of fact about which 'you are confident', or in Barnes' terms producing 'presentational talk'. Given Thandile's experience of school Science where all learning support materials and all assessments have been available monolingually in English, and the dominance of summative assessments, his perspective is not surprising. Thandile's experience of learning Science at school has been profoundly shaped by language ideologies.

[2] In his explication of talk and learning, Barnes (1992) distinguishes between 'presentational' talk and 'exploratory' talk. He likens 'presentational talk' to 'final-draft' type communication where fluent explanations in full sentences using discipline-specific registers are the expectation. Exploratory talk by contrast is hesitant, incomplete and enables 'working-on-understanding' (1992: 126). While his focus is on spoken language, this description can also be applied to written texts.

This paper proceeds from an acknowledgement of the significant ways in which language ideologies shape and constrain the use of language as a resource for learning in 'multilingual' or linguistically diverse classrooms. The pedagogical impact of language ideologies is by no means limited to schooling in Southern contexts. However, our focus will be on analysing one example of pedagogical practice which aims to move beyond the constraints of current language ideologies and to enable bilingual isiXhosa/English students to use a wide range of resources from their semiotic repertoires (Kusters et al, 2017) for learning Science in a South African high school. In many post-colonial educational contexts where English is dominant but access to the resources of English is severely restricted, debates contesting the merits of 'mother-tongue' or 'home language' instruction versus English language of instruction dominate discussions of language and learning (eg Heugh, 2013; UNESCO, 1953, 2003; Skutnabb-Kangas, 1994; Banda, 2000; Setati, 2008). We will argue that such debates which pit one named (Blommaert, 2006) language against another distract us from how the resources of language and other semiotic modes are or are not being used for learning in classroom discourse and learning materials (McKinney, 2017).

We begin with a review of the dominant language ideologies that currently shape the use of language in schooling before reviewing debates on language of instruction in post-colonial contexts. Acknowledging the limitations for learning of a view of language as object, and the colonial invention of African languages (Makoni, 1999; Makoni and Pennycook, 2006) we explore how the concepts of translanguaging (Garcia and Li Wei, 2014; Li Wei, 2017; Makalela, 2015) and trans-semiotising (Lin, 2015) can enable us to design rich learning activities which engage students in 'languaging-for-learning' (Guzula, McKinney and Tyler, 2016). After outlining our methodological approach which is informed by linguistic ethnography as well as intervention, we analyse a series of learning activities where students were actively engaged in translation across 'languages' and registers to define the scientific concept of 'molecule'. We aim to analyse how translanguaging and trans-semiotising in this activity enabled learners to work productively with both linguistic ideologies and with scientific concepts. Significantly, we argue that disrupting language and register boundaries through processes of disinvention and reconstitution not only enabled the students to take up confident positions as 'knowers' but also enabled the students' current understanding of concepts and registers to surface giving a fine-grained view of mis-understandings that required further pedagogical explanation.

Language ideologies and monolingualism in education

The hierarchical valuing of language use and of speakers in relation to their language use is largely informed by beliefs about language or language ideologies. Like ideology more generally, language ideologies go beyond the ideas that one individual may have in one particular site, referring rather to a network of beliefs and values that circulate, existing across a number of people and sites. They are constructed through discourse, that is, systems of power/knowledge (Foucault, 1980) and are also embodied. Significantly, Woolard and Schieffelin argue that language ideologies show 'a mediating link between social structures and forms of talk' (1994, 55). A powerful language ideology shaping language in education policy and curricula is the notion of 'named languages' (such as 'English', 'isiXhosa') as unitary, stable objects, clearly differentiated from one another, and existing in the individual mind. Blommaert describes this ideology as 'the cultural construction of language in general as a stable, contextless individual mental object' (Blommaert, 2006, 512). This leads for

example, to policies specifying that a single named language should be used as language of learning and teaching; that proficiency in a language can be developed generically and in a few timetabled hours of teaching and learning in a week, with the expectation that students can develop proficiency in using a language by learning about the grammatical structure of that named language. Another dominant language ideology, and similarly linked to the Western episteme is the myth of monolingualism as the norm, or what some have drawn attention to as the historical monolingual bias in applied linguistics (Canagarajah, 2007; Makoni and Meinhof, 2004; May, 2014). This myth assumes that the ideal or 'normal' language user has command of one named language. The far reaching consequences of the construction of languages as boundaried objects and of a monoglossic orientation to language for policy and practice in education have, however, yet to be acknowledged. Despite the challenge to monolingualism as normative, debates and discussions of language and learning in post-colonial contexts are dominated by a concern for which named language should be used as language of instruction (or language of learning and teaching, LOLT, as it's called in South Africa). This is usually framed as the merits of an African language as 'mother tongue' versus merits of a European language of instruction.

