THE PLACE OF LANGUAGE IN SUPPORTING CHILDREN'S MATHEMATICAL DEVELOPMENT: TWO GRADE 4 TEACHERS' USE OF CLASSROOM TALK

A thesis submitted in fulfilment of the

requirements for the degree of

DOCTOR OF PHILOSOPHY

RHODES UNIVERSITY

by

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November 2017

STATEMENT OF ORIGINAL AUTHORSHIP

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

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ABSTRACT

Measures of mathematics achievement (documented locally, and in internationally comparative terms) have shown that South African learners whose first language (L1) is different from their language of learning and teaching (LoLT) are at a significant disadvantage, most particularly learners from vulnerable or marginalised communities. This transdisciplinary case study looks at two experienced Grade 4 teachers' mathematics classroom talk practices. It is situated within a second language (L2) teaching/learning context in which teachers and learners share the same first language, but mathematics learning and teaching takes place officially through an L2 (English).

The study is located within a qualitative and interpretive framework. It brings together insights from a range of distinct but complementary theoretical disciplines in its analysis of the empirical classroom observation and interview data. Its theoretical framing derives initially from professional literature relating to L2 teaching and learning. This is then embedded within a broader theoretical frame deriving from the work of Vygotsky, Bernstein and Halliday, each of whom has focussed on the centrality of language to the teaching/ learning process, as well as contributed to a heightened appreciation of socio-cultural influences on learners' meaning-making processes.

The study illuminates some of the linguistic challenges to L2 children's maximal participation in the learning of school mathematics. It points too to the significant challenge many South African mathematics teachers face in trying to meet curriculum coverage and pacing demands, while simultaneously facilitating their learners' ongoing induction – in and through L2 predominantly – into mathematically-appropriate discourse. Grade 4 is a year in which such challenges are often more acutely felt. Independently of the transition across to an L2 for the majority of South African learners, this is the year also where - relative to the foundation phase years - learners encounter an expansion of knowledge areas and more specialised academic text. Many learners struggle to adjust to these higher conceptual and linguistic demands, often leading to what has been termed a 'fourth-grade slump'.

The study highlights the need for more sustained and proactive challenging of perceptions that English as LoLT is the obvious route to educational - and subsequent economic - opportunity. Recognition of the consequences deriving from the choice of English as the main LoLT for mathematics teaching and learning could help counterbalance deficit discourses implicating poor teaching as a major contributor to South Africa's poor mathematics education outcomes.

The study highlights further that, if language is genuinely to be used as the 'tool' for learning it is claimed to be, synergistic opportunities for the dovetailing of insights into L2 learners' literacy/ numeracy development require further exploration. It points to the need for ongoing professional development support for teachers of mathematics (at both pre- and in-service levels) that focuses on broadening and deepening their understandings around the linguistic, and hence epistemological, consequences of learning mathematics through an L2. Expanding mathematics teachers' repertoires of strategies for supporting learners' developing cognitive academic language proficiency (CALP) in mathematics (in both L1 and L2) would involve a

conception of ‘academic language’ in mathematics which goes beyond a constrained interpretation of ‘legitimate’ mathematical text as that which is in texts such as curriculum documents and text books. Especially important here are strategies which foreground the value of classroom talk in assisting L2 children towards becoming more confident, competent and *explorative* bilingual learners, and thereby, more active agents of their own mathematical meaning-making processes. The study argues that such meaning-making processes would be further strengthened were *additive* bilingualism (in place of current predominantly subtractive practices) to be genuinely taken up as core to any teaching and learning of mathematics in contexts such as those described in this case study.

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LIST OF ACRONYMS

ANA: Annual National Assessment
BICS: Basic Interpersonal Communicative Skills
CALP: Cognitive Academic Language Proficiency
CAPS: Curriculum and Assessment Policy Statement
DBE: Department of Basic Education
DHET: Department of Higher Education and Training
DoE: Department of Education
EFAL: English First Additional Language
EHL: English Home Language
FAL: First Additional Language
FET: Further Education and Training
FP: Foundation Phase (Grades 1-3)
HL: Home Language
IP: Intermediate Phase (Grades 4-6)
L1: Referring to the first (home or mother-tongue) language
L2: Referring to a/the second language
LiEP: Language in Education Policy
LO: Learning Outcome
LoLT: Language of learning and teaching
NCS: National Curriculum Statement
NICLE: Numeracy Inquiry Community of Leader Educators
OBE: Outcomes-based education
OECD: Organisation for Economic Co-operation and Development
PISA: Programme for International Student Assessment
Q: Quintile
SANC: South African Numeracy Chair
SANCP: South African Numeracy Chair Project
SFL: Systemic Functional Linguistics
SLA: Second Language Acquisition
TIMSS: Trends in International Mathematics and Science Study
ZPD: Zone of proximal development

ACKNOWLEDGMENTS

I owe several debts of gratitude to people who – in both big and small ways – have contributed towards making this PhD journey feel as enjoyable and worthwhile as it has been.

Thank you first and foremost to my supervisor, Professor Mellony Graven. From the moment Mel invited me into her South African Numeracy Chair space, she has been a remarkable source of inspiration. Her generosity of spirit, her enthusiasm, and her superb intellect have kept me energised and motivated throughout. It has been an absolute joy working with her. I want here to thank also Sarah Murray; my friend, mentor, masters' degree supervisor and valued colleague. Sarah helped me towards a much deeper understanding of how language works, and of how literacy might best be taught so as to make positive differences for learners confronting the challenge of learning in and through a second language.

Thank you to Ms M and Ms P for welcoming me into their Grade 4 classrooms, and for their generous sharing of insight around some of their challenges at the mathematics/ language interface. Thank you too to their respective Principals. And thank you also to the Grade 4 Class of 2014. I saw so much potential in these young people. I hope that life's circumstances treat them gently.

Thank you to my Departmental colleagues. I greatly appreciate and value their friendship, support, and encouragement, and thank them for the times they stepped in to cover for me during periods of study and other leave.

Thank you to the Rhodes University Library staff for their always efficient support. In particular, I thank Nicolene Mkhathali.

Thank you to the Rhodes University hierarchy, in particular the office of Dr Peter Clayton, Deputy Vice-Chancellor (Research and Development), for funding support, and for granting me the study leave I needed in order to complete this work. I am indebted also to the South African Numeracy Chair Initiative of the FirstRand Foundation (with the Rand Merchant Bank), Anglo American Chairman's Fund, Department of Science and Technology and the National Research Foundation for their financial and logistical support.

Thank you to Sash, Noma, Nombulelo, Sarah and Mareial for their help with my data transcription challenges, and a special thank you to Dr Pam Vale. She has been incredibly generous in terms of time and expertise in helping me attend to the final formatting of this thesis document. Pam, together with Drs Lucy Sibanda and Lise Westaway, has been a fellow traveller along the PhD road. My congratulations to all three of them. My only regret was my falling behind them in crossing that finishing line!

And finally, I thank my lovely family: my husband, Sirion; our son and daughter-in-law, Justin and Robyn; and their three beautiful little boys, Rory, Baxter and Tyler. Thank you for all the love and support you have given me. You have had to weather for far too long a 'half presence' on the home front. To Sirion especially: thank you for having been so wonderfully patient, generous and encouraging throughout this lengthy journey. Thank you for your wisdom; for the (endless!) cups of tea late into many nights; and for your repeated reminders that I should stick to working in *linear* fashion on this thesis.

I close these Acknowledgements by listing the publications and presentations I have generated since becoming a member of the SANC Project. I am grateful to Mellony and the rest of her SANC team for their collegiality and unstinting motivational and intellectual support in helping towards the production of these.

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Robertson, S-A., & Graven, M. (under review). A socio-linguistic perspective on the struggle to move beyond ritualized teaching in supporting numeracy learning in and through a second language. [Special Issue: *Educational Studies in Mathematics*.]

Robertson, S-A., & Graven, M. (under review). Using a transdisciplinary framework to analyse mathematics classroom talk. [Special Issue: ZDM *Mathematics Education*.]

Robertson, S-A., & Graven, M. (2017, November). *Challenges to transitioning from ritual to explorative participation in mathematical sense-making*. Paper presented at the South African Research Association for Early Childhood Education (SARAECE) Eastern Cape Regional Conference on Re-Imagining Early Childhood Education in South Africa, Rhodes University, Grahamstown.

Part 1: Introduction to the study

CHAPTER 1: CONTEXTUALISING THE STUDY

CHAPTER 1: INTRODUCING AND CONTEXTUALISING THE STUDY

> *We internalize talk, and it becomes thought. We externalize talk, and it becomes our link to social reality. We elaborate talk, and it becomes our bridge to literacy.*
>
> (Rubin, 1990, p. 3)

1.1 INTRODUCTION

This case study investigates the role of language in supporting children's mathematical development. Its particular focus is on how two teachers (Ms M and Ms P)[1] use classroom talk in mediating children's mathematical learning at the Grade 4 level. The thesis's subtitle: 'Grade 4 teachers' use of classroom talk' is not to imply an emphasis on *teacher* talk (though the data do indeed show a predominance of teacher talk). Rather, its purpose is to turn the spotlight on some of the ways in which the participating teachers *used* talk (theirs and their learners') in the observed mathematics lessons.

The issue of language in relation to mathematics education has become a source of concern in many parts of the world, particularly in the last 30 years (O'Halloran, 2015). Challenges relating to the language of mathematics are perhaps most acutely felt in countries where an overwhelming majority of learners are learning their mathematics through a second language (L2).

The crucial role of talk in the teaching/ learning process too has received increasing attention these past decades as views about what constitutes 'knowledge' and our understandings of the elements contributing to optimal circumstances for 'knowledge building' evolve. In relation to mathematics, Lerman (2000) specifically highlighted what he called a 'social turn' in which "the traditional mathematical pedagogy of transmission of facts" (p. 22) was challenged, opening the way for a more interactive view of knowledge building processes. The 'social turn', he argued, contributed to ideas about "meaning, thinking, and reasoning" being viewed as much more 'situated' "products of social activity" (Lerman, 2000, p. 23) rather than simply the outcome of detached and ostensibly objective reasoning by an individual learner.

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1 In line with the commitment to ensure confidentiality and anonymity (see Section 3.6 of Chapter 3), I invited the two teachers to choose their own pseudonyms. 'Ms M' and 'Ms P' were the pseudonyms they chose for themselves. Similarly, where I cite specific instances of classroom talk during which Ms M or Ms P addressed questions or comments directly to particular learners by name, I have replaced children's actual names with ones taken from an online list of Xhosa first names (retrieved June 13, 2016, from https://standiwe.wordpress.com/2012/03 /16/xhosa-names-their-meanings/).

Acknowledgment of, and research into, the social and cultural (as opposed to purely cognitive) dimensions of learning, has highlighted the centrality of social interaction. It is through such interaction that learners engage in actively 'negotiating' and thereby 'making' meaning of classroom activities. The emphasis on social interaction (in cultural context) has been fuelled in large measure by insights deriving from Vygotsky's sociocultural[2] ideas. These ideas, as I explain later, provide one of the main explanatory and analytical lenses for the present study.

Renshaw (2004) described the "construct of 'dialogue' [as] a generative one", bringing together as it does, "researchers whose primary interest is in the link between speaking and thinking, between the social and the individual" (p. 2). Writing about children's meaning making in the science classroom, Scott (1998) noted the growing influence of Vygotskian thinking on "how meanings are developed through language and other semiotic means in the classroom" and an increasing focus on "the ways in which understandings are developed in the *social context* [italics added] of the ... classroom" (p. 46). In relation to mathematics learning, Walshaw and Anthony (2008), on the basis of their review of mathematics classroom research literature, pointed to the "large body of empirical and theoretical evidence ... demonstrating the beneficial effects of participating in mathematical dialogue in the classroom"; indeed, that "effective instructional practices *demand* students' mathematical talk" (p. 523) [italics added]. In referring to their own research in primary mathematics classrooms conducted some years earlier (2002), however, these authors noted, that many children "did not know how to explain their mathematical ideas" and that many "were decidedly ill at ease [about sharing] their thinking with others (Walshaw & Anthony, 2008, p. 524). The onus, they noted, lay with the teacher to carefully induct (or socialise) learners into appropriate ways of participating in mathematical dialogue.

