

Yes, it is “immersion” of a sort, but not one that conduces to mathematical sense-making

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Immersion models require the concurrent teaching of mathematics and of a second language. Research evidence suggests that few teachers possess sufficient pedagogical knowledge and skill to manage both these tasks adequately. The argument in this position paper is that the construct of ‘language-as-resource’ offers a more equitable bridging pathway into mathematical sense-making than do many immersion models, and this is illustrated using examples from South African schools.

This paper provides a theoretical discussion of the challenge of making mathematical meaning when learning takes place through a second language (L2). Our goal is to provide some reflective critique of, and stimulate further discussion on, immersion/submersion practices. At MERGA 2018 we based a conference presentation around a South African 4th grade teacher’s struggle to mediate her students’ mathematical sense-making in an L2 setting (Robertson & Graven, 2018a). During question time we were asked whether this learning context was not simply ‘immersion’, and, if so, why the deficit story when so many immersion stories are successful. We acknowledge that in English-medium South African schools in wealthier areas, immersion of non-English-speaking students has mostly been successful. For the context we were describing, however, immersion took such a subtractive form that the experience of these Grade 4 students and their teacher was more akin to ‘submersion’. On subsequent reflection we resolved to explore this immersion/ submersion tension in more detail. As migration trends globally continue to create more linguistically-heterogeneous classrooms, immersion/submersion tensions play out increasingly across mathematics educators’ practice landscapes. In contributing to discussion around ways for making more equitable the mathematics education experiences of students in immersion/submersion contexts, we draw on two areas of research literature: First, literature on the value of dialogic pedagogies for strengthening students’ mathematical sense-making; second, literature around second language acquisition, particularly in relation to where L2 is to be used for academic purposes. We illuminate our discussion with empirical data from two South African Grade 4 mathematics classrooms, asking the question: ‘Of the two different immersion/submersion models observed here, which appears to better conduce to mathematical sense-making?’

Contextual framing

A variety of immersion models exist. Sound immersion programmes aim at “developing fluency in an initially unknown language through content-based teaching in the second/foreign language, at no expense to the home/first language of the students” (Swain & Lapkin, 2005, p. 170). At the most additive end of the bilingual education spectrum, the addition of a second language into the pedagogic mix neither replaces nor displaces a student’s L1 (Baker, 1993), and the student is thereby helped to achieve linguistic and literacy proficiency in *both* languages commensurate with curriculum content demands. At the other end of the spectrum, however, where ongoing support for a student’s academic development in the L1 is absent and content teaching takes place exclusively through the

2019. In G. Hine, S. Blackley, & A. Cooke (Eds.). *Mathematics Education Research: Impacting Practice (Proceedings of the 42nd annual conference of the Mathematics Education Research Group of Australasia)* pp. 604-611. Perth: MERGA.

L2, the resultant erosion, loss even, of the L1 (Baker, 1993) effectively constitutes 'submersion'. The immersion programmes developed in Canada's Quebec province in the mid-1960s are reflective of some of the best immersion practices. Initial impetus for developing these was a desire to promote French/English bilingualism and biliteracy. We note in passing that French and English enjoy more closely equivalent status as international languages, than would, for example, be the case between English and one of South Africa's indigenous African languages. Equivalence of status undoubtedly represents one significant 'buy-in' factor contributing to the success stories coming out of Canadian immersion programmes. Canadian programmes have been emulated to varying degrees elsewhere, though there has also been some misappropriation of the term 'immersion' to describe programmes more subtractive in nature (Cammarata & Tedick, 2012). At the most subtractive end of the immersion continuum lie 'submersion' programmes, alternately termed "sink-or-swim" programmes (Cummins, 2007, p. 165). In such programmes, students are plunged into learning content through an L2 with limited formal support for or access to the L1.