Language of Instruction and languaging-for-learning

In the laudable interests of access to quality education, UNESCO has advocated 'mother tongue' language of instruction for all children as a basic requirement of quality education since 1953 (UNESCO, 1953; 2003). But as Ag and Jørgensen (2013) have pointed out, 'the belief that every person must have a particularly close relationship to one language, almost invariably the "mother tongue" of the person' is also a consequence of a monolingual ideology (2013, 527). In other words, the notion of mother tongue, and the idea that all children/adults have a single dominant language that is learned from birth, (re)produces the monolingual child as normative. The notion of mother tongue also aligns with language as object, and invokes a single standard language, denying the heteroglossic nature of language and multiple varieties of named languages. Related to this is the concern that for many African children in urban contexts characterized historically by migration, urban vernaculars vary greatly from the standardised forms of languages named in the South African constitution that informs language in education policy (Makoni, Makoni and Rosenberg, 2010). In such cases, it is the concept of mother tongue itself that can deny these learners access to learning through the linguistic repertoire and practices which are most familiar to them and which they bring with them to formal schooling. A further concern is with the politicized use historically of mother tongue education to prevent access to English in some British colonial contexts. De Klerk (2002) shows the historical relationship between mother tongue education and the apartheid mandated inferior Bantu education. Bantu education enforced mother tongue medium of instruction initially for the duration of primary schooling (to Year 8) and then later to Year 4, with a sudden transition thereafter to English or Afrikaans language of instruction. Mother tongue education thus came to be associated with restricting learners' access to English[3].

[3] See Brutt Griffler (2002) on use of mother tongue medium of instruction in order to restrict access to English in the British colonies of Lesotho and Sri Lanka.

African scholars such as Makoni (1998; Makoni and Pennycook, 2006) and Makalela (2015) draw attention to the colonial invention of indigenous languages in Southern Africa as a product of missionary interventions[4]. As Makoni (1998) has pointed out, the legacy of the colonial invention of African languages in South Africa lives on powerfully through post-apartheid language rights in the constitution. While attempting to undermine the dominance of Afrikaans and English through the inclusion of nine indigenous languages as official, the language rights clause continues the ethnolinguistic categories used to divide and rule African people during apartheid. These official named languages inform and constrain what is considered legitimate as a language that can be used and studied as subject in education (Makoni, 1998). Colonial constructions of indigenous languages have in many cases nevertheless become sedimented into people's linguistic repertoires. And, despite their colonial construction, many people have strong attachments to or investments in the official South African named languages.

Makoni and Pennycook point out that 'some indigenous communities' reject local over European languages as languages of instruction in schooling because European languages are associated with formal education and access to the Western Episteme. Schools are often seen as sites of access to Western knowledge systems while indigenous education is positioned as taking place in the home (Makoni and Pennycook, 2005, 149). They argue that

> It is not enough to acknowledge that languages have been invented, nor that linguistic metalanguage constructs the world in particular ways. Rather, we need to understand the interrelationships among metadiscursive regimes, language inventions, colonial history, language effects, alternative ways of understanding language, and strategies of disinvention and reconstitution (2006, 3-4).

Recent student protests and struggles for "free decolonised education" in universities in South Africa suggest a critique of the exclusive valorisation of Western knowledge systems and a desire to expand what counts as knowledge and legitimate language use in the curriculum (Christie and McKinney, 2017; Rhodes Must Fall, 2015). University student activists have begun to invent ways of bringing local, heteroglossic language use into the academy, such as through establishing multilingual print and online news media that disrupt language boundaries and monolingual publishing norms[5].

Beyond the impasse: translanguaging and trans-semiotising as strategies of disinvention and (re)constitution

In our view, rather than debating which single named language should be the official language of learning and teaching, a more productive discussion would be focussed on how to use language and broader semiotic resources effectively for learning, or 'languaging-for-learning' (Guzula, McKinney and Tyler, 2016). It should be beyond question that children *need* (never mind having the right) to

[4] Makoni and Pennycook (2006) cite the influential work of Mudimbe (1988) on the 'invention of Africa' in relation to Europe as well as of Ranger (1983) on the colonial invention of traditions in Africa and Harries (1987) and Fabian (1991), amongst others, on the specific invention of language and discrete named languages. As their own review of the literature shows, the notion of languages as socially constructed and invented has been carefully documented.

[5] An example of this is *Vernac News* established by students at the University of Cape Town in late 2014 and now available online. https://vernacnews.co.za/

learn through language use that is familiar to them, or put differently, language use that they can understand. However, specialised scientific registers are not anybody's 'home language' as Gee has pointed out through his distinction between primary and secondary Discourses (Gee, 2008). Given the power of the language resources named as English in many post-colonial contexts, schools are expected to provide opportunities to learn this language. Without policy makers paying attention to the processes of language learning, schools are expected to do this by delivering all curriculum and assessments exclusively in English from Year 4 onwards. Succeeding in the school system thus requires all learners to be at minimum bilingual in the language resources of their homes and the kind of monolingual English resources required of schooling. Yet the same system continually positions all learners as monolingual, and frequently as deficient English monolinguals. This positioning happens through curricula, textbooks and assessments that are available in English only, and through official education department communications to schools that ask teachers to refrain from 'code-switching' in classrooms (see e.g. Western Cape Education Department [WCED] minute, 2014a; WCED, 2014b; Probyn, 2009). Anglonormativity - 'the expectation that people will be and should be proficient in English and are deficient, even deviant, if they are not' (McKinney, 2017, 80) - is the dominant ideological force in this context.

