⌘ AOSIS

A mathematics teacher's response to a dilemma: 'I'm supposed to teach them in English but they don't understand'

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Background: English is the dominant language in South African schools although it is the home language for less than 10% of the population. Many schools have yet to embrace the Language in Education Policy's advocacy of additive bilingualism. This has led to a majority of the country's children learning and being assessed through a language in which they lack proficiency.

Aim: This article draws on second language teaching and learning theory to make a case for more systematic support for learners' second language development and for legitimation of use of home language in mathematics classrooms where a different language is the official medium. The article shares empirical data from a South African Grade 4 mathematics teacher's classroom to illuminate arguments in favour of additive bilingualism.

Setting: A non-fee-paying public school in Eastern Cape province of South Africa.

Methods: Data were collected through lesson observations, teacher interviews and assessment data generated by a professional development project initiative.

Results: The 'illuminatory' lesson data suggest that allowing learners to use their home language alongside English facilitated their mathematical sense-making. This suggestion is strengthened by assessment data from a larger development project mandated with exploring ways for improving the quality of primary mathematics teaching and learning.

Conclusion: Insights from this article add to many other calls made for more sustained and serious consideration of the pedagogical and epistemological value of multilingual approaches for South African classrooms.

Keywords: additive bilingualism; bilingual learners; language-as-resource; mathematical sense-making; multilingualism; second language acquisition principles.

Introduction

This article explores multilingualism in terms of some pedagogical and epistemological implications for making South African mathematics classrooms more equitable. The objective of the article is mainly conceptual and theoretical. In the second half of the article, we, however, illuminate our conceptual and theoretical discussion with empirical data relating to a Grade 4 mathematics teacher's classroom. The teacher in question is Ms P. She teaches in a non-fee-paying public school serving isi-Xhosa-speaking children in the Eastern Cape province of South Africa. Grade 4 marks the point at which a majority of South African learners, including those at Ms P's school, make an official transition to English as their main language of learning and teaching (LoLT).

The 'illuminatory' material comprises a small subset of lesson observation and interview data about aspects of Ms P's mathematics teaching practices, plus assessment data generated in the course of one of the professional development projects organised by Rhodes University South African Numeracy Chair. The assessment data provide insights into Ms P's Grade 4 learners' performance relative to three of Kilpatrick, Swafford and Findell's five strands of mathematical proficiency (National Research Council 2001).

Literature review

Each of the subsections making up this literature review focuses on a facet of the language or learning interface. We begin with a short subsection on additive bilingualism. This principle, although strongly advocated in South Africa's 1997 Language in Education Policy (LiEP), has yet

been neither fully articulated nor widely implemented. The next subsection provides an overview of orientations towards language policy and practice. Here we draw mainly on the work of the late American scholar Richard Ruiz. We then have a subsection on factors influencing decisions and choices regarding language policy and practice in relation to teaching and learning. In the South African case, the literature shows how perceptions regarding the status of English as a 'language of power' have tended to outweigh arguments favouring mother tongue as the language most likely to strengthen learners' epistemological access. In recognition of the fact that equitable practice depends on a balancing of such competing views, the final subsection of the literature review focuses on different models for bilingual education relative to ensuring that all learners' language learning needs are supported.

Mistrust of 'additive bilingualism'

In line with South Africa's constitutional recognition of 11 official languages, the country's LiEP endorses multilingualism. In particular, the LiEP identifies additive bilingualism as a core 'underlying principle'.

Additive bilingualism involves educational support for, and maintenance of, learners' home language(s) while at the same time 'providing access to and the effective acquisition of additional language(s)' (Department of Education [DoE] 1997:1). The eventual goal of additive bilingualism is that learners develop high levels of proficiency in both the home and the additional languages. Subtractive bilingualism, by contrast, involves learners' home language(s) being set aside in favour of another language, a situation commonly experienced in Africa. Even post-independence, many African countries have opted to continue using a former colonial language rather than an indigenous one as their main language for administrative and educational purposes.

South Africa's LiEP mandates School Governing Bodies with choosing which of the 11 official languages their school should use as its LoLT. The policy recommends that schools pursue a course 'most supportive of general conceptual growth among learners' while simultaneously 'counter[ing] disadvantages resulting from different kinds of mismatches between home languages and languages of learning and teaching' (DoE 1997:1–2).

Despite the LiEP's advocacy of additive bilingualism, however, many black South African parents are sceptical of the suitability of their home languages as vehicles for their children's social and economic advancement. Many of these parents, having been victims of apartheid education, 'associate [home language education] with inferior education' (Nomlomo 2006:131). Their distrust of the motives behind calls for greater emphasis on mother tongue education, for at least the early years of schooling, has led many to choose English as the LoLT for their children.

Orientations towards language in multilingual contexts

Ruiz (1984) identified three main orientations in debates about language policy and practice in multilingual contexts. These were 'language as problem', 'language as right' and 'language as resource'. By 'orientation', he referred to 'a complex of dispositions toward language and its role, and toward languages and their role in society' (Ruiz 1984:16). As an analytic heuristic, Ruiz's initial thinking around the three orientations has, as Hult and Hornberger (2016:31) note, 'not worn out with time, but has only become more powerful'. Ruiz's (1984) work has been cited by, among many others, mathematics education academic Mamokgethi Setati-Phakeng in her analyses of multilingualism in and for mathematics teaching and learning in South African classrooms and elsewhere (see, e.g., Planas & Setati-Phakeng 2014). We recognise the value of Ruiz's tripartite distinction and briefly outline some core features of each orientation. We begin with his 'language as problem' orientation.