Barnes (in Mercer & Hodgkinson, 2008, p. 2) notes, "The communication system that a teacher sets up in a lesson shapes the roles that the pupils can play, and goes some distance in determining the kinds of learning that they engage in." Implicit in this is a 'social practice' view of language which, as Street (2005) notes, is more about "language as a resource rather than as a set of rules" (p. 136), a point echoed by local academics, particularly Adler and Setati, in their research into mathematics teaching and learning in multilingual South Africa (see, for example, Adler, 1998, 1999, 2001; Setati, 2008; Setati, Molefe & Langa, 2008).

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2 I have throughout used the non-hyphenated forms 'sociocultural' and sociolinguistic' when referring to the *theoretical frameworks* these words describe. In referring, however, to 'socio-cultural' and 'socio-linguistic' *circumstances*, I use the hyphenated form.

I became interested in examining patterns of Grade 4 teacher-learner talk in mathematics lessons in my region (Eastern Cape Province, South Africa) so as to begin identifying possible links between these patterns and the learning that appears to be taking place in such classrooms. The impetus for this study comes from ongoing concerns about the quality of such learning. South African learners' low levels of achievement in mathematics are well-documented both locally (see, for example, Fleisch, 2008; Graven 2014a), and in internationally comparative terms (Moloi & Strauss, 2005; Reddy, 2006; Moloi & Chetty, 2010; Spaull, 2013a; Reddy et al., 2016[3]). I briefly share some aspects of these attainment levels in Sections 1.10 and 1.11 of this introductory chapter. Such levels are testimony to the distressing reality that in a great many South African mathematics classrooms, children struggle with the meaning-making process. In reference to South African children's low levels of numeracy and literacy, Jordaan (2011) argued as follows:

> … one of the most important reasons for the poor achievement of South African learners is that the pivotal role of language in education is neglected in curriculum and in teacher-training programmes, resulting in limited language awareness, and consequently inadequate teaching methods that lead to language difficulties across all curriculum areas. This is a problem irrespective of whether English or one of the African languages serves as the medium of instruction, or is the subject of study. (p. 1 of 12, online article)

In the remainder of this chapter I outline first the broad goals of the study and then spell out the research questions I used to pursue these goals. Having done this I identify some of the factors that motivated my decision to focus on teachers' use of talk in mathematics classrooms. I then provide an initial overview of the research sites of the study and contextualise them within South Africa's broader educational landscape. I close the chapter by outlining the overall structure of the thesis.

1.2 GOALS FOR THE STUDY

My *overarching purpose* for this study is to explore the place of language – in particular the role of classroom talk - in the teaching and learning of mathematics. I have sought to achieve this purpose through pursuit of the following four goals.

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3 This last-mentioned source is a report on the outcome of South Africa's Grade 5 learners' first participation in TIMSS (Trends in International Mathematics and Science Study). While South Africa's Grade 5s came 47th of the 48 countries participating in TIMSS 2015, the analyses of the findings nonetheless constitute a useful baseline against which to map out future intervention strategies.

In familiarising myself with some of the extensive work done by the mathematics education community on the place of language in mathematics teaching and learning, I was struck by some appealing synergistic possibilities in the mathematics and language/literacy education literature. A *first goal*, therefore, was to open up for consideration some areas of potential synergy in using insights from language and literacy development research to work at the literacy/numeracy interface as I reflect on the role talk plays as a mediational tool in mathematics classroom learning. I tackle this goal via my review of some of the literature dealing with aspects of literacy and numeracy development in a predominantly L2 environment, and - in particular - the important contribution of talk to such development.

My *second - more theoretically-oriented – goal* is to explore the merits of bringing to bear on this case study three different sources of theoretical insight from three important theorists, each of whom prioritises language, and each of whom is widely used across language and literacy and mathematics education research (though not together). The theorists are Vygotsky, Bernstein and Halliday, who, in combination, represent insights from the disciplines of psychology, sociology and linguistics respectively. In examining some of the ways the two research site teachers (Ms M and Ms P) use talk as a mediational tool for mathematical meaning-making, I have drawn mainly on the following aspects of Vygotsky, Bernstein and Halliday's work:

- Vygotsky's sociocultural theory of learning (*inter alia*, 1930; 1962; 1997a; 2012);
- Bernstein's work around the different speech codes children bring to school, and his ideas relating to recognition and realisation rules (*inter alia*, 1959; 1964; 1972; 1990; 2000); and,
- Halliday's systemic functional linguistics (SFL) view of language as a social semiotic resource (a systemic resource for making meaning) (*inter alia,* 1974; 1993; 1994a; 1994b; 2002; and with Matthiessen, 2004).

Given the vast body of knowledge that each of these major theorists represents; I devote a chapter to each of them. In each chapter I tease out those aspects of their work that I see as relevant to my exploration of the talk taking place in Ms M's and Ms P's observed lessons, weaving in empirical data from these lessons as a way of illuminating certain aspects of either Vygotsky's, Bernstein's or Halliday's ideas.

My *third - more empirically-based - goal* is to share part of the story of Ms M's and Ms P's Grade 4 mathematics teaching in terms firstly of the ways in which they use classroom talk to mediate their learners' learning; and secondly, in terms of what they identify as enabling/

constraining factors impacting on the classroom context. In light of the relatively short period of empirical data-gathering, I cannot, of course, tell a complete story. What I do share, however, will, I hope, resonate with other teachers working under similar circumstances, as well as with members of the broader mathematics education community who share similar concerns around language and the teaching and learning of mathematics (most especially as these play out in L2 contexts). In telling Ms M's and Ms P's stories, I use empirical data from their observed lessons and their interviews to illustrate aspects of their use of classroom talk in trying to support their learners' linguistic and conceptual development.

Because language is so clearly a major contributory factor to the inequalities plaguing South Africa's mathematics education landscape, not least being its impact in terms of epistemological access to mathematics (Setati Phakeng, 2014), *my fourth goal* for this study is that its insights should make available an additional lens for investigating ways for making mathematics teaching/ learning environments more equitable. In both Ms M's and Ms P's Grade 4 classrooms - at least officially - mathematics lessons are conducted through the primary medium of English. My empirical data indicate that the language policies at the two schools constitute significant barriers in terms of equity to many of the children in relation to their ability to engage in productive talk around their mathematics learning. This vulnerability may be most especially severe at Ms P's school, which perhaps goes some way towards explaining her choice of making extensive use of her learners' L1 (isiXhosa) in the lessons observed.

1.3 RESEARCH QUESTIONS FOR THE STUDY

The following sets of research questions guided me towards actualizing the goals of the study:

- Why is classroom talk seen to be so important relative to children's learning of mathematics, and what synergies between this and language/literacy development might there be?

- How might drawing on three different sources of theoretical insight (from Vygotsky, from Bernstein, and from Halliday) enhance our understandings of the crucial links between language and learning? In particular, what might they add to this case study exploration of teachers' use of classroom talk in support of their Grade 4 learners' learning of mathematics?

- What is the nature of talk in the observed Grade 4 mathematics lessons? How does such talk appear to mediate the learning of mathematics? In what ways do the teachers use their learners' emergent bilingualism as a resource for teaching and learning?

- What informs the participating teachers' classroom talk practices during their Grade 4 mathematics lessons? What do they identify as enabling/ constraining factors in relation to the oral interactions taking place during their mathematics lessons? What implications might these have for teachers working in similar contexts? And what implications might these have for issues of equity?

In attempting to respond to these research questions I am encouraged by Eysenck's observation that the merit in a careful examination of "individual cases [lies] not in the hope of proving anything, but rather in the hope of learning something" (2013/ 1976[4], p. 9). My overarching goal for this case study investigation, therefore, is that - as I share the story of this case study investigation into Ms M's and Ms P's use of classroom talk in their Grade 4 mathematics lessons - I illuminate the centrality of language in mathematical meaning-making in ways that both resonate with, and extend the thinking of readers from the broader mathematics education community, perhaps most especially those involved in similar teaching/ learning circumstances. I address the question of 'generalisability' in Chapter 3 (methodology discussion).

1.4 'SWIMMING UP THE WATERFALL'[5]: MOTIVATION FOR THE STUDY

I entered this research from the standpoint of someone deeply invested in issues of language and literacy, and a profound concern for how these appear to be playing out in the broader South African landscape as regards South Africa's post-1994[6] constitutional commitment to redressing the imbalances of the past and to bringing about greater equity.

Strong synergies exist between literacy development and numeracy development. In this I can but echo Bohlmann and Pretorius's argument that "it is important to explore more closely the

4 The double date entry shown here is the APA (American Psychological Association) system's referencing convention for referring to a republished text. In this instance, the Eysenck text was originally published in 1976, then republished *in its original form* (that is, <u>not</u> as a new edition) in 2013.

5 Macdonald (1990; 2002)

6 South Africa's 1994 elections marked the first time that all of the country's citizens over the age of 18 were able to vote. These elections saw the transition from the Nationalist Party's apartheid system to majority rule under a newly elected African National Congress (ANC) government.

relationship between mathematics and literacy in a multilingual country such as South Africa since learners' proficiency in the LoLT (language of learning and teaching) will undoubtedly affect their understanding of mathematics" (2008, p. 42). Most recently, Reddy et al. (2016) note the significant advantage enjoyed by those learners "across the TIMSS 2015 cohort" who "always or almost always spoke the language of learning and teaching at home" (p. 8) as compared to those whose HL [home language] was different from the LoLT. Reddy et al. (2016) indicated that this amounted to "on average, a 78 point advantage" (p. 8). (See Section 1.11 for further discussion of TIMSS 2015 findings.)

Having worked in the literacy field for several years - as a writer of English Second Language textbooks, and as a university lecturer on various English Language Teaching teacher education programmes (at both pre- and in-service levels) - I wanted to see whether I might use insights acquired through working in literacy development to explore aspects of mathematical literacy development. In particular, my hope was that, in so doing, I might enhance my, and the South African mathematics education community's, insights into the dual challenge confronting nearly three-quarters of South African learners by the time they reach Grade 4; namely, becoming literate and numerate in and through English: a language they are still in the process of acquiring.

South African language curriculum documents generally avoid the term '*second* language', referring instead to children learning a '*first additional* language' (FAL) (Department of Basic Education (DBE), 2016)[7]. The reasoning behind the alternative nomenclature is partly ideological ('second' being easily equated with notions of 'second best'). It is also fuelled by South Africa's post-apartheid commitment to multilingualism and the ideal of all South Africans becoming proficient users of more than just their home language - not simply for communicative purposes in everyday contexts, but also for more cognitively-demanding, academic purposes. The nomenclature thus carries a pedagogical intent. Given the economic and political dominance of English in this country, and its consequent dominant position as the main LoLT, it is seen as vital that the English FAL curriculum be geared towards developing in learners precisely those high levels of proficiency they need to cope with cross-curricular academic language demands. This intent embraces the principles of 'additive' (as opposed to 'subtractive') bilingualism. (See Section 2.4.3 of the next chapter for my discussion

7 In 2010 South Africa's Department of Education (DoE) was split into two separate departments: Department of Basic Education (DBE), and Department of Higher Education and Training (DHET).

of 'bilingualism'.) And, finally, there appears also to be a psychological intent; the hope that – ultimately – as part of their developing identity, learners come to include a sense of themselves as competent bilinguals (or multilinguals).

Almost three decades ago, Macdonald, leader of the Threshold Project Team investigating how African learners in South African primary schools coped with making the transition from learning in their home language (HL) to learning in English, titled one of the Project's two main reports "*Swimming up the waterfall* ..." (1990). She later explained her choice of the waterfall metaphor. It was to "convey the nearly impossible demands put upon African children in their pursuit of genuine learning through the medium of English in primary school" (Macdonald, 2002, p. 112). She concluded that - notwithstanding South Africa's various curriculum revision and other post-1994 educational reform initiatives – under South Africa's new educational dispensation African children were "indeed *still* [italics added] swimming up the waterfall" (Macdonald, 2002, p. 135).

To 'animate' Macdonald's claim, I include (copied verbatim, and with their permission) the 'voices' of three L2 learners (now themselves practising teachers) recalling their own early efforts at 'swimming up the waterfall':

> In grade four I can remember doing some activities in English. ... We could only seat *[sic]* and listen to the teacher. There was no chance to say anything. ... I could not ask or add anything due to poor language skills. I became inferior in English and felt uncomfortable in class. ... The language barriers blocked my thinking capability. (Elizabeth Nuugonya, written personal communication, March 20, 2017)

> Culturally, I was only equipped with a home language. ... The school announced and declared "no speaking vernacular" within the school premises advocating English only. Meaning the only tool I had to help me navigate through education was prohibited; I had no means to communication, at first I became a much quiet boy in the school ground. At last I found no relevance of staying in school, I decided to quit from school. I went to live with one well up family in town who employed me as a house boy, cleaning, washing dishes and cooking. (William Kakambi, written personal communication, May 1, 2017)[8]

> Memorising was the only way one could pass because we could not construct even a single sentence in English. ... Even if I tried my level best and spend

8 Fortunately William's withdrawal from education was not permanent. He returned, persevered, and eventually obtained his teaching qualification, although, as he noted, in so doing, he "became too old for the classes [he] was in".