In practice, as student Thandile draws attention to in the opening conversational extract to this paper, it is unusual for learners to grapple with concepts or 'work on understanding' (Barnes, 1992) in Science using monolingual English language resources. Rather when involved in discussions, student (and often teacher) language use is highly heteroglossic (Bakhtin, 1981). Following Bakhtin, *heteroglossia* can be defined as the simultaneous use of a diverse range of registers, voices, named languages, or codes, and draws attention to the potential tensions between different voices and registers (Bailey, 2007; Ivanov, 1999). This heteroglossic language use has first been described in the South African schooling context as code-switching for epistemic access (Adendorff, 1993; Setati and Adler, 2000; Setati, Adler, Reed and Bapoo, 2002; Probyn, 2009) both in language learning and content learning classrooms. A heteroglossic concept that has recently gained traction in pedagogical contexts of increasing linguistic diversity in North America and the United Kingdom is *translanguaging*. In contrast to the ideologies which cast monolingualism as normative and languages as clearly boundaried objects, the concept of translanguaging proceeds from multilingual languaging as the norm (Antia, 2017; Blackledge and Creese, 2017; Garcia, 2009; Garcia and Li Wei, 2014; Makalela, 2015).

Translanguaging has been defined in a number of ways with emphasis on the description of communicative practices involving a wide range of linguistic and semiotic resources, as well as on the ideological dimension of disrupting a monoglossic and monomodal understanding of language. Blackledge and Creese (2017) also foreground the ways in which people 'bring into contact different biographies, histories and linguistic backgrounds' as they translanguage. Drawing on previous work on code-switching in schooling and higher education (e.g. Setati et al, 2002, Paxton and Tyam, 2010), South African scholars have taken up the notion of translanguaging to foreground the innovative ways in which teachers and learners maneuver within a constrained language environment in order to get teaching and learning done. Some scholars emphasise the identity work involved in translanguaging (Kerfoot and Bello-Nonjengele, 2014; Makalela, 2014) while others focus on the cognitive advantages of creative translanguaging for understanding content (Probyn, 2015; Krause and Prinsloo, 2016) paying attention to the transgressive and dilemma-filled nature of the practice in this English-dominant context. Msimanga and Lelliott (2014), while not using the term

'translanguaging' refer to the use of 'unconventional' communication resources such as home languages not included in the LOLT for understanding Science content. In our own take up of translanguaging in South African pedagogical contexts (e.g. 1 authors' text, 2 authors' text), our focus has been on translanguaging

- as a normative communicative practice among bi/multilinguals;
- as an ideological position which resists the notion of named languages as autonomous, bounded objects; and
- as a descriptive term which incorporates semiotic modes beyond language.

Recently Li Wei has argued for a conceptualisation of translanguaging as a 'practical theory of language' (2017, 1). Extending the ideological work of the term, Li argues that such a theory can contribute to our understanding of two significant theoretical issues in linguistics: language and thought and the modularity of mind (2017, 10). The fluid and dynamic communicative practices of multilinguals, Li argues, challenge first the common view that we think through one language or through a named language ('a named linguistic entity') and second that we think exclusively through language.

Translanguaging as a theory of language thus acknowledges the deeply heteroglossic, multimodal and multisensory nature of communicative practice. This aligns with Angel Lin's (2015) term 'trans-semiotising' which emphasises the trans-semiotic nature of much multilingual languaging:

> The proposal of trans-semiotising as a communicative strategy broadens our horizon about bi/multilingual communication, since languages...not only interact with each other but also intertwine with other semiotics (e.g. visual images, gestures, sound and music) in human communication practices during which the common semiotic repertoire expands under the contributions of communicators (He et al, 2016, p.5)

This powerful theorising of language and communicative practice has significant implications for language in education, including languaging-for-learning. The term *trans-semiotising* has the advantage of avoiding the logocentrism of *translanguaging*, which as a term privileges the linguistic, even though the concept encompasses different modes in communication. While Li Wei draws attention to the transformative nature of translanguaging practices, working from the principles of linguistic ethnography (Copland and Creese, 2015) convinces us that no communicative practice is by definition transformative (or constraining). Translanguaging, rather, has the *potential* to liberate multilinguals from the tyranny of monoglossic and monomodal conceptions of communicative practice as the norm. Our argument is that in order for translanguaging to be transformative *and* to be productive for learning, *translanguaging as pedagogy* must be deliberately designed. In the research reported on in this article, (author) as facilitator deliberately attempted to design what Makoni and Pennycook call 'counter practices [to colonial invention of language] through disinvention' (2005, 141). She did this by designing tasks that required students to translate and translanguage across registers and named languages in order to make meaning in Science. Here translanguaging is used to disrupt monoglossic conceptions of language as normative, as well as to disrupt what is considered legitimate language use for learning Science. Mindful of the political complexities of language rights, and of recognising the deeply heteroglossic nature of all language

use, our goal in this paper is to present and analyse an example of a strategy for disinventing and (re)constituting language in order to learn Science with Year 9 learners in South Africa.