'Problem-solving has', Ruiz (1984:15) suggested, 'been the main activity of language planners from early on'. This, however, has mostly been to do with 'the problem' of how to optimise minority language group learners' transition into proficient use of the dominant language of a particular society. Such transition was seen to reduce the risk of such groups becoming victims of social and economic disadvantage. Ruiz saw this 'solution' as deriving from a deficit view of linguistic minority groups and from a perception that these groups' interests would best be served through assimilation into the mainstream language group. This 'policy of subtractive bilingualism' has, Ruiz (1990:17) noted, often been 'regarded as benign by the dominant society – a way of providing equality of opportunity'.

'Equality of opportunity', while an excellent principle, is notoriously difficult to achieve in practice, and Ruiz's second orientation, 'language as right', stands in sharp contrast to the idea that assimilation constitutes a 'benign' route towards equality of opportunity. Instead, the language-as-right orientation seeks to promote the validation, and therefore maintenance, of minority group languages, and the cultural mores embedded therein, and to protect these languages from being overwhelmed by a society's more politically and economically dominant language(s): Afrikaans and, in particular, English, in the South African case. The language-as-right orientation supports minority language groups' right to mother tongue education. It recognises the importance of mother tongue, most especially in the foundational years of schooling when children acquire their initial literacy and numeracy. Mother tongue is seen as the medium most likely to optimise a child's conceptual and epistemological access in mastering these core foundational proficiencies. Setati (2008: 106–107) in her exploration of teachers' and learners' perceptions of English as the 'obvious' medium through which to learn mathematics noted however that epistemological arguments tend to be undermined by teachers' and learners' perceptions of 'the linguistic capital of English and the symbolic power it bestows on those who can communicate in it'.

In terms of Ruiz's third orientation (language as resource), multilingualism and diversity are acknowledged as being inherently valuable – politically and economically – both to a society and to its individual members (Ruiz 1990):

> To the extent that the language-as-resource orientation draws attention to the social importance of all communities and their languages, and to the extent that it promotes tolerance and even acceptance of minority languages, it holds promise for reducing social conflict in a way that the other two cannot match. (p. 17)

All three of Ruiz's orientations are evident in South Africa's language planning and policy debates during the past several decades. The apartheid era language policy had been (DoE 1997):

> [F]raught with tensions, contradictions and sensitivities, and underpinned by racial and linguistic discrimination [which] affected either the access of the learners to the education system or their success within it. (p. 1)

South Africa's (1997) LiEP thus represented:

> [A]n integral and necessary aspect of the new government's strategy of building a non-racial nation in South Africa [in which] … respect for languages other than one's own would be encouraged. (p. 1)

The 'language of power' versus the 'power of mother tongue' debate

The decision by many black South African parents to choose English over mother tongue for their children's schooling reflects a somewhat paradoxical re-interpretation of the language-as-right orientation envisaged by Ruiz. While Ruiz's language-as-right orientation advocated language minority groups' right to home language instruction on the basis of cultural affirmation and enhanced epistemological access, a majority of black South African parents have seen it as their democratic right – obligation, even – *not* to choose mother tongue, but to go instead for English as their children's main LoLT. Describing English as a 'dominant symbolic resource', Setati (2005:74) observed that choices around language are 'as much, if not more of, a function of politics as it is of cognition and communication'. In exercising their democratic rights to choose this dominant symbolic resource for their children's schooling, it could be argued that parents have – albeit unwittingly – jeopardised Ruiz's language-as-resource orientation. The choice of English, a language in which the majority of black South African children lack proficiency, presents a serious threat to their chances of gaining meaningful epistemological access in the classroom. In such circumstances, far from being a 'resource', English in fact acts as a barrier to classroom sense-making, so becoming Ruiz's (1984) 'language as problem', although not in the sense in which he characterised the nature of 'problem'. Given that English is a home language for less than 10% of the country's population (Statistics South Africa 2012), but that, by Grade 4, nearly 80% of South African children are officially learning in English (Department of Basic Education 2010), the impediment to epistemological access is huge.

That such threats have been actualised is borne out in both national and international assessments of South African learners' literacy and numeracy levels. On the international front, the country's participation in several cycles of the International Association for the Evaluation of Educational Achievement (IEA) Progress in International Reading Literacy Study (PIRLS) and of Trends in International Mathematics and Science Study (TIMSS) assessments provides compelling evidence of the literacy and numeracy crises facing the education system. In his stark analysis of South African learners' performance on such assessments, Spaull (2019) observed that '78% of Grade 4 learners cannot read for meaning in any language' and that:

> … 61% of Grade 5 learners could not add and subtract whole numbers, have no understanding of multiplication by one-digit numbers and cannot solve simple word problems, i.e. they cannot do basic mathematics. (p. 3)

Reddy et al.'s (2016:8) report on South African Grade 5 learners' participation in TIMSS 2015 noted the significantly better scores for those learners who 'always or almost always spoke the language of learning and teaching at home' as compared to those whose home language was different from that used in school. The implications of this correlation cannot be ignored, not least because in every Curriculum and Assessment Policy Statement document, South Africa's Department of Basic Education (DBE) (2011:4) reiterates its commitment to 'ensuring that the educational imbalances of the past are redressed, and that equal educational opportunities are provided for all sections of the population'.

The language through which South Africa's mathematics learners are taught has clear redress implications. Research-based discussions of the value of more equitable, multilingual practices for South Africa's mathematics classrooms abound. Adler, Setati-Phakeng and colleagues, for example, have made decades-long and substantial contributions to this area (see, e.g., Adler 2002; Phakeng & Moschkovich 2013; Setati 1998, 2012; Setati & Adler 2000; Setati, Chitera & Essien 2009; Setati, Molefe & Langa 2008). Similar work has been undertaken in the Eastern Cape province of South Africa, the province in which Ms P teaches (see, e.g., Webb 2010; Webb & Webb 2008).