Submersion features commonly in South African schools. Macdonald (2002) likened the ensuing "linguistic and conceptual challenges" for learners in such contexts to "swimming up the waterfall" (p. 111). Consistent with South Africa's post-apartheid democratic commitments, the country's Language in Education Policy gives the individual the right to choose the language of learning and teaching. Although policy indicates that this right ought to "be exercised within the overall framework of the obligation on the education system to promote multilingualism" (Department of Education, 1997, p. 1), in practice the trend in South African schools has been towards monolingualism. Many parents of Black African students do not 'buy-into' the idea of mother-tongue education. Their memories of 'divide-&-rule' practices under apartheid make them distrustful of mother-tongue education (Nomlomo, 2006). They see English, given its power and status, as the language most likely to improve their children's chances of accessing 'social goods' (Setati, 2008). Thus, despite it being the L1 for less than 10% of the South African population (Stats SA, 2012), English is, by Grade 4, the chosen official language of teaching and learning (LoLT) for 80% of the country's school students (Department of Basic Education, 2010). South Africa's poorer, mostly Black African, students have been especially compromised by having to cope with the increased cognitive-processing load that learning mathematics through an L2 involves, and the fact of high numbers of students learning through an incompletely mastered L2 has been directly implicated in South Africa's low levels of achievement in school mathematics in both national and international assessments (Reddy et al., 2016; Taylor & von Fintel, 2016). Given mathematics' vertically-integrated conceptual structure, incomplete or confused understandings around just a few conceptual building blocks can have cumulative, potentially irredeemable consequences for progression. By third grade assessment data show that gaps of as much as three years' worth of learning have opened up between the poorer children attending South Africa's non-fee-paying schools and those attending its wealthier fee-paying schools (Spaull & Kotze, 2015). The scale of this learning gap problem is huge: Children in non-fee-paying schools (located mostly in areas where little English is spoken except within the classroom context) represent the majority of the country's students.

Literature review

One of many positive outcomes deriving from sociocultural theory (Vygotsky, 2012) is its having so powerfully drawn attention to the mediating role of language and the importance, therefore, of well-structured classroom dialogue in mediating students' sense-making (Green & Joo, 2016). There has been exponential growth over the past four decades in the number of research publications focusing on classroom dialogue (Howe & Abedin,

2013), and, in particular, on dialogic pedagogies, through which students are helped to capitalise on “the power of talk to foster thinking, learning, and understanding” (Kim & Wilkinson, 2019, p. 72). Prominent among researchers in the area of dialogic pedagogy are Mercer and colleagues with their ‘Thinking Together’ project (Britain) (see, for example, Mercer & Dawes, 2014); and Resnick, Michaels, O’Connor and colleagues with their work around ‘accountable talk (United States) (see, for example, Resnick, Michaels & O’Connor, 2018). For an example of Australian initiatives around meaning-making and dialogic classrooms, see Edwards-Groves and Davidson (2017). Each of these initiatives highlights the value of students pooling their social and cognitive resources: first to share, and then to expand upon, their current understanding/s of curriculum content.

Creating environments conducive to such pooling of resources has proved difficult. Studies of mathematics classrooms, including two recent South African studies (Westaway, 2017, and Robertson, 2017) reveal a persistence of teacher-dominated, monological-type classroom exchanges characteristic of the initiation-response-evaluation/-feedback structure first empirically identified by Sinclair and Coulthard (1975). Notwithstanding Lemke’s (1990) labelling this three-part exchange structure the ‘triadic dialogue’, dialogue, *per se*, featured only rarely. Rather, in both studies, a predominance of what Barnes (2010) termed ‘right answerism’ was observed: teachers’ repeated use of closed questions to solicit information on things already taught. This practice of ‘right [or, in many instances, ‘wrong’] answerism’ functioned to constrain students’ opportunities to move forward, and, through thinking aloud together, talk their way into new understandings (Barnes, 2010).

A concurrent focus on mathematics curriculum content and on developing students’ academic language proficiencies requires that mathematics teachers working in immersion contexts need also to be teachers of second language. Research indicates, however, that “most immersion teachers lack pedagogical content knowledge when it comes to language”; plus, “our understanding about content and language integration in immersion teaching remains incomplete” (Cammarata & Tedick, 2012, p. 254). Optimising the blend between focusing on linguistic ‘form’ (lexical and syntactic features of L2 relevant to particular curriculum content), focusing on linguistic ‘function’ (ways of ‘making meaning’ appropriate to this content) and focusing on actually teaching this content is a challenge that calls for extensive understanding of second language acquisition principles.