Heteroglossic and multimodal meaning-making in Science

Scholars working in social semiotics have described the heteroglossic nature of scientific discourse in terms of its registers and multimodality. The differences between colloquial language, for example, and the language of written or entextualised Science in journal articles and textbooks have been elucidated using tools from systemic functional linguistics. Science language makes use of technical vocabulary, passive verb constructions and nominalisations to a much greater extent than colloquial language (Gee, 2004; Halliday and Martin, 1993). However, the focus on these differences creates a binary between the two registers which can be unhelpful for understanding how learning occurs in Science. Translanguaging literature focuses on flexibility and fluidity in languaging which makes analysis of multilingual discourse using the constructs of separate named languages an impossibility. In the same way, scholars of Science discourse in learning contexts and in spaces where the activity of 'doing Science' occurs, such as in research laboratories, have identified hybridity and meshing of registers in 'getting Science done/learnt' (Gibbons, 2006; Lemke, 1990). This hybridity stands in contrast to the monoglossic ideologies found in Science curricula and language in education policies. Jay Lemke and Pauline Gibbons (both working with English only discourse data) argue that hybrid registers are particularly important for learning Science:

> For most of their education in science, most students will need to learn "bilingually" in both colloquial language as well as in scientific language. / Students will begin to grasp semantic and conceptual relationships in colloquial language first. Then they will substitute scientific, technical terms for colloquial words. Only much later will they be able to speak "pure science". Along the way their version of scientific language will be an "interlanguage", a sort of *hybrid* of colloquial and technical registers. (Lemke, 1990, 172/173)

> I suggest that the kind of register-meshing that results in (a) hybrid discourse is an important factor in the successful learning of new academic registers with young second language learners. (Gibbons, 2006, 131)

Lemke uses metaphors from applied linguistics (e.g. 'interlanguage') to describe the different registers which are necessary to learn science well. The static notions of 'pure science' and 'interlanguage' are problematised through the use of the quotations marks, and we concur that in fact the register students use may elude our analysis as one or other named register due to precisely that fluidity and flexibility that Lemke is arguing for. There are contexts in which scientists are required to conform to stricter register conventions which exclude everyday registers, such as in scientific journal articles, but these are remote from science students in school and form a small part of scientists' total discourse.

Lemke goes on to recommend that in learning the 'foreign register of science' students should undertake translation practice.

> Students should regularly have (...) practice in class in restating scientific expressions in their own colloquial words, and also in translating colloquial arguments into formal scientific language. (1990, 173)

Lemke's comments about register here have serious implications when considered in the light of our multilingual students in South Africa. If students' colloquial registers are so important in the learning of Science, what detrimental consequences are we unleashing on students if we exclude their colloquial registers just because they happen to be classified as part of a separate named language for which there is no provision in the LOLT of the school? Students will be left stranded with no bridge to the scientific register.

Methodology

The data presented in this paper formed part of a linguistic ethnographic case study of the meaning-making practices of 36 Grade 9 students as they studied the topic 'Chemical Reactions' in Natural Science. The study was undertaken by the second author in 2016 in a state-funded high school in a peri-urban (township) area of Cape Town which attracts high-performing learners from the surrounding primary schools. As a home language speaker of English she also drew on her Afrikaans and isiXhosa resources during the course of the study. The official LoLT of the school is English, but almost all the students who live in the township are isiXhosa/English bilinguals and use features of both of these named languages in their daily interaction both in and out of school. The students acknowledge that they are more familiar with urban varieties of isiXhosa than the 'deep' rural isiXhosa varieties of which they also have some knowledge. The nine-month long project was shaped by the epistemological perspective of linguistic ethnography (Copland and Creese, 2015). (author) became a participant-observer in the Natural Science classroom for the duration of the chemical reactions topic, taking up the twin roles of learner (of Science and isiXhosa) and researcher. She also created a weekly study group for volunteer students from the class which formed the intervention component of the study. The study group intervention was designed as a space where translingual practices were normalised and resources from learners' full semiotic repertoires were welcomed as tools for learning. García and Li Wei (2014) distinguish between translanguaging as an adaptive space—viewed by policy makers, educators and learners as a necessary evil—and as an established space—where 'the translanguaging norm of bilingual communities' is authorised (García & Li Wei, 2014, 133). Following this definition, the study group was conceptualised as an established translanguaging space.