Setati et al.'s (2008) study reported that presenting mathematics tasks in two language versions, the learners' home language and English, had been found to promote more conceptually oriented interaction between learners. As the authors noted, the dual-medium worksheet presentation afforded learners the opportunity of drawing on 'the linguistic resources they have' (both home language and English) and at the same time ensured that they retained 'access to the language of power [English], which they so much want to gain access to' (Setati et al. 2008:24). Despite such positive findings, however, uncertainty and indecision about the LoLT question for South African classrooms persist. South African schools appear to be moving in a monolingual (English) direction. Heugh's (2017:4 of 4 online source) warning that 'successful education, especially for vulnerable

and marginalised communities, cannot occur unless children understand the language/s through which it is provided' has increasing cogency, and resonates well with an interview comment made by Ms P, the first part of which is built into our article title: 'I'm supposed to teach them in English, but they don't understand … so most of the time, I speak Xhosa, the one that they understand'. Ms P's use of the word 'supposed' perhaps implies a measure of unease about not sticking to English as the LoLT in her Grade 4 mathematics lessons. In this she is not alone. Because of the widely held deficit views about the practice of code-switching, many black South African teachers feel that they need to 'smuggle the vernacular' into their classrooms (Probyn 2009). Far from being illicit, this practice, if applied in a considered and systematic way, is, in fact, fully consistent with the LiEP's advocacy of additive bilingualism. Teachers' sense of code-switching's illicitness is an indication of the Department of Basic Education 's failure to adequately brief teachers about the tenets underpinning the country's LiEP. Similar failures relate to adequate briefing of the country's parents, many of whom are unaware of the potentially negative consequences of choosing English as their children's LoLT. Research in Eastern Cape schools, for instance, has revealed that many School Governing Bodies (of which parents are a statutory part) were not especially 'well-equipped to make decisions about school language policy' (Probyn et al. 2002:29).

Becoming proficient in the language of the classroom

In this section, we focus on literature relating to language as a tool for learning. Swain (2006) uses the word 'languaging' to describe the act of using language to mediate understanding of complex ideas. All learners, particularly bilingual learners, need support in becoming proficient in languaging.

We locate our discussion within a broadly sociocultural theoretical framework (Vygotsky 1986/1934). In terms of this framework, communication (principally linguistic) in social context is recognised as fundamental to all processes of teaching and learning.
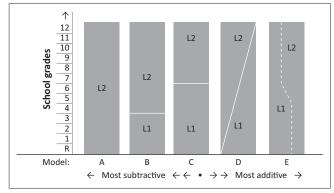
Vygotsky (1986/1934) was among the many who saw language as the single most powerful cultural tool to develop, interrogate and communicate thoughts and ideas. As such, 'a prime aim of education should … be to help children learn how to talk together such that language becomes a tool for thinking collectively and alone' (Mercer & Littleton 2007:68). Drawing on ideas around the centrality of communication in social context, Littleton and Mercer (2013) coined the term 'interthinking' to capture the link between social and cognitive aspects of joint talk *en route* to effective sense-making. Learners who are not proficient in the language of their classroom will find engaging in 'interthinking' in and through that language a severe challenge, and therefore an impediment, to their sense-making attempts.

The fact that the challenge of mathematical sense-making was real and debilitating for a majority of South Africa's

Grade 4 learners may be inferred from their 2014 Mathematics Annual National Assessments (ANA) scores (2014 being the last year when ANAs were written). The national Grade 4 average for mathematics was 37% (Department of Basic Education 2014), and performance was the weakest for non-English-speaking learners.

Grade 4 is a particularly demanding transition point for many learners. This is the year in which learners leave the more carefully scaffolded foundational phase and encounter the higher conceptual and linguistic demands of an expanded range of curriculum areas and more specialised academic text (both verbal and written). For a majority of black South African learners, this coincides with an official switch from an L1 LoLT to English as the L2 LoLT. Macdonald (2002) used the metaphor 'swimming up the waterfall' to convey the extent of the challenges involved in this transition. In specific reference to mathematics cognition and language in South African classrooms, Henning (2013:59) suggested that 'the cognitive load becomes unbearable for some children at [this] time when mathematics cognition is accelerated'. To achieve 'a wider gaze on [the challenge of] learning mathematics and learning language in tandem', she therefore called for the inclusion of research insights from cognitive psychology and from cognitive neuroscience (Henning 2013:69).

The switch to English as LoLT in Grade 4 is described in the literature as an 'early exit' model of bilingual education (Walter 2008). Various models of bilingual education exist; however, drawing on the literature around bilingual education, we have created Figure 1 to show the five most common models of bilingual education. They are arranged from the 'most' to the 'least' subtractive in terms of the extent to which they either deny or allow legitimate space for learners' L1 in contexts where an L2 is used as LoLT. Model B and, to a lesser extent, Model C reflect early exit models. They, and most especially Model A, where learners are plunged straight into an L2 LoLT from Day 1, place a threefold responsibility on content area teachers. They need to scaffold their learners' developing subject area knowledge and proficiency; they have to do so in an L2, and they must thus play a central part in contributing to these learners' acquisition of the relevant, subject-specific L2.

FIGURE 1: Models of bilingual education.

The field of second language acquisition (SLA) is vast. For the purposes of this article, however, we briefly outline below the SLA ideas of language theorists Krashen (2009) and Swain (1985) and Swain and Lapkin (1982, 2013). We then outline aspects of the work of Cummins (2000, 2005, 2008, 2015). His ideas have been immensely influential for more than four decades in providing insights into how education systems might enhance the learning trajectories of their bilingual learners.

Although Krashen's (2009) explanations have been criticised for underestimating the complexity of the SLA process, they too have been influential. His ideas and those of Swain and Lapkin (1982) are sometimes portrayed as opposing each other. On the contrary, however, we view them as complementary.