> sleepless nights studying, there were some questions that required my own understanding but because of my poor background in English I failed to answer them, however if those questions were in my mother tongue I could have performed better. (Junilla Iindombo, written personal communication, May 3, 2017)

The last-cited student made the further point that there was only ever one answer to a question; that being, the exact wording their teacher expected of them. This was, she explained, "the only answer which could be marked correct, but to me that was rote learning because we were just memorizing." In Section 2.4.1 of my Literature Review chapter I include an example from one of Ms M's observed lessons of a similar demand for what, to her, constituted 'legitimate text' (after Bernstein, 2000). (See also Chapter 6.)

Grade 4 is the first year of the Intermediate Phase (IP) [9] of education in South African schools, "a critically important period" in relation to both literacy and numeracy development (Taylor, 2014, p. 23). In this grade the majority of South African learners begin to experience the full force of the waterfall as they make their transition from HL to English as the main LoLT. It is also the grade where learners need, in Taylor's words to "make the transition from arithmetic based on counting to becoming proficient in the more sophisticated tools of mathematics" (2014, p. 23). In relation to both of these transitions, most South African IP learners are, Taylor notes, "at least two years behind curriculum expectations" (2014, p. 23). This lag, and the accompanying challenge it poses to teachers and learners, is acknowledged by South Africa's DBE.

> By the time learners enter Intermediate Phase, they should be reasonably proficient in their First Additional Language with regard to both interpersonal *and cognitive academic skills* [italics added]. *However* [italics added], the reality is that many learners still cannot communicate well in their Additional Language at this stage. The challenge in the Intermediate Phase [IP], therefore, is to provide support for these learners at the same time as providing a curriculum that enables learners to meet the standards required in further grades. (DBE, 2016, p. 12)

9 South African schooling is divided into two 'bands': General Education and Training (GET) and Further Education and Training (FET). The GET band comprises three phases: Foundation Phase (Grades 1-3); Intermediate Phase (Grades 4-6); and Senior Phase (Grades 7-9). The FET band comprises Grades 10-12 and non-higher education vocational training.

The difficult task of learning content in and through a language in which learners are not yet proficient has strong implications for issues of equity. I quote – at some length – what Ouane and Glanz (2010) wrote of Africa's language(s) of learning circumstances:

> In a 1953 landmark publication, UNESCO underscored the importance of educating children in their mother-tongue (UNESCO, 1953). ... Yet, more than 50 years since the first UNESCO statement, and despite a plethora of books, articles, numerous conventions, declarations and recommendations addressing this issue, including a range of conclusive experiments of using local languages in education and polity, most African countries continue to use the former colonial language as the primary language of instruction and governance.
>
> Africa is the *only* continent [italics added] where the majority of children start school using a foreign language. ... There are objective, historical, political, psycho-social and strategic reasons to explain this state of affairs in African countries, including their colonial past and the modern-day challenge of globalisation. There are [also] a lot of confusions that are proving hard to dispel, especially when these are used as a smoke-screen to hide political motives of domination and hegemony. (pp. 4-5)

The scale of the inequity of such 'domination and hegemony' is manifest in evidence which shows that – contrary to any post-1994 pledges "ensuring that the educational imbalances of the past are redressed, and that equal educational opportunities are provided for all sections of the population" (DBE, 2011, p. 4) - gaps in South African learners' achievements in language and mathematics across the different socio-economic sectors of our society, are in fact widening (Reddy, 2006; Robertson, 2015; Reddy et al., 2016). As Graven (2014a, p. 1039) notes, in South Africa we have "an 'extreme' case of performance gaps between high and low socio-economic status learners". In its media statement on the release of the 2015 findings from South Africa's first ever participation in TIMSS at the Grade 5 level, the Human Sciences Research Council highlighted the clear correlation that their analyses showed between "early learning experiences and future educational success", but noted that socio-economic status differences significantly compromise the quality of learning opportunity available to "those most in need" (2016, unpaged), an issue I return to in the next chapter (Section 2.4.5).

The poverty/affluence lines in South Africa, due in large measure to this country's history of 'separate development' (apartheid), generally coincide with our historical racial and linguistic segregation. Just over two decades of full democracy have done little to erase such division. Every atom of additional insight we may gain into the ways in which LoLT issues impact on South Africa's literacy and numeracy outcomes has the potential to help lessen the insurmountability of the "debilitating learning deficits" (Spaull & Kotze, 2014, p. 22) dogging a huge percentage of South Africa's young learners. There is growing recognition, from government and the private sector, of the need for intervention in the early years of schooling (Robertson & Graven, 2015; Adler, 2017), for, as Spaull and Kotze, citing Heckman, warn: "the later in life we attempt to repair early deficits, the costlier the remediation becomes" (2014, p. 27).

The presence of one of two South African Numeracy Chairs (SANC)[10] at my own university, and the interest expressed by Professor Mellony Graven (the incumbent of the Rhodes University chair) in research around links between language and numeracy gave me the opportunity to explicitly combine my own interest in aspects of children's literacy development in and through their L2 with one of the research priorities identified by the University's Project (SANCP) [11]. In my own bringing together of insights from the academic literature (both professional and theoretical) and from an actual empirical field, I hope to thereby make my own contribution towards enhancing the SANCP's insights into ways of further supporting the teachers and learners in its project schools. Raising mathematics teachers' awareness of the role of language in mathematics teaching and learning, and of how especially crucial it is that children be given opportunities to *engage verbally* is a particular priority for SANCP. Towards this end, the SANCP team has so far hosted two public lectures by prominent members of the South African mathematics education community on issues around language (in particular multilingualism in mathematics)[12].

1.5 ORACY SKILLS AS TOOLS FOR LEARNING

Definitions of 'literacy' inevitably impact on and shape the ways in which the teaching of

10 Rhodes University's SANC Chair is one of six national government-private funded chairs set up to seek solutions for the various challenges facing South African mathematics education. Four of the chairs are focused on mathematics education at secondary school level (Grades 7-12), while the focus of the other two chairs (at the Universities of Rhodes and Wits) is on improving mathematics teaching and learning at the primary school level (Grades R-6).

11 While the focus of this study is on language in relation to children's *mathematical* development, issues relating to foundational *numeracy* need also to be taken into consideration. SANCP's main concern, as its name indicates, is on strategies for improving numeracy teaching and learning. This, in part, is a response to research data such as that used by Taylor (2014, cited above) that have shown that the majority of South African IP learners lag two or more years behind what is expected of them by the IP mathematics curriculum, thereby pointing to the need to attend to these children's foundational numeracy.

12 These were Dr Lyn Webb's presentation: '*Using language as a resource in multilingual mathematics classrooms*' (4 September 2012); and Professor Mamokgethi Setati Phakeng's presentation: '*Mathematics in multilingual classrooms in South Africa: From understanding the problem to exploring solutions*' (7 February 2014).

literacy is approached. Many early definitions tended to foreground mastery of the skills of reading and writing, and “references to the place of spoken language in school or to the need for children to be *articulate* [italics added] as well as literate” (Halliday, 1994a, p. 51) were relatively uncommon. As Alexander (2004) notes, however, “After years as the poor relation of reading and writing, speaking and listening are at last gaining the attention they deserve” (unpaged). Alexander subsequently described “literacy and oracy” as being “overlapping and mutually supportive registers” (2015, p. 430). It is now widely accepted that listening and speaking are equally important tools in the meaning-making interactions taking place in our classrooms, perhaps most especially in the earlier phases of schooling.

The term ‘oracy’ was coined by Wilkinson, director of the Oracy Research Unit in the University of Birmingham’s School of Education. As he explained, “It was felt necessary to have a term for the skills of listening and speaking which would be parallel to “literacy” for the skills of reading and writing” (Wilkinson, 1968, p. 743). Oracy, then, refers to the ability to understand and use spoken language as a tool for learning. As such, it thus encompasses both receptive (listening) *and* productive (speaking) elements. Observations of the talk taking place in both research site classrooms indicate that the current emphasis tends towards the former (receptive) element, a prominence consistent with findings elsewhere. In 2011, for example, Graven noted that in many of the classrooms she visited teachers appeared to value learner listening over learner speaking. On a few occasions she even witnessed children who dared venture a question, being scolded for not having *listened* attentively enough (personal communication, March 12, 2014). Graven (2015) provides further insight into this situation from a learner perspective. In completing a mathematics dispositional questionnaire for SANCP, one learner, when asked to explain what she did when she did not know an answer in mathematics, included in her response the following: “I’m getting scared because the teacher says you didn’t listen” (Graven, 2015a, p. 6).

Listening is a key learning skill. Writing on second language teaching and learning, Nunan (2015) described listening as “the gasoline in the engine of second language acquisition” (SLA), adding that “without access to comprehensible input … a second language won’t happen” (p. 33). Effective learning cannot, however, proceed by listening alone. More *productive* forms of linguistic engagement (principally through speaking) are necessary also to give L2 learners opportunities to work on their production of ‘comprehensible output’

(Swain & Lapkin, 1995). I revisit the notions ‘comprehensible input’ and ‘comprehensible output’ in Section 2.4.1 of the next chapter.

Successful listening and speaking requires ‘reciprocality’. Learners’ capacity to listen in order to make sense of classroom talk (discourse[13]), and their capacity to *themselves* engage in such discourse together make up the two sides of the oracy coin. Equally important is that teachers too - in guiding the discourse of the classroom - listen deeply to their learners’ verbal contributions. By so doing they are able to better identify misapprehensions as well as opportunities for the opening up of potential zones of proximal development (ZPDs). (See Chapter 5 (Section 5.6) for discussion of the Vygotskian construct of ZPD.)

1.6 ‘LITERACY’ IN THE CONTEXT OF MATHEMATICS LEARNING

Newer definitions have emerged in which literacy is seen much more broadly than simply to do with the verbal and the written. Such narrowness, wrote Lemke, “is intellectually untenable today” (2008/2002, p. 22). Not only is literacy now seen to be an *ongoing* “developmental process” (as opposed to some “fixed and finite state”) (Hammond, Burns, Joyce, Brosnan & Gerot, 1992, p. 9), but it is also seen as encompassing a range of different *forms* of literacy such that the term has now become ‘pluralised’: ‘literacies’ or ‘multi-literacies’.

Such different literacies or forms of literacy include mastery in and/or of specific areas of knowledge, such as ‘scientific literacy’, ‘computer literacy’, and, in relation to the present study, ‘mathematical literacy’[14]. Hence, for example, Castanheira, Crawford, Dixon and Green (2001) wrote of the “literacy demands” and “literate actions and practices” associated with different content areas, and noted the ‘situated’ nature of such demands, actions and practices (p. 354).

This broad, but situated, sense was well-captured by Moll (1994) who described literacy as “a particular way of using language for a variety of purposes, as a sociocultural practice with intellectual significance” (p. 201). And it is this same broadening of the scope of what falls

13 I am mindful that people use the term ‘discourse’ in different ways. In Section 1.5 I briefly clarify some of these different ways.

14 My use here of the term ‘mathematical literacy’ is not to be confused with the National Curriculum Statement school subject, *Mathematical Literacy* [ML], (which since 2006 South African FET learners have the option of choosing in place of *Mathematics*). What I am here referring to is ‘literacy *in* mathematics’. (Concern has recently been expressed at the decline in the number of National Senior Certificate candidates registered for Mathematics (as opposed to ML). This decline is cause for concern. It contributed – in part – to fueling the present study.)

within a ‘literacy’ ambit that perhaps informed Colombi and Schleppegrell (2008/ 2002) in articulating their definition of literacy as a “form of social action where language and context co-participate in the meaning-making enterprise” (p. 2). Similarly - perhaps also in recognition of this broadening scope - Haneda and Wells (2000) defined literacy as “the disposition to engage appropriately with texts of different types in order to empower action, thinking and feeling in the context of purposeful social activity” (p. 430). My motive in citing Haneda and Wells last (out of chronological sequence) is their inclusion here of the word ‘disposition’. The notion of disposition in relation to early mathematics learning is an area currently attracting considerable local research interest (see for example Graven, 2012a; Graven & Heyd-Metzuyanim, 2014; Graven, Hewana & Stott, 2013; Hewana & Graven, 2015).