Discourse data from the class lessons and the study group was collected through video and audio-recording. The data presented in this paper was collected during the last study group meeting of the project. The first half of the session was dedicated to reflecting on the Chemical Reactions unit as studied in the study group and the classroom. Then during the second half, (author) set up a translation exercise in which the students worked in pairs. Using a multilingual dictionary of Science and Mathematics terms as a resource (Young, Van Der Vlugt, & Qanya, 2005), (author) designed a worksheet with key concepts from the topic described in paragraph form. In the dictionary, a concept is defined in English, Afrikaans, isiXhosa and isiZulu (in that order) with occasional accompanying graphics or diagrams. On (author)'s worksheet, only the isiXhosa definition of each concept was reproduced and a space was left for the students to provide an English translation. Once this was complete, and as a result of the discussion during the first translation, (author) asked the pairs to perform a further translation from the Xhosa definition into a more informal isiXhosa that they would be comfortable using amongst their peers.

Findings

(Re)Constituting registers for Science

We start by considering the written translations made by two of the students during the translation activity. We have reproduced, below, the source text which was made available to the students and the two texts produced by Yonela and Thandile as they worked on the translation from isiXhosa to English of the definition of 'molecule'. Although the instruction was to work collaboratively to arrive at the best translation, Yonela and Thandile could not reach consensus and thus each produced their own version.

The first translation

Source text: Xhosa, Young et al

> Imoletyhuli lelona suntswana lincinci lembumba elinakho ukuzimela; lenziwe ngee-athom zohlobo olunye okanye ezahlukeneyo, umz. Imoletyhuli enye yamanzi ngu-H2O; eyehayidrojini ngu-H2 kwaye ihlala izezohayidrojini zimbini endalweni.

Yonela's first translation

> A molecule is the smallest part of matter of the compound that can stand or split on its own, as it is made up of one/different kinds of atoms, for example one molecule of water is H2O, for hydrogen is H2 and there are always two hydrogens in nature.

Thandile's first translation

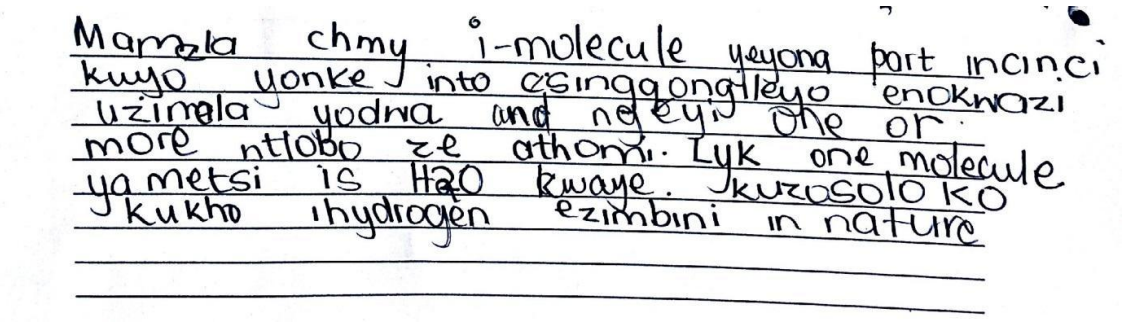
> A molecule is the smallest part of the compound that can stand or split on its own, as it is made up of one/different kinds of atoms, for example one molecule of H2O/water has 2 hydrogens and that will stay the same in nature.

The first translation required the learners to draw on and develop their knowledge of a register for Science in isiXhosa. As Thandile expressed in the extract at the beginning of this paper, using mixed resources including isiXhosa for *formal* communication of an idea or knowledge that one has mastered is unprecedented in these learners' Science education. This is despite the fact that the very same dictionary from which the activity is derived exists in multiple copies in Thandile's classroom - but remains untouched on the shelves. Therefore the written Science definition in isiXhosa is experienced very much as a 'foreign register' (Lemke, 1990) and its inclusion in a school Science study group is transgressive of the school language policy and normative classroom practice. The definition is recognisable as a register for Science in that it includes features such as technical vocabulary (eg. 'isuntswana') and the passive voice (eg. 'lenziwe ngee-athom'). After reading the source text students needed to utilise a register for Science in English, with which they would have been much more familiar for receptive language use, but not necessarily for production. In fact data from the broader study showed no production of student-generated written definitions in any language during the complete unit of study. Written activities in class were limited to short, usually one-word, answers.

The content of the first translations revealed the students' appreciation of the conventions of a scientific register and the conceptual rigour with which they undertook the task. In Yonela's first translation, she draws on her knowledge of the Science register in isiXhosa to bring the scientific meaning of 'isuntswana' (a particle/a part) into her English translation. While Thandile translates 'suntswana' as 'part', Yonela extends her translation to 'part of matter' to align more with a scientific register which is justifiably the meaning intended by the writer of the source definition. Even the awkward rendering of 'that can stand or split on its own' which appears in both Thandile and Yonela's translation is revealing of conceptual rigour as it is the result of a debate between the pair over whether 'can stand on its own' or 'can split' is the best translation of 'ukuzimela'. In fact both phrases get at the meaning of the isiXhosa word which denotes independence. In the English version in Young et al (2005) the expression is rendered as follows: 'can exist alone'.