Krashen's (2009) argument is that an L2 is acquired through processes essentially similar to the way children acquire their L1. His SLA theory comprises five main hypotheses, two of which we briefly discuss here, the first being his 'input hypothesis'. In terms of this hypothesis, Krashen (2009) suggested that comprehensible input (i) is the main driver of SLA. By this he was referring to L2 input pitched *just beyond* learners' current levels of L2 proficiency. Krashen (2009:21) expressed this as 'i+1'. His point here relates to the importance of learners being challenged to put cognitive effort into unpacking the meaning of the L2 input they receive. If input is pitched too low, that is, if it is too easily comprehensible, this would reduce learners' incentive to engage cognitively. If, by contrast, input is pitched too high, learners might become discouraged and give up. In Krashen's view, one of the best ways of acquiring an L2 is for it to be used as the LoLT, thus creating an important and authentic reason for its acquisition. In such a context, meaning would need to be negotiated through, for example, the asking of questions, the use of gesture, pictures and physical objects, and/or by reference to learners' existing knowledge about a topic. It could also be negotiated by modifying input when needed, through, for example, repetition, paraphrasing and requests for clarification.

The second hypothesis of Krashen (2009) is the 'affective filter hypothesis', which emphasises the importance of the affective dimension. A supportive classroom setting would, he argued, lower learners' affective filters, thereby making them more willing to maintain the effort required to work at making input meaningful, and, in time, willing also to attempt their own verbal contributions in and through the L2. According to Krashen, the combination of input made comprehensible, a reassuring learning environment and an authentic need to communicate is what is needed to push language learners towards acquiring – largely subconsciously – the target language: '[t]he effective language teacher is someone who can provide input and help make it comprehensible in a low anxiety situation' (Krashen:32).

Swain and Lapkin (1982) and particularly Swain (1985) challenged Krashen's (2009) assertion that it is possible to achieve effective SLA through largely subconscious means.

Learning a second language, they pointed out, necessarily involves both conscious and subconscious processes. Swain and Lapkin (1982) were particularly sceptical about Krashen's (2009) emphasis on the comprehension-driven receptive skills (mainly listening, but also reading) as the main mechanisms for SLA. While Swain (1985) acknowledged the importance of comprehensible input, she cited several studies which argued that input, however comprehensible and well-scaffolded, was wholly inadequate for genuinely effective SLA: the productive skills (speaking, in the first instance, and subsequently writing also) were equally, if not more, important. Comprehensible output had to be seen as the more important marker of communicative competence, and, perhaps even more importantly, academic proficiency in a particular language. As Swain (1985) noted, comprehension of an L2 and production of that L2 are two quite different processes. When learners listen to or read a language, it is not only linguistic knowledge that aids their meaning-making processes. A range of top-down cues (e.g. contextual information and background knowledge) help them unpack the meaning of a particular text. A form-driven focus in which learners are required to actually produce the L2 themselves (in either spoken or written form) is what forces learners towards doing the more demanding but linguistically important kind of syntactic processing. This is the kind of processing that most likely helps them become genuinely proficient in using the more academically – as opposed to socially-oriented – forms of that particular L2. It calls for a much higher measure of linguistic knowledge about how that particular language actually works: 'using the language, as opposed to simply comprehending the language, may force a learner to move from semantic processing to syntactic processing' (Swain (1985:249). The requirement that learners speak or write in an L2 (as is required in classrooms where L2 is used as the LoLT) means that they are forced into wrestling with the lexical and grammatical components (syntax) of the L2. Opportunities, therefore, to practise producing that language, together with constructive feedback on how successful they are being in conveying their intended meanings in it, are what is most likely to help learners develop their academic proficiency in this L2. At the same time, however, Swain and Lapkin (2013) note the importance of appropriate use of learners' L1 in L2 classrooms. They cite Vygotsky's (1986:206) point that, in the process of acquiring a second language, learners necessarily turn to their 'native language as a mediator between the world of objects and the new language'. In other words, learners' L1 is an important cognitive tool for achieving proficiency in the L2. Principled use of the L1 is therefore viewed as both pedagogically and epistemologically beneficial (Swain, Kirkpatrick & Cummins 2011):

> It is a waste of time to tell students not to use [L1] when working through cognitively/emotionally complex ideas, as they will do so covertly if not allowed to do so overtly. By being able to use [L1] initially, learners are able to know the full range of what they want to express in [L2]. (p. 15)

Cummins's work is concerned less with issues relating to SLA as such. His main emphasis continues to be on ways of mediating the dual challenge encountered by language

minority learners when they are in the early stages of acquiring their L2 and of developing academic proficiencies in it. Writing on ways of tackling South Africa's 'bleak picture of … underachievement' among rural and township learners, he notes that helping L2 learners to develop such academic proficiencies is essential to remediating this situation (Cummins 2015:272). He notes also that an appreciation of the 'educational legitimacy and academic relevance' of these learners' L1s is essential (Cummins 2015:278). These two points highlight an almost inevitable tension between 'access' and 'inclusivity' in multicultural or multilingual classroom settings. By 'inclusivity' we refer to practices that actively seek to recognise and affirm minority group learners' linguistic and cultural identities, and their related prior knowledge and experience. 'Access', on the other hand, here refers to the need to equip learners with the kinds of powerful knowledge most likely to open up socio-political and economic opportunities for them in the wider society. Mathematical knowledge, and knowledge about how language works in different contexts, is prominent among such forms of knowledge. Balance is called for in catering to the competing demands of 'inclusivity' and 'access'. Teachers should not let one overwhelm the other. If they were to go too far towards providing access to the powerful forms of knowledge, minority group learners may lose by not having their social and cultural identities and experiences adequately affirmed. If, on the other hand, teachers were to go too far towards shaping the curriculum around aspects of minority group learners' cultural and linguistic identities, these learners may then have less opportunity to engage with the more powerful forms of knowledge. This would then put them at risk of ongoing marginalisation, and existing societal inequities would also then continue, unabated, unchanged and unchallenged.