In broadening the definition of literacy in the ways envisaged by Haneda and Wells (2000), it is important not to underestimate the essential contribution of the oral texts young South African learners’ encounter in their mathematics classrooms and the roles these play in developing their mathematical literacy. Given a view of literacy as “a dynamic process”, oral interaction provides the means whereby “what literate actions mean are continually … constructed and reconstructed by individuals as they become members of a [particular] group … engaging in [the kinds of] literate actions that mark membership” of that group (Castanheira, et al., 2002, p. 356). Herbel-Eisenmann (2009), noted that “spoken language is the primary mode” in teaching and learning (p. 174). Defining mathematics as a “specialized form of literacy”, she noted also that its language went beyond simply mathematical terminology and definitions (2009, p. 174). What was needed, therefore, was that more purposeful, explicit, “careful and thoughtful attention [be given to classroom discourse] in mathematics education” (2009, p. 174).

The Organisation for Economic Co-operation and Development (OECD) Programme for International Student Assessment (PISA) identifies the following literate actions as markers of mathematical literacy[15]:

> … an individual’s capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena. It assists individuals to recognise the role that mathematics plays in the world and

15 Other ways used to refer to ‘mathematical literacy’ include ‘critical numeracy’, ‘mathemacy’, ‘quantitative literacy’ or, simply, ‘numeracy’ (Atweh, Bose, Graven, Subramanian & Venkat, 2014, p. 10).

to make the well-founded judgments and decisions needed by constructive, engaged and reflective citizens. (2012, p. 4)

Although Kilpatrick, Swafford and Findell chose to use the term '*proficiency*' over 'literacy', their conceptualisation of proficiency has obvious parallels with the PISA definition of mathematical literacy (National Research Council, 2001)[16]. They encapsulated what mathematical proficiency should comprise in the following five-stranded visual representation (Figure 1.1, below). Their choice of a rope metaphor clearly underscores the "*interwoven and interdependent"* [italics in the original] nature of these five components (National Research Council, 2001, p. 116).

Taking the strands in Figure 1.1 from left to right, *adaptive reasoning* refers to a "capacity for logical thought, reflection, explanation, and justification"; *strategic competence* to the "ability to formulate, represent, and solve mathematical problems"; *conceptual understanding* to the ability to comprehend "mathematical concepts, operations, and relations"; *productive disposition* to a "habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy"; and, finally, *procedural fluency* refers to the exercise of "skill in carrying out procedures flexibly, accurately, efficiently, and appropriately" (National Research Council, 2001, p. 116).

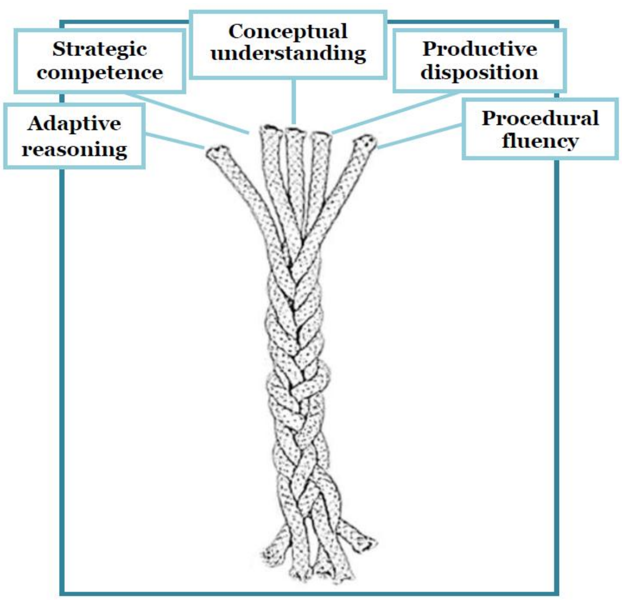

Figure 1.1: **Intertwined strands of mathematical proficiency** (National Research Council, 2001, p. 117).

16 While Kilpatrick, Swafford and Findell are the editors of *Adding it up: Helping children learn mathematics*, I have here used the referencing citation suggested in the document itself. I note though that many who cite this text simply refer to it as Kilpatrick et al. (2001).

In Chapters 8 and 9 I make brief reference to some assessment outcomes from SANCP's monitoring of aspects of Ms M's and Ms P's Grade 4 learners evolving mathematical proficiency. The assessments were in part based on these strands (National Research Council, 2001).

An important point made by Castanheira, et al. (2002), not mentioned in either the PISA or the National Research Council's conceptions of mathematical literacy, relates to issues of 'access': "*opportunities* [italics added] for constructing and acquiring the repertoire of literate practices needed to participate in socially and culturally appropriate ways" (p. 356). In the case of the majority of South Africa's IP learners, Graven (2014b) noted that Annual National Assessments (ANAs) and other assessment outcomes indicate that many learners lack grade appropriate foundational mathematical understanding. Their capacity to participate is thus compromised. Without "recovery of foundations"[17], Graven argued, these learners' opportunity to learn is effectively cut short. Because the "curriculum is beyond [their] ZPD", they merely "play school" (2014b, PowerPoint Slide 20 of 44). In relation to the present study, a key part of "the repertoire of literate [and numerate] practices" (Castanheira, et al., 2002, p. 356) and thus an enhanced opportunity to learn, relates to accessing and using mathematically appropriate discourse. It is this discourse that I briefly explore in the following section.

1.7 MEDIATING SHIFTS ALONG THE DISCOURSE MODE CONTINUUM

Before introducing the idea of a 'mode continuum', I briefly clarify the term 'discourse'. Rymes (2016) defined it in relatively simple terms as 'language-in-use' (p. 5). Cook (2013) went somewhat further than this. 'Discourse', he explained refers to "a stretch of language in use of any length and in any mode, which achieves meaning and coherence for those involved" (2013, p. 431). The idea of 'discourse' investigated in the present study goes even further than this insofar as it relates to particular kinds of discourse: *classroom* discourse/ *mathematics classroom* discourse/ *mathematics* discourse. In analysing these different kinds of discourse relative to Ms M's and Ms P's observed Grade 4 mathematics lessons I show how other

17 This is a reference to the early numeracy intervention programme, *Mathematics Recovery* (MR), originally conceptualised by Australian academic Professor Robert (Bob) Wright and colleagues. For discussions of aspects of Wright et al.'s MR programme in the local (South African) context, see, for example, Stott, Mofu and Ndongeni (2017) and Wasserman (2017).

elements in their respective classroom situations may have served to disrupt aspects of the 'meaning' and 'coherence' Cook alluded to in his definition. As I illustrate through my various data excerpts, linguistic elements, as well as other – contextual – elements, gave rise to some disjunctions between the mathematical 'meaning' and 'coherence' Ms M and Ms P sought to achieve, and the 'meanings' some of their learners' appeared to make. Such disjunctions then had knock-on effects on the success with which Ms M's and Ms P's learners were able to navigate the mathematical 'mode continuum'.

Schleppegrell (2012a) noted that "success in school calls for using language in new ways to accomplish increasingly challenging discursive tasks" (p. 409). An important aspect of the present study involved looking for ways in which Grade 4 mathematics teachers use talk to help mediate their learners' shifts along the 'mode continuum' (Gibbons, 2003, after Halliday) from common-sense ways of thinking and talking about mathematics towards more literate, formalised and systematic ways of doing so. In Vygotskyian terms, this entails moving from 'everyday' and 'spontaneous' concepts towards the more 'academic', 'abstract', 'scientific'[18] mathematical concepts likely to predominate as learners move on up through the grades. The challenge of making such a mode shift is inevitably compounded where (at least officially) the main LoLT in a mathematics classroom does not coincide with the main language (L1) that learners use at home. Wong Fillmore (2009) noted that language teaching, irrespective of what subject areas is operative at a particular moment in time, needs to be "an abiding and continuing instructional concern" in order that learners gradually come "to see how academic language works" and so then develop the ability "to *use* the linguistic resources they are discovering in their own communicative efforts" [italics added] (p. 14). A helpful construct in the context of a 'mode shift' from the 'everyday' to the 'academic' is that of 'discourse'.

The discourse of mathematics is multi-semiotic (Schleppegrell, 2007; O'Halloran, 2005; 2011). Making meaning of mathematical discourse thus involves considerable "semiotic integration" (Lemke, 2002, p. 22). Mathematics draws on three main semiotic resources (what O'Halloran (2011, p. 218) termed "building blocks") for thinking about, talking about, and representing mathematical ideas and knowledge. In addition to language *per se*, mathematics also uses symbols (for example - at the simplest level of mathematical symbolism - the **+/-/x/÷/=** signs), and visual images (for example, diagrams and graphs).

18 After Kozulin, in the Introduction he wrote for Vygotsky's revised and expanded version of *Thought and language* (Vygotsky, 2012, p. xviii).

The combination of the language, the symbols and the visual representations used in mathematical text may make it more complex than many other types of text. As O'Halloran (2011) points out, the discourse of mathematics is, in fact, "more than the sum of the meaning potential of [these] three semiotic resources" (p. 234), and - as such - requires significant of meaning "across [these] multiple semiotic resources" (p. 235).

I deal with the construct of 'negotiation of meaning' in Section 2.4.1 (Literature Review chapter). Ms M's and Ms P's learners need, however, to negotiate meaning at both the linguistic and the mathematical level. Mathematics teachers (especially those working – as Ms M and Ms P do – in L2 circumstances) need, therefore, in Schleppegrell's words, "to apprentice students into the technical language of mathematics" (2007, p. 143). They need to help them navigate their way across and between the semiotic resources both of the L2 LoLT (English, in this instance) *and* of mathematics. This involves giving explicit attention not just to grade appropriate mathematical discourse, but also to the provision of opportunities for what Barnes (1976) described as more 'exploratory' forms of talk.

As noted in this section's opening paragraph, the term '*discourse*' is used in different ways across different contexts. So, for example, in their construct of teachers' Mathematics Discourse in Instruction (MDI), Adler and Rondo (2014) have a very context-specific and specific use for the term. MDI, they explain, incorporates more than just classroom talk. It includes *all* of the ways in which mathematical ideas are communicated in classrooms[19]. "Understanding how teachers' MDI supports mathematical learning," they note, "matters deeply" (Adler & Rondo, 2014, p. 10).

In the present study, the main focus is on the discourse (talk) that took place during Ms M's and Ms P's observed Grade 4 mathematics lessons. In line with the points made above about the multi-semiotic nature of mathematical discourse, I note Gee's conception of 'discourse' as "always involve[ing] *more than* language [italics added]" (1999, p. 25).

Like Bernstein, whose ideas around discourse I deal with in Chapter 6 (Section 6.5), Gee has made important contributions to discussions around literacy and discourse. Gee (1989) differentiated between 'discourse' and 'Discourse'. While I acknowledge the distinction made, here I use the lower-case version throughout my own discussion, except where I quote directly from his work. Before providing his own 'definition' of 'discourse' and how he saw it as linked

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19 Adler and Rondo's conception of MDI comprises "three interacting components of a mathematics lesson: [1] a sequence of examples and related tasks; [2] accompanying talk; [and 3] patterns of interaction" (2014, p. 9).

to literacy development, Gee made two further distinctions.

- First he distinguished between 'primary' and 'secondary' discourse, primary referring to the "home-based" (1989, p. 7) discourse identity acquired through one's socialisation into and membership of a particular family, socio-cultural group and community; secondary discourses being those acquired through interactions within "non-home-based social institutions" (1989, p. 8), amongst which are included schools[20].
- Second, he distinguished between 'dominant' and 'non-dominant' discourses, the former being those secondary discourses that carry within them "the (potential) acquisition of social "goods" (money, prestige, status, etc.)" (1989, p. 8).

Discourse, for Gee, is "a socially accepted association among ways of using language, of thinking, and of acting that can be used to identify oneself as a member of a socially meaningful group or "social network"" (1989, p. 18). In the case of the present study these 'ways of using language, of thinking and acting' pertain to Ms M's and Ms P's efforts to help their learners move along the mode continuum towards mastery of the secondary discourse ('mathematics') in ways that could increasingly enable them to more fully participate as novice members of the broader mathematics community.