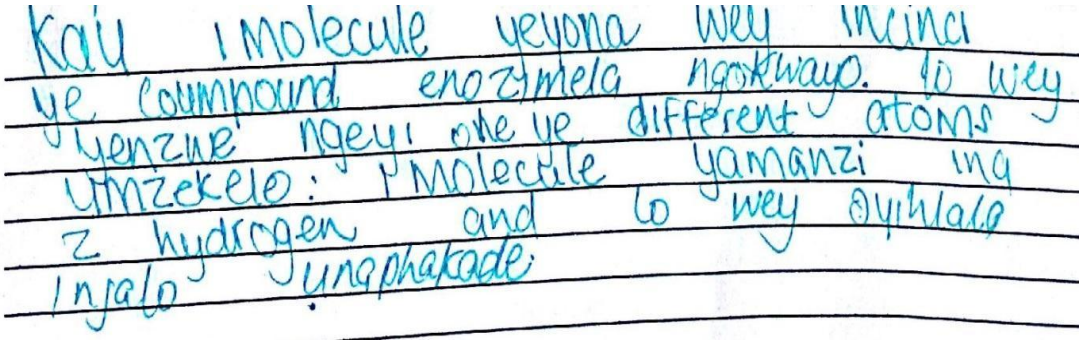
The second translation

Yonela's second translation



(Listen my friend, a molecule is the smallest part of all the things surrounding us, that is able to stand on its own and it is made up of one or more types of atoms. Like one molecule of water is H2O and there will always be two 'hydrogens' in nature.)

Thandile's second translation



(My friend, a molecule is the smallest thing of a compound that is able to stand on its own. This 'thing' is made up of one of the different atoms. For example: a water molecule has two hydrogen and that's how it's going to stay forever.)

As a result of the students' objections to the 'deep' nature of the isiXhosa source text, the second translation required the students to transform the Science content for an audience of peers. This involved the use of an unconventional mode (written) to communicate about Science topics with

this audience as well as the meshing of two registers which are usually kept separate at school. The weaving together of social, or informal, registers with scientific registers into one heteroglossic utterance is described by Gibbons as 'register-meshing' (2006, 131). This novel task therefore demanded some scaffolding.

(author) suggested that the students begin with a friendly greeting to get the feel for the register which was called for in this fictionalised communication setting. The students picked this up easily in their use of 'chmy' and 'kau', both meaning 'friend'. Here Yonela uses the text messaging abbreviation convention for the word 'tshomi' (friend). She employs this convention again in 'lyk' (like/for example). Deumert (2014) shows how communication on mobile phones is itself a mixed mode drawing on both spoken and written registers. By drawing on these conventions, Yonela extends her register-meshing even further.

The registers which Yonela and Thandile create in this task do not conform to a particular patterned set of conventions, but rather features of different registers are drawn upon freely and variably. The features of English and isiXhosa used by each student are instructive here. Yonela draws on an English feature in 'lyk' [like] while Thandile draws on the isiXhosa 'umzekelo' [example] to translate the same lexeme, but later Yonela draws on the isiXhosa feature 'kwaye' while Thandile uses 'and' again for the same source lexeme. This practice exemplifies the radical definition of natural translanguaging offered by Otheguy, Garcia and Reid:

> We... define 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 (2015, 283)

The students' disruption of register binaries occurs at the level of orthography as well. The source text renders the term being defined as 'imoletyhuli' - an orthography which induces a more 'Xhosalised' (Paxton and Tyam, 2010) pronunciation than both students' versions: 'i-molecule' and 'imolecule'. This reconstitution of a version of a scientific term in isiXhosa is indicative of the students' interest being demonstrated in an act of appropriation.

After the four new versions of the definition of molecule had been created, Yonela and Thandile had an ensemble of expressions which could then be compared and contrasted for different meaning affordances. What difference does it make to the meaning if we use 'yonke nto esingonqileyo' or 'the smallest part of matter'? The value in working with different expressions of a definition in Science lies in the flexibility which this affords students. Lemke pits flexibility against rote-learnt fixed wordings as follows:

> We do not want students to simply parrot back the *words*. We want them to be able to construct the essential *meanings* in their own words, and in slightly different words as the situation may require. Fixed words are useless. (91)

Lemke's valuing of the learner's 'own words' rather than 'parroting' stands in contrast to Thandile's assertion that it is 'only explanations' that can be expressed in a mixed language (his most familiar language use). It is through the explanations - each time using slightly different words organised into reconstituted registers - that the essential meanings of Science may be constructed.

Trans-semiotising for working-on-understanding

The texts above are a product of the vibrant, argumentative and conceptually rich interaction between the translating partners and the wider group. In this section, we consider the debate between Yonela and Thandile about the meaning and translation of 'imoletyhuli enye yamanzi ngu-H2O' to analyse how the students employed translanguaging and trans-semiotising to make their nuanced arguments.