Two aspects of Cummins's work resonate particularly well with South African circumstances. Firstly, there is the distinction he makes between basic interpersonal communicative skills (BICS) and cognitive academic language proficiency (CALP) (see, e.g., Cummins 2008). Secondly, there is his linguistic interdependence hypothesis (Cummins 2000). In relation first to the BICS/CALP distinction, Cummins (2008) points out that even in optimal circumstances it takes learners significantly longer to acquire CALP in their L2 than it does for them to acquire everyday conversational fluency, or BICS, in an L2. Well-established research findings indicate that it may take as much as 5–7 years to develop L2 CALP. A lack of understanding about the differences between BICS and CALP has accounted for a disproportionate percentage of L2 learners being assessed in learning deficit terms. A questionable conflation of these learners' linguistic proficiency and their overall cognitive potential led to lowered expectations for such learners, a reduction in the cognitive demands placed on them, and, so too, to fewer opportunities for them to develop and strengthen their CALP. Cummins's linguistic interdependence hypothesis underscores the importance of learners' L1 as an already present source of linguistic and conceptual understanding that could be transferred to the L2. As he points out, and as illustrated in Figure 2, 'conceptual knowledge developed in one language helps to make input in the other language comprehensible' which can then form the basis for the development of common underlying proficiencies across both languages (Cummins 2000:39).
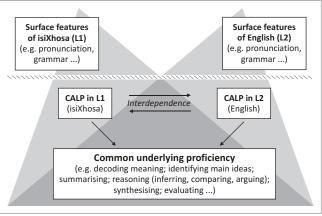
Cummins (2015:278) labels monolingual approaches in multilingual contexts exclusionary and devaluing, and argues instead for an expansion of 'the instructional space to include learners' and teachers' multilingual repertoires'. Through his 'dual-iceberg' metaphor he sought to illustrate that while surface features of learners' L1 and L2 may differ (in terms of their grammar, phonology, etc.), conceptual understandings and academic-type proficiencies developed initially in L1 are transferable to the L2 level (Cummins 2005).

'Illumination' via empirical data from a Grade 4 mathematics teacher's classroom

While this is largely a conceptual and theoretical article, in the next section we draw on data from a case study of Ms P to illuminate aspects of our review of the literature.

Some methodological considerations informing the broader case study

The small-scale case study on which this article rests was carried out by the first author as part of a larger naturalistic, qualitative and broadly interpretive study that explored mathematics teachers' use of classroom talk. Data for the broader study were generated through lesson observation and from interviews with Ms P and one other teacher (Ms M). Both were Grade 4 teachers in two public schools serving isiXhosa home language learners. Observation data were collected over a 4-week period: two consecutive weeks in each school, during which time a total of 31 mathematics lessons were observed. Separate interviews with both Ms P and Ms M were conducted at the beginning and towards the

Source: Adapted from Cummins, J., 2005, 'Teaching for cross-language transfer in dual language education: Possibilities and pitfalls', in Paper presented at the TESOL, Universidad BogaziciTurquía, Estambul, 23rd September 2005, pp. 1–18
CALP, and cognitive academic language proficiency.

FIGURE 2: Cummins's dual-iceberg metaphor in support of his 'common underlying proficiency' claims.

end of the period of observation. Field notes and a research journal were kept throughout the process. All ethical protocols were observed. These included voluntary participation, informed consent, the right of withdrawal, the right to confidentiality and the preservation of anonymity through the use of pseudonyms.

Both Grade 4 teachers were invited to contribute to the case study on the basis of their membership of the Numeracy Chair Project's professional communities. The project, set up and run by the second author, is committed to working with teachers, learners, researchers and district office personnel in identifying and trialling 'sustainable and practical' ways for improving the quality of mathematics teaching and learning outcomes in primary schools (http://www.ru.ac.za/sanc/). Both Ms P and Ms M had participated in one of the project's professional development programmes. In this sense, both case study sites represented 'purposive', 'opportunity' samples (Denzin & Lincoln 2005). Lessons and interview sessions were audio- and video-taped and then transcribed verbatim. A native speaker of isiXhosa proficient in English assisted in the translation process for those sections of lesson transcripts where isiXhosa was used. Translations were subsequently cross-checked by a second native isiXhosa-speaker. As part of the validation process, both teachers were given the opportunity to review their respective lesson and interview transcripts. Key categories and themes relating to the focus on mathematics teachers' use of classroom talk were then identified from the transcript data. The two questions driving the remainder of this article are as follows:

- What evidence is there to suggest that Ms P's language practices may have facilitated her Grade 4 learners' mathematical sense-making?
- In what ways do Ms P's Grade 4 mathematics classroom language practices align with SLA principles?

We argue that, in combination with our review of some relevant literature, the data we share in responding to these questions provide positive albeit tentative evidence of the value of learners' home language (L1) having a legitimate space alongside their additional language (L2) in the mathematics classroom. The use of L1 in the classroom is more important given the societal contexts within which many South African mathematics classrooms operate. Independently of issues relating to LoLT, many are encumbered by socio-economic and other factors that impact negatively learners' opportunities to achieve mathematically.