There are those who regard aspects of Gee's arguments as problematic. While recognizing the merit in many of his lines of argument, Delpit, for example, expressed reservations about a potential for "a dangerous kind of determinism" (1992, p. 298) as regards the perceived capacity of certain groups of individuals (for example, minorities, women, children from lower socio-economic status backgrounds) to transcend their primary discourses in the acquisition of what she labelled "status discourses" (p. 298) (i.e. Gee's 'dominant discourses'). Such perceptions, Delpit (1992) argued, can, and often do, contribute to a sense of powerlessness and paralysis on the part of the groups involved as well as on the part of their teachers.

1.8 DECISION-MAKING AROUND SCHOOL LANGUAGE POLICY

Research has repeatedly indicated that some groups of children find mastery of 'secondary' discourses easier than do others, and that this differential mastery frequently correlates with

20 I note some similarities between Gee's and Bernstein's ideas about discourse. Certainly Gee's description of 'primary' and 'secondary' discourses is close to Bernstein's distinction (1999) between 'horizontal' discourses (everyday, commonsense knowledge) and 'vertical' discourses (specialised forms of knowledge). [I have not been able to establish whether Gee was influenced by Bernstein's work (or vice versa) beyond noting Gee's citing of Bernstein in some of his texts (though I have yet to come across a Bernsteinian citing of Gee).]

socio-cultural, socio-linguistic, and socio-economic factors (see, for example, Heath, 1983; Chall & Jacobs, 2003; Hart & Risley, 2003; and – locally - Hoadley, 2005). Each of these factors was to some extent at play in Ms M's and Ms P's Grade 4 mathematics classrooms. The most significant factor relative to the present study, however, is the socio-linguistic one: in particular the *language* through which Ms M's and Ms P's Grade 4s were expected to access, and use, the secondary (mathematics) discourse; as well as the extent to which these learners were able to continue drawing on their L1s (even as they transition across to an L2[21] LoLT).

South Africa's Language in Education Policy (LiEP) (DoE, 1997, p. 1) states that its "underlying principle is to maintain home language(s) while providing access to and the effective acquisition of additional language(s)". School Governing Bodies are mandated with choosing which of the country's eleven official languages a particular school should use as its official LoLT. Madiba (2013) suggests that, notwithstanding the stated commitment to multilingualism, and, "although not explicitly stated as such, it is clear that the policy direction is one of foregrounding English as the 'main' language of South Africans" (p. 4). Most South African schools have, in fact, chosen English as their LoLT. As Tables 1.2 and 1.3 (Section 1.8) show, by Grade 4 almost 80% of the country's learners are (officially) learning in and through English.

As noted earlier, Gee saw literacy as involving "*the mastery of or fluent control over a secondary Discourse*" [italics in the original] (1989, p. 9), and that such mastery has the power to provide access to social goods. It is this 'social goods' aspect of discourse that Setati (2008) identified as a motivating factor behind many black South African parents' choice of having their children educated through the medium of English; this despite the risks this might pose in terms of epistemological access (to, in this instance, the discourse of mathematics).

Bloch (2002) too has focused on concerns around epistemological access in relation to choices of LoLT. As she explained, one reason for such concern was that [so few] South African teachers were "trained to educate children from diverse linguistic … backgrounds" (2002, p. 65). Hegemony of English at the expense of learners' indigenous languages, she therefore saw

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21 It is the *sound* not the actual first letter of a word that determines whether we use 'a' or 'an', and since readers are likely to read 'el two' rather than 'second language' when they encounter the L2 abbreviation (i.e. a *vowel* sound, rather than a consonant sound), I have consistently used 'an' not 'a' in these instances.

as posing the significant risk that English would become a “medium of *de*struction” (after Chick), rather than the language of literacy and social and economic opportunity envisaged by many parents (2002, pp. 65-66). It is likely that many South African parents are unaware, however, of such potentially destructive consequences. Research in Eastern Cape schools, for instance, found 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, Murray, Botha, Botya, Brooks & Westphal, 2002, p. 29).

Heugh (2017) observes that “successful education, especially for vulnerable and marginalized communities, cannot occur unless children understand the language/s through which it is provided” (p. 4 of 4, online article). Heugh has been consistently critical of what she saw as South Africa’s Ministry of Education’s failure to adequately alert parents to the consequences for their children of particular LoLT choices (see, for example, Heugh, 2002a and 2002b). Heugh is a staunch advocate of additive bilingualism with extended use of mother-tongue. Based on her participation in extensive cross-national studies over many years, she argued that “successful education requires mother-tongue-medium education throughout, but an absolute minimum of six to eight years of mother-tongue … instruction” (Heugh, 2011, p. 154). Benson (2004a) similarly explained in the background paper she prepared for one of UNESCO’s Education For All Global Monitoring Reports, that ‘late exit’ transitional programmes where children have four to five years of instruction through L1 before making the transition to an L2 have been shown to offer better results than do ‘early exit’ ones. The latter, in her view, “try to do too much too fast and fail to produce optimal results” (2004a, p. 15).

I explore the distinction between ‘additive’ as opposed to ‘subtractive’ approaches to bilingualism in the next chapter (Section 2.4.3). For the moment, however, I simply highlight in Figure 1.2 below my graphic depiction of some bilingual options for L1/L2 teaching and learning contexts.

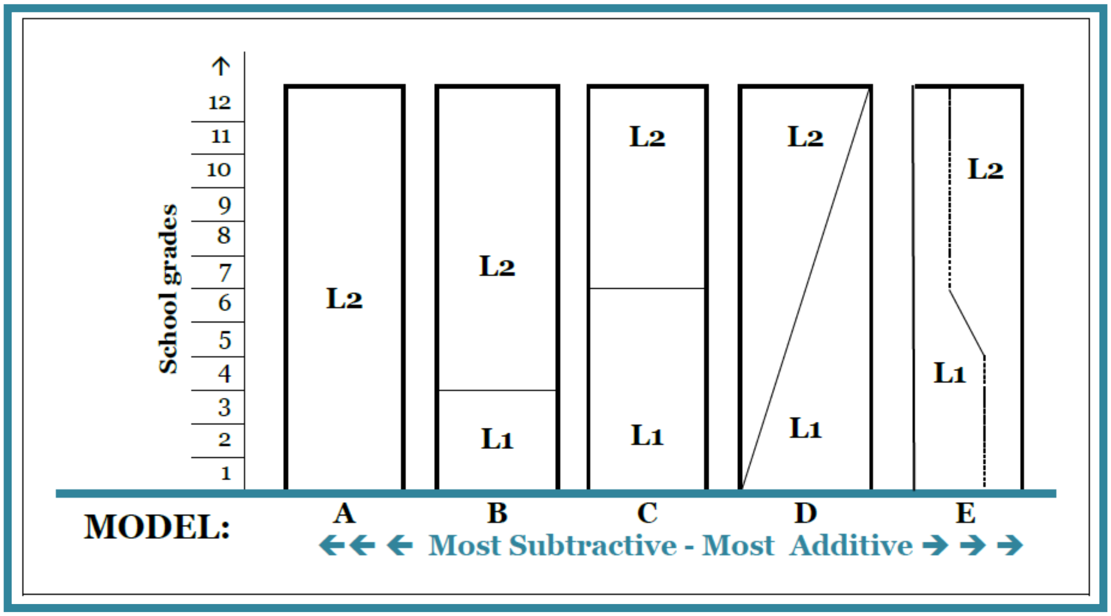


Figure 1.2: **Some models for bilingualism in L1/L2 contexts**

In terms of Figure 1.2, Model C would come closest to satisfying Heugh's *minimum* requirement; Models D and E are closer to what she would regard as optimal; Models A and B represent the respective LoLT choices at Ms M's and Ms P's schools. What this indicates is that Ms M's and Ms P's schools' LoLT policies sit at the 'most subtractive' ends of the continuum represented in Figure 1.2.

1.9 TALK: "A TOOL FOR TRYING OUT DIFFERENT WAYS OF THINKING AND UNDERSTANDING" (Barnes, 2010, p. 7)

Issues of subtractive and additive bilingualism aside, there is also a need, as Gee asserted, to focus not so much on "language, or literacy, but [on] *social practices* [italics added]" (1989, p. 5). This sort of social emphasis provides a helpful counterbalance to earlier, predominantly individualistic, cognitivist interpretations of teaching and learning. "Learning," Vygotsky wrote, "presupposes a specific social nature and a process by which children grow into the intellectual life of those around them" (1997a, p. 34). Two essential elements towards helping learners 'grow into' and make conceptual sense of the 'intellectual life' of their mathematics classrooms are 'reflection' and 'communication' (Hiebert et al., 2000).

> Reflection occurs when you consciously think about your experiences. It means turning ideas over in your head, thinking about things from different points of view, stepping back to look at things again, consciously thinking about what you are doing and why you are doing it. (Hiebert et al., 2000, p. 5)

This view of reflection speaks to metacognitive aspects of thought. Hiebert et al. then define ‘communication’ as follows:

> Communication involves talking, listening, writing, demonstrating, watching, and so on. It means participating in social interaction, sharing thoughts with others and listening to others share their ideas. (2000, p. 5)

Clearly, both these behaviours are *heavily* language dependent, and, while reflection may appear to be a more ‘internalised’ (and thus less ‘visible’) activity than communication, both are intrinsically linked to the verbal interactions taking place within the mathematics classroom. In this context language is, in Vygotskian terms, a primary ‘tool’: first as a “means of communication”; and “subsequently ... to organize ... thought” (Vygotsky, 1997a, pp. 34-35).

In referring specifically to *oral* language, Vygotsky noted that "speech is not only a means to understand others, but also a means to understand oneself" (1997b, p. 95), a point I explore further in Chapter 5. For children such as those in Ms M’s and Ms P’s mathematics classrooms, the use of the schools’ official LoLT (English) for communicating with oneself and with others inevitably poses a considerably greater challenge than might be the case were they to attempt this through their L1. As Janks (2004) has argued, while access to English constitutes - in Bourdieuian terms - ‘linguistic capital’, such access may come at a price for a great many L2 learners. Reporting on research she had conducted in a South African primary school, Janks noted the inhibiting effects of English as LoLT on learners’ capacity to participate, such that most of the children she observed were “mute, robbed of language”, yet “c[a]me alive” when allowed to speak an African language (2004, p. 34).

In Table 2.5 of Chapter 2 I identify some features typical of spoken (as opposed to written) language. Gibbons (2006, after Eggins, 1994) described it thus: “Spoken language typically involves turn-taking; is context dependent and dynamic in structure; is characterized by ‘spontaneity phenomena’ such as false starts, incomplete clauses and hesitations ...” (p. 33). Consistent with these features is Barnes’s comment that a particular advantage of talk in a classroom context is that, unlike, for example, writing, talk is “easy and impermanent. We can *try out an idea and change it* [italics added] even as we speak. Exploratory talk ... provides a ready tool for trying out different ways of thinking and understanding” (2010, p. 7). Such talk will almost certainly be infinitely less “easy”, however, for those learning through a second, or additional, language (as was the case for the children observed in Ms M’s and Ms P’s Grade 4 mathematics classrooms).

There is a risk, also, that the key role talk plays firstly in exposing children to ideas and then secondly in helping them wrestle orally with these ideas may become all but invisible: its vital place in the unfolding of a lesson tending either to be overlooked or taken for granted. Often, too, in more teacher-led lessons, teachers may be so intent on hearing the 'right answers' from their learners, that they may hear 'the answer' without hearing, or indeed, encouraging, 'the talk'. This may perhaps be especially the case in mathematics classrooms where, as Lerman (2000) observed, a "mathematical pedagogy of transmission of facts" (p. 22) has left a troublesome legacy that mathematics educators continue still to struggle to reconfigure. I further explore aspects of classroom talk in my review of literature in Chapter 2. (See, in particular, Section 2.3).

1.10 THE RESEARCH SITES

The empirical data for this study derive, as noted, from the Grade 4 Mathematics classrooms of Ms M and Ms P. Both teachers work in township schools in the Eastern Cape Province of South Africa. Some non-South African readers may not be aware of the particular connotation the word 'township' carries in South Africa. It is used to refer to the apartheid-era urban residential areas designated for 'non-whites'. Significant geographical separation along racial lines persists even today. Townships are generally located on the periphery of towns and cities. They are often poorly resourced in infrastructural terms, and are, in some areas, little more than shanty towns where residents are crowded together in abject poverty. In the case of the two research site schools, both, but particularly Ms P's, serve less affluent sectors of the community. Because of the legacy of geographical separation, the *lingua franca* of the community is predominantly isiXhosa; meaning, that for Ms M's and Ms P's learners, their only regular contact with English was in the classroom, and opportunities for interacting with *native* speakers of English was extremely limited.