Yonela argued for the English translation to read 'one molecule of water is H2O' which is equivalent to the English version in Young et al (2005, 152). Thandile, however, disagreed:

> Ha-a
> why 'i-molecule of water is H2O'
> water is H2O
> it's the same thing
>
> (No
> Why 'a molecule of
> Water is H2O'
> Water is H2O
> It's the same thing)

Yonela then countered:

> like Thandile sine-water (accompanied by a beat gesture[6])
> uba like one molecule yalamanzi
>
> (Like Thandile we have water
> if like one molecule
> of this water)

Thandile sees no distinction between the meanings of 'water' and 'H2O' and therefore objects to what he sees as poor style in the form of tautology in the published isiXhosa definition. Yonela makes a conceptually fine point about the difference between water as a substance ('sine-water') and water as a molecule ('one molecule yalamanzi') – a point which has not been made in the class lessons or the study group by the teacher or (author). She does not succeed, however, in convincing Thandile and he resolves the tautology by employing the forward slash to show that water and H2O are semantically equivalent in his understanding:

> 'one molecule of H2O/water has 2 hydrogens' (Thandile's first translation)

In countering Thandile's tautology assertion, Yonela employs the stylistic features of the genre of argument to make her case. Yonela introduces an example to support her point by using the connector 'like' then sets up the imaginary subject under investigation, 'sine-water', by calling it into being verbally and emphasising it through a beat gesture. She then puts forward the first term of the argument using 'if'. Employing trans-semiotising, including features of different named languages and different modes, Yonela achieves the genre of scientific argumentation. It is through trans-

[6] A beat gesture is a rhythmic hand movement usually for emphasis (Kress, Jewitt, Ogborn and Tsatsarelis, 2001)

semiotising and disinventing named languages that she is able to infuse her scientific argument with her own intentions thereby appropriating the new Science discourse (Bakhtin, 1981; Kress et al, 2001; Ballenger, 2010). She is also able to maintain her social identity as cooperative peer with Thandile by using this meshed register (Gibbons, 2006).

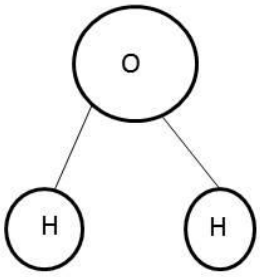
As she has failed to convince Thandile, Yonela changes tack and text type. She suggests drawing up a glossary of terms so that they may agree on the meaning of the words they are using in their translation. Thus she brings in further semiotic resources showing her flexibility, and all the time using a meshed linguistic register which is her most familiar resource.

> Thandile how about 'ba
> le nto
> like 'ba
> for each word siyenze apha
> le nto ba
> sibhale i-meaning yalo
>
> (Thandile how about like
> This thing
> Like like
> for each word we make here
> this thing like
> we write its meaning)

Deploying incomplete statements and hesitation, her expression here is typical of exploratory talk (Barnes, 1992, 126). She uses the colloquial filler 'like' often to allow herself thinking time.A third student in the group, Mbulelo, also weighs in on the argument with a suggestion for resolving the dispute between Yonela and Thandile. He draws on another mode: drawing in the form of a ball-and-stick diagram:

> U'ba iyanixaka
> 'fethu
> nitheni ningazobi la nto
>
> (If it's too complicated for you
> my man
> why don't you just draw that thing)

Mbulelo's reference to drawing indexes the ball-and-stick diagrams that the learners have been exposed to in class and exhorted by their teacher to use as an aid to understanding and accuracy when completing chemical equations. The diagram for water would be a version of this:



O = oxygen atom; H = hydrogen atom

Mbulelo invokes a very useful mode for expressing the meaning of a molecule. His suggestion also incorporates a one-upmanship jibe which allows him to display both academic and social roles simultaneously (Ballenger, 2010). Like Yonela, he can perform his social identity while making a methodological point about the Science problem at hand.

Disinvention: Developing criticality and language awareness

The translation activity as a whole offered students the opportunity to talk explicitly about language for Science in a way which potentially developed their critical faculties and enlarged their awareness of the role of language in learning. (author) set up the activity of translating the dictionary definition within a critical frame ('I want to know how did they [authors of the dictionary] do in terms of translating' and 'you're the experts'), encouraging critique of both the source text and the task. The redesign (Janks, 2010) of the task was in fact a response to the students' criticism of the definition in a scientific isiXhosa register that she provided. Despite the fact that they had not completed a task like this before, nor in fact produced any written definitions of their own in their lessons, students were very comfortable in taking up the position of knower unproblematically and talked about the language use in the source text critically as follows:

> Miss do you realise this is like...deep...deep Zulu. (Thandile)
>
> Asithi like 'ba formal Xhosa thina (We don't speak like like formal Xhosa) (Yonela)
>
> 'Funeka sizibhale kaloku but kengoku sisiXhosa esidibene ne-English (We must write them but it's Xhosa that is combined with English). (Thandile)

Both Thandile and Yonela distance themselves from the language of the source text. Thandile identifies it as another named language, isiZulu, which is a language in the same language family (Nguni) as isiXhosa. Yonela highlights its formality in opposition to her spoken language, which she models skillfully in the utterance using features of English ('formal'), isiXhosa ('thina') and colloquial abbreviations ('ba'). This 'urban vernacular' (Makoni et al, 2010, Makoni and Pennycook 2006) was variously described by the learners as: 'isigingqi' (language of the local area), 'tsotsitaal' (gangster's language), 'Capetonian Xhosa', 'siyamixa' (we mix), and 'ekasi Xhosa' (isiXhosa of the township). In describing the different varieties of language that abound the learners are developing their metalinguistic awareness.