Aspects of Ms P's mathematics classroom language practices

As per its Governing Body decision, the language policy at Ms P's school is L1 LoLT (isiXhosa) for Grade R-3 learners. English is taught from Grade 1 as a first additional language. In Grade 4 they move to an L2 LoLT (English). Were it not for Ms P's continued and extensive use of isiXhosa, this shift would represent an early exit model of bilingualism, in other words, 'subtractive bilingualism' (as represented by Model B of Figure 1). In fact, however, despite her expressed

unease about how much isiXhosa she used in the observed mathematics lessons, Ms P's language practices aligned more closely with the country's LiEP advocacy of 'additive bilingualism'. While we do not have substantive evidence in support of it, we suggest that these language practices may have aided Ms P's learners' mathematical sense-making. We posit this on the basis of assessment data collected in 2014 by Rhodes University South African Numeracy Chair from Ms P's school (as well as from the other schools participating in the final year of one of the Chair's development projects). This was in the same year that the broader qualitative case study was undertaken. It was also in this year that South Africa's last cycle of ANAs was written. Ms P's Grade 4 learners did not fare well in these ANAs. Their average percentage in Mathematics ANA was 27.3% (South African Numeracy Chair 2014), which was below the provincial and national averages (DBE 2014). Aspects of the ANA assessment process, and in particular, linguistic aspects, have, however, been called into question (see, e.g., Sibanda 2017; Sibanda & Graven 2018). More interestingly, for the purposes of the present article, the assessment data for Ms P's learners are generated by the South African Numeracy Chair Project, which are presented in Table 1. The project's assessment instrument was adapted from Askew et al. (1997) and measured Grade 4 learners' average scores on three of Kilpatrick, Swafford and Findell's five strands of mathematical proficiency (National Research Council 2001). 'Conceptual understanding' refers to the ability to comprehend 'mathematical concepts, operations, and relations'; strategic competence refers to the 'ability to formulate, represent, and solve mathematical problems'; and adaptive reasoning refers to a 'capacity for logical thought, reflection, explanation, and justification' (National Research Council 2001:116). As shown in Table 1, Ms P's learners performed well on these assessments relative to other project schools.

While the scale of the broader case study is not sufficient to make substantive claims, we believe that the figures in Table 1 are a sufficiently interesting reflection on both Ms P's learners' emerging levels of mathematical proficiency and on her classroom language practices to make them worthy of further investigation. These data, we believe, highlight how Ms P's learners' opportunities for mathematical sense-making may have been strengthened by her having countenanced the extensive use of their native isiXhosa during the observed mathematics lessons (and there is no apparent reason for thinking that the amount of isiXhosa permitted in other [unobserved] mathematics lessons was any less).This is consistent with Cummins's (2005) claims regarding the transferability of 'common underlying proficiencies' across L1 and L2 (Figure 2).

TABLE 1: Ms P's Grade 4 learners' average per cent scores on the South African Numeracy Chair Project's mathematical proficiency assessment.

Group	Conceptual understanding	Strategic competence	Adaptive reasoning	Overall average
Ms P's learners	52	34	64	50
Project cohort	51	25	29	35

Source: South African Numeracy Chair (SANC), (2014), South African Numeracy Chair database, SANC Internal report, Unpublished.

It was also a regular feature of her observed lessons that she would call on a series of individual learners to come up to the chalkboard to share their mathematical thinking with their fellow learners. Ms P explained her rationale for encouraging this form of 'interthinking' (after Mercer & Littleton 2007) as follows:

> I want them to tell the others. I believe that they learn from each other. […] If sometimes something they don't take it seriously from me, when the other one is doing it, 'Oh, *ubani* ["somebody"] is doing it like this!' […] That's why I say, 'Say something. Don't just do it for yourself. Do it for – with them'. […] it's a part of sharing when they are doing there on the board. That's why I say, 'Speak, so that they can hear what you are doing. Don't just write'. (Robertson 2017: Interview data)

Having indicated that Ms P's classroom language practices may well have assisted her learners in their mathematical sense-making, we now share some actual classroom data illustrating these practices. We have selected for this purpose a small data set from one of Ms P's 17 observed lessons (Lesson 16). The lesson lasted for 75 min, longer than that was scheduled. As the longest of Ms P's observed lessons, it provided more opportunities for a holistic analysis of the classroom communication patterns. 'Observed pattern/s of communication' was the main category of data relevant to the two questions we set out to explore in this article about the ways Ms P's language practices aligned with SLA principles as she mediated her learners' mathematical sense-making. Talk in Lesson 16 comprised 132 turns. While Ms P's turns were extensive, learners' responses to her urging them to '*Thetha*' ['talk'] were limited (many being gestural rather than verbal). Most of Ms P's front-of-class utterances were in English, barring an occasional question or comment (e.g. '*Masiswape incwadi. Masitshintshe*'. ['Let's swop our books. Let's swop'.]). Almost all her one-on-one exchanges were in isiXhosa (Turns 44 through to 126). Two-thirds (66%) of Ms P's turns were pedagogically meaning-oriented. The rest related to routine classroom management. There was only one disciplinary utterance, which was made in isiXhosa.

The lesson was divided into two main activities: a 'whole-class' checking of a numeric flow diagram homework task and an individually done two-digit multiplication task: 23 × 17 (and, for early finishers, 32 × 24).
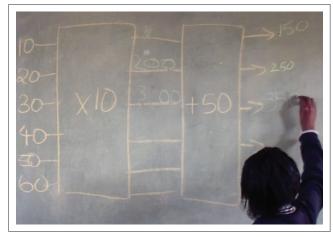
Numeric flow diagram

For the first activity, Ms P drew a numeric flow diagram on the chalkboard (see Figure 3) and called on individual learners to come up and show their classmates how each line should be filled in. Ten learners were called upon to assist in the completion of this task.