Krashen’s controversial distinction between ‘acquisition’ and ‘learning’, and his claim that “formal rules, or conscious learning, play only a limited role in second language performance” (2009, p. 16) may have led to some underestimation of the challenge immersion teachers face in helping students become sufficiently proficient in an L2 to cope academically. For Krashen (2009), effective language teaching involves creating low anxiety situations in which input (i) is pitched just a little beyond students’ current levels of understanding (‘i+1’). Current theory sees both acquisition (which may indeed be largely unconscious) and learning (requiring explicit attention) as contributing to second language acquisition. Further, while acknowledging the importance of comprehensible input (which mainly develops the *receptive* language skills of listening and reading), other language theorists, Swain and Lapkin (1995), for example, stress the importance also of ‘comprehensible output’. This is what forces students to practise their *productive* language skills (speaking and writing). Receptive skills can rely on top-down processing (for example, using context and prior knowledge to help make sense of input), but productive skills require a much more deliberate, explicit focus on a language’s bottom-up linguistic elements (such as pronunciation, vocabulary selection and syntax). And finally, ‘negotiation’ (after Pica) of both input and output is seen as important: “When it comes to comprehension, negotiation appears to be a powerful commodity” (Pica, 1994, p. 505).

In an immersion mathematics classroom learning mathematics content in an L2 has the potential to provide students with plenty of exposure to the L2. The potential exists also for using the L2 for authentic *and* important communicative purposes. Our own observations, however, of some English LoLT mathematics classrooms in South African primary schools suggest that neither potential is being optimally realised (see, for example, Robertson & Graven, 2018b). The observed predominance of ‘right answerism’ in these teachers’ mathematics teaching practices, and the absence of dialogic-type interactions, served to restrict the quantity as well as the quality of both input and output. This is further complicated by the fact that few of the teachers with whom we have had contact in our region have language teaching experience. Most see themselves as teachers of mathematics, not teachers of English language. Further, most are not themselves native speakers of English; they are native speakers of the indigenous African language of the region: isiXhosa. Because, however, there is such ambivalence around use of African ‘mother tongue’ in classrooms, when comprehension break-downs do occur, opportunities to negotiate meaning using the L1 that teachers’ and students’ share are often avoided: “decision makers at many levels tend to work on the assumption that children will ‘get by’ if schooling in mother tongue is not available” (Pinnock & Vijayakumar, 2009, p. 11). Where minority students fail to ‘get by’, Cummins (1979) suggested that, rather than simply attributing this to socio-cultural and socio-economic factors, questions ought to be asked also around submersion/immersion circumstances, particularly in submersion situations, given students’ lack of official access to L1. Other things being equal, it is widely accepted that it is simpler, more efficient, and probably most effective to develop initial literacy, numeracy and early curriculum content knowledge through the L1 (Ouane, 2003). Once established, as Cummins’s (1979) linguistic interdependence hypothesis articulated, common underlying literacy- and numeracy-based knowledge and skills in the L1 *transcend* surface feature differences between languages (in terms, for example, of vocabulary, pronunciation and grammar). Linking this to the distinction Cummins makes between BICS (basic interpersonal communicative skills) and CALP (cognitive/ academic language proficiency), (see, for example, Cummins, 2017), it follows that in the process of second language acquisition, any CALP a student may have in his/her L1 is transferable across into an L2. CALP here refers not simply to understanding of equivalent specialist vocabulary (for example, ‘addition’ and its isiXhosa equivalent ‘udibaniso’), but also to academic skills such as reading mathematical texts for their meaning; recognising differences between *explaining* a mathematical procedure and *discussing* which strategy might be more efficient for solving a particular mathematical problem, and so on. In examining ‘appropriate use of L1’ in immersion classrooms, Swain and Lapkin (2013) note the futility of barring L1 usage from a classroom. No matter how strict the embargo placed on its usage, a proportion of students’ inner languaging (‘languaging’ being the term Swain introduced to capture the act of using language to mediate cognition) and their languaging with classmates will (even if, perforce, covertly) be done in the L1. Analysis of languaging practices in immersion classrooms revealed that students used their L1 in three main ways: to ‘move a task along’ (for example to unpack and make sense of the requirements of the task); to ‘focus attention’ (to, for example, search for equivalent L2 lexical and syntactic information); and for ‘interpersonal interactions’ (for example, for resolving differences of opinion) (Swain & Lapkin, 2013, pp. 109-110). These findings led to their recommendation that students be permitted to use L1 in immersion contexts, but that this needed to be in pre-agreed, purposeful ways.