Ms M's and Ms P's classrooms represent 'opportunity samples' in that their schools were amongst those participating in the SANC initiative set up at Rhodes University in 2011. Rhodes University's SANC Project, under the guidance of the incumbent Chair, Professor Mellony Graven, works with teachers, learners and researchers in an endeavour to find "sustainable and practical" ways of improving the quality of numeracy outcomes in primary schools (http://www.ru.ac.za/sanc/).

Ms M and Ms P were members of SANCP's teacher professional development (PD) project, NICLE (Numeracy Inquiry Community of Leader Educators), a research and development project focused on "supporting Grade 3 and 4 numeracy and mathematics teachers in developing foundational knowledge of learners (not achieved in earlier grades)" (Graven, 2015b, p. 5). The project ran from 2011 to 2015[22]. During this five-year period NICLE met regularly. In 2011 and 2012 NICLE met almost fortnightly, and, from 2013, almost monthly during school term time. Some forty three regularly-participating teachers from 12 schools, and some district officials, took part in this PD programme. I participated in NICLE alongside the teachers from 2013 to 2015.

Worldwide, the pattern is that socio-economic status correlates closely with educational outcomes. South African public (state) schools are classified into five quintiles depending on a school's catchment area. Using census data, catchment areas are assessed in terms of the income, unemployment rate and level of education of the communities different schools serve. The level of state funding a school receives is determined by its quintile status. Quintile 1 represents the "poorest" public schools; Quintile 5 the "least poor" public schools (DoE, 1998, page 15 of 22, online article). Adler and Pillay (2017) in discussing the stark differences in educational outcomes across the quintiles, explain that, despite the State's 'pro-poor' ideology, in terms of which a greater proportion of state funding is allocated to the poorest schools (Quintiles 1-4), the educational performance of learners attending Quintile 1 to 4 schools is "increasingly below the required level" (p. 13). In terms of measured achievement outcomes in mathematics, Schollar (2008) noted that a majority of South African learners attending these schools lagged by as much as three years behind grade standard.

The research sites for the study fall in the middle of the quintile range. Ms P's school is a Quintile 3 public school. Children attending this school do not pay school fees. Ms M's school recently opted to change from a Quintile 3 to a Quintile 4 public school. In line with this shift, the school charges a fee higher than many other township schools. Ms M noted that for 2014,

22 As Graven (2015b) explains, however, SANCP's development work included not only its NICLE programme. It also included after-school Math Clubs, a homework drive, and the setting up of various family mathematics events. Through these initiatives the Project aimed at "addressing the gaps in foundational knowledge" of Grade 3 and 4 learners at the participating schools, as well as "creating strengthened mathematics learning dispositions that foreground sense making, steady effort, resilience, confidence and a love of mathematical activity and engagement" (p. 1).

whereas at "other schools, maybe the school fees is R50 for the whole year; here I think it's R140 per month[23]" (Interview 1M, Lines 131-130).

The shift to Quintile 4 was a deliberate mechanism to shield the school from aspects of less than optimal service delivery on the part of the state (School's Principal, personal communication, November 7, 2014). By way of contextualizing the school's decision to make this shift, in 2012, for example, administrative weaknesses in two of the country's provincial education departments (one of which being the Eastern Cape Department of Education) led to these provincial departments being singled out for "special guidance" and monitoring of "service delivery" at national level (DBE, 2013a, p. 17).

Bernstein and Halliday have independently argued that, given that learning is "inherently a semiotic (meaning-making) process" (Halliday, 1993, p. 94), it might best be seen as a form of language learning. However, "differences in the use of language arise out of a specific context" (Bernstein, 1972, p. 213). In Figure 1.3, below, I highlight three interconnected aspects of the linguistic contexts in which Ms M and Ms P teach their mathematics lessons.

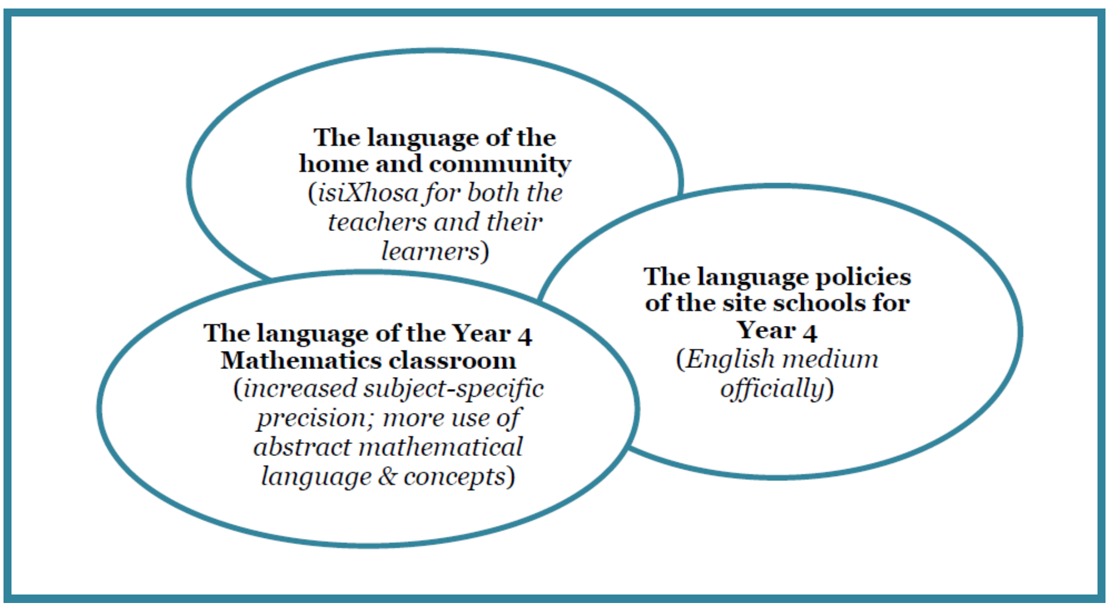


Figure 1.3: **Aspects of the linguistic contexts in which the research site teachers are working.**

23 This amount was, at that time, roughly equivalent to US$10. [I have subsequently established that the monthly fee was in fact R130 over eleven months (R1430 per annum).]

The three aspects shown in Figure 1.3 are:

- Firstly, that Ms M and Ms P and their respective learners all share the same home language (isiXhosa, the language of the majority of the people living in the Eastern Cape region[24]).
- Secondly, that, in terms of their schools' LoLT policies, by Grade 4, English is the main LoLT at both schools. For Ms P, Year 4 marks her learners' official transition from isiXhosa to English as LoLT. I use the adjective 'official' advisedly here for – as the empirical data show – talk in those mathematics lessons of Ms P's that I observed still made heavy use of isiXhosa. Ms M's school has a 'straight for English' policy. This means that her learners are in their fourth year of English as LoLT, and – as the empirical data show – most of the talk in those mathematics lessons of Ms M's that I observed was indeed in English. Both LoLT choices at the Grade 4 level, as I indicated in Section 1.10, represent 'subtractive' models of bilingualism rather than the more 'additive' models advocated in South Africa's LiEP document (DoE, 1997).
- Thirdly, that the language of mathematics itself raises linguistic issues. The mathematics register constitutes an important part of the "semantic resources" for making meaning in mathematics (Halliday, 1974, p.69), and is thus integral to learning the subject matter of mathematics. As learners move on up the grades this register becomes increasingly abstract relative to the everyday. (I elaborate further on Halliday's notion of a mathematics register in Chapter 7 (Section 7.7).)

A further inconsistency to note in relation to the linguistic context in which Ms M teaches is that, even though English is in reality her learners' 'additional language', in curricular terms, it – paradoxically – is labelled a 'home language'. The children's *actual* home language is taught as their 'first additional language'. This reflects an anomaly in curriculum policy, whereby schools opting to go the 'straight for English' route are expected to gear their English language teaching towards the achievement of the learning outcomes contained in the English Home Language (EHL) curriculum (Department of Education (DoE), 2002a), *despite English not being the HL of their learners.*

24 Census 2011 figures for the distribution of the four main home languages across the Eastern Cape population are IsiXhosa 77,6%, Afrikaans 10,4%, English 5,5% and Sesotho 2,4% (Statistics South Africa, 2012).

The Grade 4 ANA results for 2014 for both schools show that a significant proportion of the learners struggled to make meaning of their mathematics learning. Table 1.1 below provides some initial insight into the schools' respective 2014 ANA performances.

Table 1.1: Mathematics ANA Scores (2014): Some percentage ranges for Grade 4 learners at the research site schools

	Ms P's school			**Ms M's School**		
Percentages	Learner no's	% of learners	**Learners below/ above 50%**	Learner no's	% of learners	**Learners below/ above 50%**
0-30	**55**	**63.2**	**80** (91.9%)	**24**	**36.9**	**49** (75.4%)
31-39	**15**	**17.2**		**10**	**15.4**	
40-49	**10**	**11.5**		**15**	**23.0**	
50-59	**3**	**3.4**	7 (8.0%)	**8**	**12.3**	**16** (24.6%)
60-69	**2**	**2.3**		**5**	**7.7**	
70+	**2**	**2.3**		**3**	**4.6**	
n=	**87** (+8 absentees)			**65** (no absentees)		
School average	**27.3%**			**37,9%**		
Provincial average	**34.8%**					
Differential	**-7.5%**			**+3.1%**		
National average	**37%**					
Differential	**-9.7%**			**+0.9%**		

Data derived from SANCP Database[25] (2014); plus DBE (2014, pp. 9, 52).

As this Table shows, while Ms P's school scored below both the provincial and national Grade 4 averages in mathematics, Ms M's school scored just slightly above these averages. In discussing these scores, Martiniello's cautionary comment (2008, p. 334), made in relation to certain (American) children's mathematics tests scores (notably children who are not native speakers of English), is equally applicable to the South African situation:

> The use of testing in education presupposes that a student's test score is an accurate reflection of her mastery of a particular content area. However, if the student is an ELL[26] and the math test includes questions the student might have

25 SANCP gathers data across all schools participating in the project. While the anonymity of individual schools is maintained, SANCP's rich database is reported on and shared in various fora (for example, with funders, and with the broader SANC community of practice forum).

26 The acronym ELL is used widely used in (particularly American) education literature to refer to those learners who are non-native speakers of English, and still in the process of becoming proficient users of English. It stands therefore for 'English Language Learner'. Other writers (for example, August & Shanahan, 2006) favour the term 'language minority student', but see also the discussion in Section 2.5.4 where yet another preference: 'emergent bilingual' (García, 2009) is mooted.

trouble understanding, it is unknown whether the low score is due to the student's lack of mastery of the math content, limited English proficiency, or both[27].

While I wholly support the re-conceptualisation of multilingualism/ bilingualism as a *resource* rather than a *problem* (Barwell, Barton & Setati, 2007; Planas & Setati-Phakeng, 2014), I believe the South African language policies and practices that have given rise to a major transition away from mother tongue and towards English as LoLT in Grade 4 create special difficulties for mathematics teaching and learning at this level. There is, to my mind, some unfortunate conflation between having opportunities to become proficient *users of* English and *using* English as the main linguistic vehicle through which to become proficient learners of mathematics, science, history, or whatever.

Despite research-based evidence showing positive correlations between "mother tongue education and scholastic achievement" (DBE, 2010, p. 5) little has yet been done to discourage the flow *away* from mother tongue in South African classrooms. Based on 2007 statistics, Table 1.2 (below) reflects something of the scale of the switch to English as LoLT nationally. This, in part, reflects a loss of faith in mother tongue by (mostly) black parents. Many of them were educated under the apartheid regime, and therefore "associate [mother tongue education] with inferior education" (Nomlomo, 2006, p. 131). It is, in part, also a result of a perception that few African languages are yet sufficiently developed to act as, as Ramani and Joseph put it, "carrier[s] of specialist knowledge" (2006, p. 8). This may to some extent, be the case. Ramani and Joseph (2006), both staunch advocates of mother tongue education, noted, however, that the kinds of 'specialist' language needed to engage with curriculum content in the earlier grades is not of an impossibly demanding linguistic order and certainly not outside of the linguistic potential of African languages.