Noticeable throughout the process was Ms P's firm but encouraging style of interaction. So, for instance, after the first child had – in silence – correctly completed the first set of numbers in the flow diagram: 10 × 10 = 100 + 50 = 150, Ms P simply commented: 'Thank you. Very good, *sisi* [Girl]. Very good'. The second child Ms P called up to complete the next

set of numbers began by saying out loud: 'twenty times ten …', but he showed uncertainty about how to proceed. He tried counting out on his fingers, but this did not seem to work. He was still unable to complete the line. 'Who can help him?', Ms P asked. '*Hlala phantsi, bhuti*' [Sit down, Boy]. The boy's place was taken by a girl who, without hesitation, correctly filled in the answer to the first part of the flow diagram, saying: 'Twenty times ten equals two hundred', as she did so. Ms P then requested: '*Sisi. Uthethe sive, sisi* [Girl. Raise up your voice, Girl]', which the child did, repeating: 'twenty times ten equals two hundred', but she then faltered on the second step. Ms P gently tried to help her refocus: 'we are here now. Two hundred plus fifty?' As the girl continued to hesitate, Ms P sent her back to her seat and called up a fifth learner. Without uttering a word, the boy filled in the correct answer: 250, and returned to his seat. Ms P handed the chalk to a sixth learner: 'Okay, *sisi* [Girl]', she said. The child came up and correctly completed her designated line: 30 × 10 = 300 + 50 = 350 (Figure 3), but, as she prepared to return to her seat, Ms P called on her to share with her classmates how she had arrived at the answers: 'where did you get that three hundred and fifty?' and, in isiXhosa, '*Wenzeni?* [What did you do?]'. The learner indicated what she had done by simply pointing at each of the numbers and operational symbols (× and +) in the sequence that she had tackled them. Her gestures clearly showed that she understood both the task and Ms P's questions. Ms P did not press her to speak.

As the girl returned to her seat, Ms P handed the chalk on to the next learner. He came up, silently filled in the correct numbers: 40 × 10 = 400 + 50 = 450, and returned to his seat. An eighth learner then followed suit, completing the next line of the flow diagram: 50 × 10 = 500 + 50 = 550, but Ms P indicated that she required more from him: '*Wenze njani ndifuna uqonda apha kwenzeke ntoni?* [How did you get the answer? I want to know]', she said. Initially the boy simply pointed to each of the numbers in sequence to show the order in which he had correctly filled in his numbers, but Ms P insisted that he tell the class how he got the answer: '*Akuthathi ngobeka, uthi* five

Source: Robertson, S.-A., 2017, 'The place of language in supporting children's mathematical development: Grade 4 teachers' use of classroom talk', unpublished doctoral thesis, Rhodes University, Grahamstown, South Africa

FIGURE 3: A learner completing her designated line of the numeric flow diagram on the chalkboard.

hundred plus fifty equals five hundred and fifty. *Susiqhatha mfondini, susirobha, susirobha mfondini.* [You don't just write an answer. You say, 'five hundred plus fifty equals five hundred and fifty. Don't rob us [of your explanation]! Don't rob us, Man!']'. Ms P did not however press the boy to repeat what she had just said. Instead, she nominated another child to come up to complete the final line of the flow diagram, and, when he seemed uncertain, she called on another child for assistance. Once this second child had helped her classmate correctly fill in the sequence, Ms P asked, '*Ngubani impendulo?* [What's the answer?]', to which the girl confidently declared 'It's six hundred. And six hundred plus fifty, it's six hundred and fifty'.

We notice from these exchanges Ms P's use of code-switching; her attempts to get her learners to 'interthink'; her awareness also that her learners were at different levels of L2 proficiency, hence her acceptance in some cases of a child's reluctance to verbalise his or her answer; and her gentle yet firm pushing in other instances for children to verbalise their answers for the benefit of the class. As she subsequently explained in an interview, some learners baulked at speaking up because 'they used to laugh to each other when someone makes a mistake. … Then the other one will be withdrawn because of that. They don't want to make mistakes. They are scared of making mistakes'.
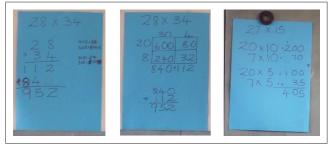
Two-digit multiplication task

For the two-digit multiplication task, Ms P allowed learners to choose which strategy they wanted to use. In an interview, Ms P explained:

> 'I want them to be comfortable with what they are doing, as long as they know what they are doing. And I can see the one who did this strategy is comfortable with this one. He can't do this one. So, I let them do the one they know'.

She had learnt about the multi-strategy principle through her participation in the South African Numeracy Chair's professional development project and expressed the view that it had had a positive effect on her learners' multiplicative reasoning. She described how, prior to this, she had simply taught the traditional vertical algorithm, which she found many of her learners struggled to fully grasp: 'it's not easy for them'. When, however, she introduced the other two methods (either decomposition or grid method), she found it had made more sense to her learners: 'these 2 – Wow! … when I came with this one … Wow! … It helps a lot'.

Using English, Ms P instructed the children: 'you do any method you know, *nhe* [you understand?]. You do any method you know. We did multiplication and we did three methods. Do you still remember them?' As she spoke, she gestured towards the three A4 manila poster-type sheets she had earlier put on the chalkboard, each with an example of a particular multiplication strategy (traditional vertical algorithm, grid method and decomposition) (see Figure 4).

Source: Robertson, S.-A., 2017, 'The place of language in supporting children's mathematical development: Grade 4 teachers' use of classroom talk', unpublished doctoral thesis, Rhodes University, Grahamstown, South Africa

FIGURE 4: Ms P's posters illustrating three strategies for solving two-digit multiplication tasks.