‘Submersion’ as compared with ‘immersion’: Classroom observations

Classroom observations took place under the umbrella of a broader case study. The study, located within a qualitative and interpretive framework, explored Grade 4 mathematics teachers’ use of classroom talk and how such talk appeared to enable and/or constrain mathematical meaning-making. Data, based on teacher interviews and classroom observation at two schools, were collected. Thirty-one mathematics lessons were observed across four teaching weeks. Audio-/video-recordings were made of each lesson and interview. Recordings were transcribed verbatim for subsequent analysis. Data from the broader study for both sites revealed low levels of student verbal participation in the observed lessons. (For further methodological detail, including discussion of the ethical protocols observed, see Robertson (2017).)

Both of the observed classrooms, taught by Ms M and Ms P respectively (pseudonyms), are in township schools (‘township’ being the term used in referring to the urban residential areas specifically designated for ‘non-whites’ during South Africa’s apartheid era). Both schools cater for students from less affluent sectors of the broader community, but Ms M’s school is fee-paying, Ms P’s is non-fee-paying. Students at both schools are native speakers of isiXhosa, as are Ms M and Ms P. Both teachers are competent bilinguals. While it was not possible to provide accurate assessments of students’ levels of English proficiency, their observed productive use of English was of a very limited sort. Few student responses to teachers’ questions during the observed mathematics lessons extended beyond two- to three-word phrases. This stood in stark contrast to their observed verbal interactions in their native tongue, both inside and outside of lesson time.

The language policy chosen by Ms M’s school is ‘straight for English’. English is the school’s LoLT from Grade 1. All subjects, except for isiXhosa lessons, are taught in English. IsiXhosa is taught as the students’ ‘first additional language’; English is taught as their ‘home language’. (Therein lies a policy anomaly, which is outside of the present paper’s brief, but see our discussion in Robertson & Graven, 2018b). The language context for Ms M’s school is therefore one of relative submersion and an example of *subtractive* bilingualism. While use of isiXhosa outside of isiXhosa lessons is condoned to a certain extent, use of English during the remaining lesson times appears strictly enforced, and formal assessment is exclusively in English. In the course of the observed mathematics lessons, Ms M used isiXhosa only rarely. This infrequent usage was for some of her one-to-one exchanges with some students. Her whole-class teaching was exclusively in English. Between students, however, exchanges were mainly in isiXhosa.

The chosen language policy at Ms P’s school is ‘early exit’. For their first three years of school, students’ native isiXhosa is the LoLT; English is taught as their first additional language. Initial literacy and numeracy development is done through isiXhosa. Grade 4 marks the official transition to English as LoLT. Consistent with the Language Policy’s principle of additive bilingualism, however, considerable use of isiXhosa continued during the observed lesson times. Ms P seemed not to be aware of this consistency, expressing unease about using so much isiXhosa: “I am supposed to teach them in English, but they don’t understand. ... so – most of the time, I speak Xhosa – the one that they understand” [Interview comment]. The language context for Ms P’s school may be seen to more closely approximate immersion than the practice in Ms M’s school, albeit that Ms P’s switching between L1 and L2 lacked the ‘systematicity’ of more formalised immersion models.