Table 1.2: Percentage of learners using English as LoLT (Grades 1-12) (2007)

Grade	**Foundation Phase**			**Intermediate Phase**			**Senior Phase**			**FET Phase**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
%	21.8	23.8	27.7	79.1	81.1	81.6	80.6	80.9	80	81.2	82	81.4

Data derived from DBE (2010, p. 16) [28].

27 For an in-depth examination of this very issue in relation to South Africa's Grade 4 Mathematics ANAs, see Sibanda (2016).

28 Currently, South Africa's senior school-leaving examinations can only be written in either English or Afrikaans. What this means, therefore, is that the balance of learners in the Senior and FET phases *not* using English as their LoLT, will be learning through the medium of Afrikaans.

Concealed within the percentage increase between Grades 3 and 4 (27.7% to 79.1%) is the fact that *less* than 7% of learners in Grade 4 had English as a HL. Table 1.3 (below) shows the relative percentages for learners' home languages as against LoLT across South Africa's eleven official language groups. The Table highlights the marked move away from all of the indigenous languages (barring Afrikaans) and towards English, such that 72.2% of Grade 4 children entering English-medium classrooms were non-native speakers of English.

Table 1.3: Grade 4 learners by home language and LoLT (2007)

LANGUAGE GROUP	Percentage of learners by home language group	Percentage of learners by LoLT	Percentage difference
Afrikaans	10.3	12.3	+2
English	6.9	79.1	+72.2
isiNdebele	1.8	0.3	-1.77
isiXhosa	21.1	3.1	-18
isiZulu	24.3	1.5	-22.8
Sepedi	10.6	1.1	-9.5
Sesotho	6.4	0.5	-5.9
Setswana	7.6	0.6	-7
Siswati	3.3	0.4	-2.9
Tshivenda	2.9	0.3	-2.6
Xitsonga	4.9	0.7	-4.7
TOTAL	100	100	

Data derived from DBE (2010, pp. 12; 16)[29].

As is elaborated upon in Chapters 8 and 9, both Ms M and Ms P identified language (especially the fact of English being the (official) LoLT at their schools) as a key barrier to mathematics learning for many of their Grade 4 learners. In this they are not alone: other teachers within the SANCP community voiced a similar concern (Robertson & Graven, 2015). This said, there was also a small number of Ms M's and Ms P's 2014 Grade 4 learners who did relatively well, achieving scores of 70%+ in their mathematics ANAs (SANCP Database, 2014), an encouraging indication that these few managed to triumph over whatever language and/ or other adversities they may have faced.

29 In considering these figures, however, it is important to note too, the DBE's cautionary comment in relation to the "strong association between mother-tongue education and academic achievement" and the difficulties learners face in learning through a non-mother-tongue, namely, that "*behind [such] self-evident nostrums lies a myriad of complications* [italics added]" (DBE, 2013b, p. 32). See the DBE's report for an articulation of some of these complications.

In the next section I provide an initial overview of aspects of South Africa's broader educational landscape. Before doing so, I conclude the present section by noting that my purpose in choosing *two* school sites was not for comparative reasons. To 'pit' the schools or classrooms against each other in this way would, in my view, be counterproductive. Rather what I hoped was that by choosing these two sites - their being at once sufficiently similar and yet sufficiently different - I would be able to generate a richer perspective around the issue of mathematics classroom talk in a predominantly second language teaching learning environment than would be the case had I worked in just one site. In so doing, I hope to contribute just that little bit more richly to SANCP's ongoing explorations into affordances and constraints affecting numeracy development in its participating schools.

1.11 SOUTH AFRICA'S BROADER EDUCATIONAL LANDSCAPE

South African teachers have been confronted by major structural and curricular turbulence since the transfer of power to the African National Congress (ANC), following on from the country's first fully-democratic elections in 1994. The "birth of a new democracy" (DBE, 2009, p. 11) placed considerable responsibility on their shoulders in terms of the roles they were expected to take on in relation to the transformation of South Africa's divided and unequal educational system. I expand on aspects of South Africa's post-1994 curriculum transformation efforts in Chapter 6 in my discussion around Bernstein's concepts of classification and framing and of recognition and realisation rules. Essentially the transformation process involved placing for the first time in the country's history the education of *all* of South Africa's learners under the remit of a single department of education, with a single set of curriculum documents for all race groups.

An outcomes-based approach to education (OBE), involving more learner-centred approaches to teaching and learning, was initially chosen by the country's newly constituted Ministry of Education. (See Graven, 2001, for a detailed Bernsteinian analysis of South Africa's first round of post-apartheid curriculum change.) Two decades on, and notwithstanding several revisions to the Ministry's original curricular design, the country remains a long way off realising its transformation goals. Huge disparities persist in the South African educational terrain, leading Fleisch, for example, to claim that two systems are operative: one for the (advantaged) rich and one for the ('previously' disadvantaged) poor (2008).

Such disparities are perhaps most clearly visible in the differential levels of literacy and numeracy attainment across different sectors of the society. Brief mention was made in the introductory section of this chapter to South Africa's Grade 5 mathematics learners' participation in the internationally-oriented assessment of mathematics and science knowledge, TIMSS 2015. Grade 4 and 5 learners from 48 countries participated in TIMSS 2015. South African learners were amongst those who participated in TIMSS Numeracy (TIMSS-N), rather than TIMSS as such. As Reddy et al. (2016) explain, "TIMSS-N asks learners to answer questions and work out problems similar to those posed in TIMSS, except that easier numbers and more straightforward procedures are used" (p. 1). TIMSS and TIMSS-N scores are, however, reported "on the same scale" (Reddy et al., 2016, p. 2).

The TIMSS achievement scale is set with a centre point of 500 and a standard deviation of 100. On this scale South Africa's Grade 5 mathematics learners were ranked 47th in TIMSS 2015, with a national average scale score of 376 points[30]. In their report Reddy, et al. (2016) note that "three-fifths of South African learners (61%) do not exhibit the minimum competency in basic mathematical knowledge required at the Grade 5 level" (p. 3). Embedded within these national scores, however, was what Reddy et al. termed a "small "pocket of excellence" … [with] the potential to participate in postgraduate studies" (2016, p. 3). This 'pocket' was the 1.3% of South African learners who achieved an 'Advanced' level benchmark (above 625 points).

Reddy et al's analysis (2016) of the TIMSS 2015 Grade 5 mathematics test scores reveals significant disparities across South Africa's provinces. The Eastern Cape Province, as previously noted, is the province in which Ms M's and Ms P's schools are situated. While the Western Cape average score was the highest at 441 points; at 343 points, the Eastern Cape Province average score was the lowest, and below the national average. Along with Gauteng province, the Eastern Cape also had the widest range of scores (348 and 340 points respectively); "a reflection," write Reddy et al., "of the high variation in learner ability" (2016, p. 4). I am tempted to challenge their use here of the term 'ability'. Given their further analysis of average scores across South Africa's different school types, I might have opted instead for a term along the lines of 'opportunity'. The national TIMSS 2015 averages for South Africa's independent, fee-paying, and non-fee-paying schools were 506, 445, and 344

30 To contextualise this score within the broader spread of TIMSS 2015 outcomes, Singaporean learners scored highest (national average 618), while Kuwaiti learners scored lowest (national average 354) (Reddy et al., 2014, p. 2).

points respectively (Reddy et al., 2016); testimony again to the unequal access to opportunity playing out across the schooling system in this country.

The setting up of one of the South African Numeracy Chair (SANC) projects at my own university in 2011 represents one of several ongoing national efforts to work towards diagnosing, and thence attempting to remedy, some of the disparities in learners' early numeracy achievements. The implementation of the ANAs by South Africa's DoE as part of the then Minister of Education, Naledi Pandor's Foundations for Learning Campaign (2008, p. 7) was another such effort. It has since been abandoned[31].

The DBE's ANA strategy involved standardised nation-wide testing of all learners in Grades 1-6 and 9 in Language and in Mathematics. The Minister of Basic Education, Angie Motshekga, in her preamble to the announcement of the 2014 ANA results, implied that weaknesses in the system derive mainly from learner shortcomings. "ANA is premised," she wrote, "on the principle that effective testing will afford learners the opportunity to demonstrate relevant skills and understanding and also assist the education system with diagnosing learner shortcomings" (DBE, 2014, p. 5). The Minister's reference here to 'learner' (as opposed to 'systemic') shortcomings is an interesting, though perhaps unintentional, sleight of hand.

I touched upon the 2014 Mathematics ANA scores for the children in the Grade 4 research site classrooms in the previous section. Looking more broadly at the country's ANA results for the FP (Grades 1-3) and IP (Grades 4-6) phases, I now briefly present some data for the Grades 1-6 Mathematics ANA scores (2011 to 2014), and, because I am exploring aspects of the numeracy/ literacy interface, the Grades 1-6 ANA scores for Language also (Tables 1.4 and 1.5, below, respectively). Not only do these ANA scores show that learners' numeracy and literacy achievements are lower than what might be hoped for relative to the considerable investment – both financially and in human terms – in improving learning outcomes, but they also show the drop-off in achievement between FP and IP.

31 The 2014 ANA outcomes constitute the most recent source of ANA data to which I have access. No ANAs were written in 2015. At the eleventh hour - just four days before they were scheduled to begin (15 September) - the 2015 ANAs were put on hold by the DBE. This was in response to pressure from teacher unions, principally SADTU (the South African Democratic Teachers' Union), who argued that the ANAs were (a) too much of an additional administrative load on teachers, and (b) a financial drain on the education system. At a Community of Practice Forum in Mathematics and Science Education (26-27 September 2017), Dr Marc Chetty from the DBE confirmed that the Department is considering introducing Numeracy Diagnostic Assessments in place of the ANAs (M. Graven, personal communication, November 15, 2017).

Table 1.4: Average ANA percentage scores in FP & IP Mathematics (2011-2014)

Phase/ Grade		2011	2012	2013	2014	2011-2014 Grade Average	2011-2014 Phase Average
FP	1	63	68	60	68	64.75	55,8
	2	55	57	59	62	58.25	
	3	28	41	53	56	44.5	
IP	4	28	37	37	37	34.75	33.8
	5	28	30	33	37	32.0	
	6	30	27	39	43	34.75	

Data derived from DBE (2012); DBE (2013c); DBE (2014).

Table 1.5: Average ANA percentage scores in FP & IP Language (2011-2014)

Phase/ Grade		2011 Language	2012 HL	2012 FAL	2013 HL	2013 FAL	2014 HL	2014 FAL	2012-2014 Average HL	2012-2014 Average FAL	Phase Average HL	Phase Average FAL
FP	1	59	58	-	60	-	63	-	60.3	-	56.9	-
	2	52	55	-	57	-	61	-	57.6	-		
	3	35	52	-	51	-	56	-	53.0	-		
IP	4	34	43	34	49	39	57	41	49.6	38	50.7	39.4
	5	28	40	30	46	37	57	47	47.6	38		
	6	28	43	36	59	46	63	45	55.0	42.3		

Data derived from DBE (2012); DBE (2013c); DBE (2014).

Of particular interest for my research focus is the fact that the fall off in achievement between FP and IP average marks across the four years (2011-2014) is notably steeper for Mathematics (55.8% down to 33.8%) than for Language (56.9% down to 50.7%); a range differential of 22.0% and 6.2% respectively. It is important to note that the range comparison made for language was in respect of HL only. Data to make an equivalent direct comparison across the phases for FAL are not readily available. In my view, especially given the large-scale migration away from mother-tongue and towards English that happens at the start of the IP phase (as per Table 1.2), the 39.4% FAL average for IP may very well be a better overall indicator of the measured language abilities for a majority of South Africa's IP learners. As Table 1.3 showed, data derived from the DBE's 2010 overview of the LoLT situation in South African schools revealed that only a small percentage of IP phase learners are in fact HL speakers of English.

The bigger range differential in the ANA scores for Mathematics may be partly explained by the fact of IP learners having to contend with what is, in effect, a treble assessment load: firstly, the IP move towards more challenging and abstract mathematical tasks; secondly, the fact that, irrespective of whether or not it is the learners' HL, by this stage English will, in most South African IP classrooms, be the main LoLT and thus the language of assessment; and thirdly, the strong likelihood that the assessment tasks will have been couched in less carefully-scaffolded language as regards vocabulary and syntactic structure (see, for example, Sibanda, 2013, 2016, 2017; Sibanda & Graven, 2015). As I discuss in Chapter 2 (Section 2.4.4), a fall off in performance in Year 4 is not a uniquely South African phenomenon. American literacy researchers Chall and Jacobs (2003) labelled this fall off the ‘fourth-grade slump’, noting that such slump is especially marked for children of lower SES.