On finding some learners struggling with the traditional algorithm strategy, she recommended that they should choose either the grid method or decomposition. Before the end of the lesson, Ms P called for a 'whole-class' check of calculations. Two learners were selected to come up in turn to demonstrate on the chalkboard how they had used their chosen method of calculation. Neither child uttered a word as they demonstrated their strategy, but both completed their calculations quickly and accurately. These learners' use of gestures in place of speaking in demonstrating their respective strategies is consistent with the developmental trajectory in SLA, whereby the receptive language skills (comprehending input) invariably precede the productive skills (producing comprehensible output).

What we particularly noticed from this second set of examples is Ms P's giving learners the opportunity to exercise their procedural fluency (first in making a choice of strategy and then successfully executing it), and her exposing learners to such CALP-like terms as 'method' and 'strategy' as compared with, for example, using everyday descriptors such as 'this way' / 'that way'.

Discussion and concluding comments

We note that in mediating her learners' acquisition of both mathematical proficiency and proficiency in the academic language relating to mathematics, Ms P's practices are quite different from that of Ms M, the second teacher in the broader case study. We have reported on Ms M's classroom language practices elsewhere (Robertson & Graven 2019). Two main differences were evident in these teachers' mathematics classroom language practices. While there was a great deal of movement between the everyday BICS and CALP in Ms M's classroom talk practices, Ms P's approach was more directly oriented towards CALP-type mathematics classroom talk. She also made extensive use of her and her learners' isiXhosa L1, which Ms M, given her school context being 'a straight for English' one (Model A of Figure 1), could not. In relation to getting the balance right between 'inclusivity' (affirmation of cultural and linguistic identity) and 'access' (access to powerful forms of knowledge), we note that Ms P may have leaned towards the side of inclusivity in making such extensive use of isiXhosa. This choice may well have

reduced her learners' opportunities for practising their use of English, thus impeding their access to this powerful global language. Notwithstanding this, much of the whole-class lesson interaction was in English, and the learners' responses, both verbal and non-verbal, indicated that the questions and instructions Ms P put before them in English represented input that they found comprehensible (after Krashen 2009). This suggested adequate levels both of linguistic comprehension and of mathematical sense-making on the part of many of Ms P's learners. The figures provided in Table 1 support our contention that Ms P's (albeit uneasy) legitimising of her learners' use of L1 provided an additional linguistic and conceptual resource with which to engage in this sense-making, a resource which, as Swain, Kirkpatrick and Cummins (2011) remarked, would be both futile and counter-productive to deny them.

The small-scale nature of the broader case study from which Ms P's data came means that the insights offered in this article are far from generalisation. In noting this, however, we note also Stake's (1995:10) submission that 'the real business of case study is particularization, not generalization'. Having shared some particulars of Ms P's language practices, and having contextualised our discussion of these practices within professional literature on SLA and on some ways for mediating the challenges encountered in multilingual teaching and learning environments, we are positive that mathematics teachers and researchers working in contexts similar to Ms P's school can 'relate' to some of the challenges Ms P faced and to some of the ways in which she chose to deal with these challenges. In voicing this hope, we close with Bassey's (1981:85) much-quoted statement in which he suggested that 'the relatability of a case-study is more important than its generalisability'. It is our hope that such case study stories build towards influencing policy. We are pleased to have heard from the teachers at Ms P's school that their school has been selected to participate in a provincial DBE trial where learning through mother tongue isiXhosa has been extended to include Grade 4, and, subsequently, Grade 5. The Eastern Cape's Director of the Language in Education Policy Unit was reported as saying that learners 'had a considerably better chance at succeeding in life if they are taught in their mother tongue' (Linden 2017:1 of 2, online source). In concurring whole-heartedly with the Director's point, we note in particular that such expansion of learners' access to their mother tongue is fully consistent with the points highlighted in our review of Cummins's (2005) ideas relative to ways for enhancing bilingual students' opportunities to learn. Eastern Cape parental reactions to such a move were, however, mixed. While one parent is reported as having described teaching in isiXhosa as 'rather useless', another parent apparently indicated that he was '100% behind his children being taught in isiXhosa', adding that 'they now understood their school work better' (Linden 2017:2 of 2, online source). Divergent views notwithstanding, we are encouraged by this evidence of a greater willingness to explore alternative ways for approaching the LoLT question in order that language may become a genuine resource for sense-making in our multilingual classrooms, rather than, as is so much the case currently, a barrier.

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Competing interests

The authors have declared that no competing interests exist.

Authors' contributions

The first author (S.-A.R.) was a post-doctoral research fellow of the second author (M.G.). This article emerged from the first author's doctoral thesis, supervised by the second author. In writing the article, while most of the actual writing was done by the first author, the second author provided considerable input in terms of contributing to discussions around the article's initial conceptualisation, responding to earlier drafts of the article and providing constructive suggestions regarding the overall content.

Ethical considerations

To proceed with her doctoral research, from which this article is derived, the first author submitted written research proposal for consideration by her Faculty's Higher Degrees Committee in April 2014. The approval granted by the Higher Degrees Committee (23 April 2014) was then tabled with the university's Education Faculty Board and ratified at its Faculty meeting (07 May 2014). Permission was then sought from and granted by both the teachers and their respective principals that the research will be conducted as proposed in the Grade 4 mathematics classrooms of their schools. Then, letters were sent out to the parents or guardians of the Grade 4 learners at these schools, outlining the purpose of the research and reassuring them about the liberty to refuse participation of their children. Once permission had been obtained from all the relevant local stakeholders, permission was then sought from the Superintendent-General of the Eastern Cape Provincial Education Department. This application was formally approved on 01 September 2014. The research followed all ethical protocols, including voluntary participation, informed consent, the right of withdrawal, the right to confidentiality and the preservation of anonymity through the use of pseudonyms in referring to the relevant institutions and the individuals within them.

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Data availability statement

Data sharing is not applicable to this article as no new data were created or analysed in this article. Data from the first author's doctoral research work were used in the writing of this article.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors.

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