In relation to second language acquisition, the verbal interaction in L2 in both classrooms followed an ‘initiation-response-evaluation’ format. Some student responses suggested that neither Ms M’s nor Ms P’s input had been fully understood. No student ‘negotiation for meaning’ was observed, so it was not possible in those instances to determine whether

comprehension breakdowns were a result of a linguistic difficulty or of a mathematical one. No student verbal initiations were observed, and the brevity of their responses to their teachers' initiations were such that these failed to constitute the sorts of sustained output practice envisaged as necessary by language learning theorists. Further, in relation to developing linguistic (as opposed to content) proficiency, verbal feedback from Ms M and Ms P was exclusively content-focussed with little attention to linguistic form or function beyond occasional reminders relating to mathematics vocabulary. This is illustrated in the following utterance from Ms M during one observed lesson: "The 'sum' ... what do we do when we hear the word 'sum'? What do we do with the numbers? What do we do?" In neither classroom were the students and their teachers operating fully within their linguistic comfort zones. Because of the strict application of 'straight for English', this was particularly the case for Ms M and her students. The situation was mitigated, perhaps, by the slightly better socio-economic status of her students as compared with those attending Ms P's school (a majority of whom live in circumstances of abject poverty). The parents of most of Ms M's students were in employment, and thus able, and to her chagrin, more willing, to pay for things such as "TV, play-station or cell-phones – of which you've warned them not to do because they should rather buy reading books" [Interview comment]. This meant that, in addition to their extensive exposure to English during lesson time, these students are also likely to encounter more English in their homes than do Ms P's students. Ms P's students, on the other hand, had greater access to their L1 as a meaning-making resource. Justifying her extensive use of L1 during the observed mathematics lessons, Ms P remarked that while one or two of her students could follow in English, many could not: "Those kids – if you are talking – speaking - English – yoh! – it's like you are not talking." [Interview comment]. Her extensive use of isiXhosa did, however, mean less exposure to English.

Concluding comments

On the basis of the foregoing discussion, including our review of literature relating to the development of linguistic and academic proficiency in an L2 through content-based teaching, we suggest that neither of the two observed classrooms (neither the one closer to immersion in terms of its additive approach to bilingualism; nor the other closer to submersion because of its subtractive approach to bilingualism) is optimally placed to achieve the dual goal of proficiency both in mathematics and in the target L2 (English).

We note that the bulk of research literature around immersion/submersion issues appears to come from a language-teaching perspective, resulting in an emphasis on identifying and articulating strategies for optimising language learning and literacy development in bi-and/or multilingual contexts. Swain (1988) noted "typical content teaching is not necessarily good language teaching. Appropriately, content teaching focuses on comprehending meaning" (p. 81). While her article included useful recommendations for how to work towards optimising the balance between L2 linguistic form and L2 linguistic function, there was little in the way of how to at the same time achieve powerful content learning. In one of her later articles, co-written with Lapkin (2013), it is acknowledged that L1 languaging appears to be "an essential, beneficial and efficient route to L2 development" (p. 124). This credit notwithstanding, Swain and Lapkin's allegiance clearly remains with second language learning, rather than with content learning.

In concluding our discussion of immersion/submersion tensions, we acknowledge the burdens that are to be found throughout the continuum. These burdens fall on teachers and students alike and a great deal of research will be necessary before they are lightened. Given that *our* target commitment is to mathematics learning, however, we argue that, until such time as there is a large corps of mathematics teachers with the requisite language teaching expertise needed to truly cope in either immersion or submersion contexts, it would be better

to uncouple language teaching and learning from mathematics teaching and learning, and focus instead on strengthening the ‘language-as-resource’ construct (after Ruiz, 1984; see, for example, Setati, Molefe and Langa, 2008): a construct which legitimates students’ use of whatever language resources they have at their disposal - whether these derive from their L1, their L2, or a combination thereof - in their pursuit of mathematical sense-making. In the South African context, this would have the added benefit of relieving Ms M and Ms P and other mathematics teachers in similar positions of their sense of unease about using the language they share with their students to mediate meaning in their mathematics lessons, and so, perhaps, increase the likelihood of their engaging in more dialogic teaching practices. This could almost certainly represent one small but important step towards re-mediating the learning gaps between rich and poor identified earlier in the paper.

Acknowledgement

This work is based on the research supported by the South African Research Chairs Initiative of the Department of Science and Technology and National Research Foundation (Grant No. 74658).

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