Thandile complains about having to provide a translation into English when according to him some of the words in the source text are already in English (eg. hydrogen). This criticism highlights the hybrid nature of Science language in that the words which Thandile is criticising in the source text are Xhosalised (Paxton and Tyam, 2010) versions of English words originally borrowed from Latin

('imoletyhuli') and Greek ('iathom', 'hayidrojini'). The engagement with the borrowing which infuses all scientific registers is a process of disinventing named languages for Science. While his comments were not pursued in the study group, Thandile is speaking into a debate around appropriate ground rules for the intellectualisation of African languages - whether new terms have to be coined, old words re-purposed for academic disciplines, or borrowing with or without Xhosalisation.

For these bilingual learners, the written scientific definitions in isiXhosa were very unfamiliar. Not only was the secondary discourse of Science unfamiliar, but it was presented to them in isiXhosa. Since the start of their Science education (formally in Grade 4) they have only been exposed to written science in English -due to the policy, curricula and publishing constraints described above. We argue that because of the added unfamiliarity of the isiXhosa Science register the students feel more empowered to be critical of it. isiXhosa is not positioned as a language of power and knowledge production and hence more rigorous standards of intelligibility are applied by these students than those which they might apply to their school textbooks in English, for example.

Discussion and Conclusion

We argue that the data presented in this paper contributes to an understanding of what it means to disinvent and (re)constitute language (and registers) in school Science in an English-dominant schooling system. We have examined the textual products of an official translanguaging task as well as students' accompanying exploratory talk and critique of the task. We have shown the Science students to be resourceful, creative and critical in the processes of register-meshing and construction of different versions of a Science definition for different purposes. The natural translanguaging of the students as they explore and grapple with Science concepts and discuss and critique the language with which they are doing this presents a challenge to monolingual and monoglossic ideologies. That they cannot be said to be speaking 'English' nor 'isiXhosa'; neither 'pure Science', nor 'pure everyday language' urges us to look beyond the debates around 'mother tongue' or English-only language policies in schools and to examine what it is that students of Science are doing with language and the other semiotic resources in their repertoires (Kusters et al, 2017). The theoretical tools of the recent paradigm shifts in applied linguistics which view all language use as heteroglossic and argues for translanguaging as a practical theory of all language (Li Wei, 2017) enable us to do this. Using the notion of register-meshing (Gibbons, 2006), for example, has allowed us to emphasise the important learning work that drawing on different features of students' repertoires enables. Translation also opens up a space for comparison and critique of registers using metalinguistic awareness. These are important processes in learning the secondary discourse of Science which is a challenge for all students of Science who must incorporate this register into an 'expanded repertoire' (Lin, 2016).

In looking at both the registers of Science and the use of features of 'named languages' we are arguing for a disinvention not just of boundaried languages but also of boundaried registers such as 'Science' discourse and 'everyday' discourse. The myth that students move from everyday to mixed/meshed through to pure discourses of Science (see Tyler, 2016) is as problematic as the myth that competent linguistic practice requires monolingual use of one named language. While students currently have to learn to perform as English monolinguals who have mastered a pure scientific register in assessments, the success of this performance is largely determined by the opportunities

for heteroglossic and trans-semiotic meaning-making they have had as they grapple with concepts; work on their understanding and incorporate a school Science identity into their identity repertoires.

We posit the following features of designed translingual/trans-semiotic pedagogies in Science:

- the use of settled registers as starting points for translation
- the explicit teaching of metalinguistic awareness for critiquing different versions of Science language and for expanding students' repertoires for Science
- creative engagement by learners in generating written and oral Science texts which draw on their otherwise ignored or marginalised semiotic resources
- the valorising of innovative/disruptive semiotic practices through informal and formal assessment and publication for a wider audience
- development of the skills of scientific argumentation to which critique lends itself
- teachers adopting a co-learner stance in the classroom, particularly where linguistic repertoires do not map neatly onto each other.

The use of multilingual glossaries and dictionaries in South African schools is contentious when viewed against the backdrop of monoglossic language policies and notions of registers for content subjects such as Science. However, given our critique of a uni-directional trajectory from home language through everyday language to English scientific language, what we have aimed to show is that it is *how* we work with such 'multilingual' resources that is important. If we work from an understanding of language and learning which disrupts these binaries, assumes fluid languaging as the norm and positions students as critical agents in their own learning; heteroglossic language-focused activities such as using glossaries and dictionaries of this nature have real potential in learning Science as well as expanding students' linguistic and semiotic repertoires.

Acknowledgements

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