Further analysis of the Grades 1-6 ANA scores provides evidence also of the significant achievement gaps across different socio-economic sectors of South African society (see Table 1.6, below), as well as revealing in some instances, when compared to the 2013 ANA scores, that these gaps have widened (see Table 1.7, below).

Table 1.6: Average ANA percentage scores for Language (HL and FAL) and Mathematics by grade and quintile [Q] (2014)

Phase/ Grade		LANGUAGE						MATHEMATICS		
		HL		Range	FAL		Range			Range
		Q1	Q5		Q1	Q5		Q1	Q5	
FP	1	59.7	76.1	16.4	-	-	-	65.1	78.4	13.5
	2	56.9	75.9	19.0	-	-	-	59.2	71.4	12.1
	3	54.0	67.3	13.3	-	-	-	52.5	68.9	16.4
IP	4	44.6	65.4	20.8	38.7	49.8	18,1	32.8	52.9	20.1
	5	46.6	65.5	18.9	44.0	56.9	26.0	32.1	55.0	22.9
	6	50.8	70.9	21.1	43.0	60.0	17.5	38.1	60.3	22.2

Data derived from DBE (2014, pp. 89-90).

Table 1.7: Average Q1/ Q5 range changes in HL, FAL and Mathematics ANA scores (c2014)

Phase/ Grade		HL			FAL			MATHEMATICS		
		2013	2014	Change status (▲/=/▼)	2013	2014	Change status (▲/=/▼)	2013	2014	Change status (▲/=/▼)
FP	1	18.1	16.4	▼	-	-	-	12	13.5	▲
	2	18.2	19.0	▲	-	-	-	15.1	12.1	▼
	3	11.3	13.3	▲	-	-	-	17	16.4	▼
IP	4	20.8	20.8	=	18.1	18.1	=	21.1	20.1	▼
	5	28.6	18.9	▼	26	12.9	▼	22.1	22.9	▲
	6	23.9	21.1	▼	15.9	17.5	▲	19.7	22.2	▲

Data derived from DBE (2013c); DBE (2014).

As the statistics in Table 1.1 showed, the Mathematics ANA percentage scores for the learners in the two Grade 4 research site classrooms straddle both national and provincial averages, and as such, may be seen as reasonably representative of the broader picture for this country’s

Grade 4 mathematics learners. While there are some serious questions around the validity of aspects of the DBE's ANA strategy (see, for example, Spaull, 2012; Spaull, 2013a; Spaull, 2013b; Graven, Venkat, Westaway, & Tshesane, 2013), it has nonetheless helped maintain focus on the ongoing disparities in South African learners' numeracy and literacy achievements, and in my own case, contributed to motivating the present investigation into the nature and role of mathematics classroom talk in supporting children's numeracy development. Spaull (2013a) notes, "Poor school performance in South Africa reinforces social inequality and leads to a situation where children inherit the social station of their parents, irrespective of their motivation or ability" (p. 60), or indeed, despite the best efforts and intentions of their teachers.

1.12 MOVING FORWARD

This thesis is divided into six parts. Part 1 comprises this single introductory chapter in which I have introduced, justified and contextualised the study.

The next two parts (Parts 2 and 3) are single chapters also. In Chapter 2 I review literature relating to the place of talk in children's mathematical development, while in Chapter 3 I reflect on methodological decisions made in conceptualizing the design for this research study, and in its subsequent implementation. In both these chapters - so as to contextualise my study within these broader literature and methodological frameworks - I have woven in illustrative samples of empirical data from Ms M's and Ms P's mathematics teaching (either from the interviews with them, or from their observed lessons). As noted below, however, their 'classroom talk stories' as such are contained in Part 5 (Chapters 8 and 9).

Part 4 comprises four chapters which provide the study's theoretical 'frame'. In Chapter 4 I present the overall theoretical frame for the study. As mentioned earlier, my more theoretically-oriented goal for the study was to distil from the work of Vygotsky, Bernstein and Halliday those aspects I saw as pertinent to a recognition of the centrality of language (particularly oral language) in children's ongoing literacy and numeracy development. In Chapters 5 through 7, therefore, I focus sequentially (making – where appropriate – cross-connections) on aspects of each of these important theorists' work, drawing on empirical data from my observations of Ms M's and Ms P's mathematics lessons to illustrate certain theoretical points.

My decision, for Parts 1 through 4, to include elements of empirical data from the two research sites ahead of the section formally dedicated to presenting and analysing data (Part 5), may seem 'unconventional'. The advantage of this break with convention is two-fold. It allows me to 'animate' and embed in concrete terms the theoretical aspects in wholly authentic and situated ways. It also ensures the 'presence' of Ms M and Ms P throughout my telling of their respective classroom talk stories.

In Part 5 of the thesis (Chapters 8 and 9) I make links between insights derived from the Literature Review chapter (Part 2), insights derived from my theoretical framing chapters (Part 4), and insights derived from my analyses of the classroom observation and interview data to round out my stories around Ms M's and Ms P's use of classroom talk. I begin Part 5 with some brief introductory comments explaining my analytical decisions. In Chapter 8 I then focus on aspects of Ms M's use of classroom talk in mediating her Grade 4 learners' mathematical learning. In Chapter 9 I do the same for Ms P's use of classroom talk. I repeat the point made earlier that there is no comparative intent to my analytical stories of Ms M's and Ms P's Grade 4 classrooms. The intention rather is that each story should, in its own way, contribute to an enriched understanding of how teachers' use of classroom talk may afford and/ or constrain children's numeracy development, most particularly where the concurrent use of a second language is involved.

Part 6 of the thesis comprises a single concluding chapter (Chapter 10). Here I pull together the main conclusions from the study, and relate these back to the literature. I also reflect on lacunae in the overall research process, and make some suggestions for areas in need of further investigation.

Part 2: Review of literature

CHAPTER 2: THE PLACE OF TALK IN CHILDREN'S MATHEMATICAL DEVELOPMENT

CHAPTER 2: THE PLACE OF TALK IN CHILDREN'S MATHEMATICAL DEVELOPMENT

*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, p. 68)

2.1 INTRODUCTION

There has been burgeoning research interest in classroom talk coupled with a growing consciousness of the vitally important functions it serves in the teaching/learning environment. This increased interest is - in part - a manifestation of the influence of sociocultural thinking. Green and Joo (2016) note that recognition of classrooms as "communicative systems [in which] … learning … is socially and discursively constructed and interactionally accomplished … in and through language in use" (p. 2) has "expanded exponentially in the past three decades" (p. 14).

A review article by Howe and Abedin (2013) provides evidence of this exponential expansion. Their review involved an extensive data base search for publications focusing on aspects of classroom dialogue. The search threw up 1532 potentially relevant publications. Having applied a set of criteria (including, for example, whether or not a publication was peer-reviewed; whether or not it was reporting on a primary, empirically-based, piece of research), these authors narrowed their final review sample down to 238 research publications. Even given Howe and Abedin's stringent narrowing-down, Table 2.1 clearly shows how research interest in classroom dialogue has grown in the course of the past four decades. However, of the 238 sampled publications, just four were from Africa (two from South Africa). Most of the publications emanated from the United States of America (USA) (93); followed by Britain (UK) (64); Australia (19); Canada (12) (Howe & Abedin, 2013, p. 328).

Table 2.1: Research publications on classroom dialogue

Decade	1972-1981	1982-1991	1992-2001	2002-2011	Total
Publications sampled	24	42	59	113	**238**

(Figures derived from Howe & Abedin, 2013, p. 328)

In this review chapter I explore some of the extensive professional literature dealing with the relationship between classroom talk and learning, both in general, and in relation to its perceived contribution to children's developing mathematical knowledge. Because I am selecting from such an extensive body of literature, gaps in coverage are inevitable. Two additional layers of complexity in the context of the present study are included in this review of the literature. These derive firstly from the research site schools' LoLT policies, and secondly from the positioning of the research site schools' learner intake along the poverty-affluence continuum. In relation to the first - as noted previously - by Grade 4 the (official) LoLT at both schools is English rather than the teachers' and children's L1 (isiXhosa). This requires that I give attention to literature relating to second language acquisition (SLA), including implications as regards content learning through L2. And then secondly, in terms of the schools' learner intake, I need to consider literature relating to the impact of socio-economic factors on schooling outcomes.

In the following sections of this chapter, therefore:

- I begin by reviewing some of the literature relating to commonly observed **patterns of classroom talk** relative to what is increasingly seen as more desirable patterns of classroom interaction. I include here also some brief discussion of views that suggest a need for more nuanced assessments of the so-called, and ostensibly 'less desirable', IRF patterns of classroom communication.
- I then move to a review of literature dealing with the perceived **value of talk**, particularly *learner* talk, in the teaching/ learning context.
- Next, I outline some aspects from the literature which 'speak' to potential **synergies across language and literacy development, and numeracy development**.
    - Because of the LoLT arrangements at Ms M's and Ms P's schools, I look first at some *ideas relating to SLA* (particularly for contexts where the L2 is simultaneously the LoLT).
    - Next I consider literature around *aspects of bilingualism*.
    - I then focus on literature to do with Cummins's *BICS* (Basic Interpersonal Communicative Skills) */CALP (*Cognitive Academic Language Proficiency) *distinction* (1979);
    - I close off with a section where I briefly touch on literature in which *links between socio-economic status and literacy/ numeracy outcomes* are highlighted.

- In the final section of this review chapter I discuss some examples of work done around **'talking to learn'** (or - as Barnes (2008) phrased it - 'talk for learning'). I have chosen to focus here first on two such approaches:
  - I start - at what might be termed a more 'generic' level - by looking at *aspects of the 'Thinking Together' teaching approach*. Central to this approach is the promotion of collaborative 'exploratory talk' (after Barnes, 1976).
  - I then look at Chapin, O'Connor and Anderson's work around *the role of discourse and discussion in mathematics education*.

For the final two sections I look first at literature dealing with the issue of cognitive demand relative to L2 learners' levels of linguistic proficiency and then close with brief discussion of a particular conception of language use by bilinguals: 'translanguaging' (a relatively new concept which, as Canagarajah (2011) notes, has emerged as a consequence of "advances in our understanding of multilingual communication" (p. 1)). As Lewis, Jones and Baker (2012a) explain, this "new and developing term" relates to the use of two or more languages "in a dynamic and functionally integrated manner to organise and mediate mental processes" (p. 641). Similarly, in a second article in the same journal issue, they explain that it represents a 'flexible language arrangement' that "tries to draw on all the linguistic resources of the child to maximize understanding and achievement" (2012b, p. 655).

2.2 PATTERNS OF CLASSROOM TALK

A particular emphasis in current discussions around classroom talk is the extent to which the pattern of this talk is monological or dialogical in nature. Writing of the former, Glenn (2007) commented that "monologic teaching practices … support assimilationist objectives by situating the teacher as the expert whose task is to deposit knowledge into passive and stable student-receptacles" (p. 755). She cautioned, however, against a "facile dialogue-monologue dichotomy" (Glenn, 2007, p. 756). Rather than a dichotomy, classroom exchanges could probably best be described in terms of where they sit along a "dialogic to monologic continuum" (Wegerif, 2006, p. 59).

Numerous studies of classroom talk patterns have demonstrated "asymmetry" in teacher-learner talk (Mercer & Dawes, 2008, p. 55); that is, talk that is largely monologic and teacher-dominated, and where learners' oral participation is mostly restricted to short responses on command (Nystrand, Gamorgan, Kachur & Prendergast, 1997; Wells, 1986, 2000; Skidmore, 2006; Alexander, 2012). van der Veen and van Oers (2017) note that these "recitation"-oriented forms of talk give "little space for children's shared thinking and reasoning" (p. 1). Such preponderance of teacher-talk has, unsurprisingly, been found to be a feature also of South African classrooms. Hoadley, for instance, cited Chick's finding of South African township teachers "adopting authoritarian roles and doing most of the talking, with few pupil initiations, and with most of the pupil responses taking the form of group chorusing" (2012, p. 189). The work of Chick to which Hoadley referred dates back to 1996, but classroom videos from Year One of the SANC project (Graven, 2012b), and classroom observations in the course of the present study, indicate that such patterns persist. The emphasis appears overwhelmingly to be on demanding that learners exercise their listening skills rather than that they practise their speaking skills.

Teacher-dominated talk is, it would seem, a deeply engrained aspect of teachers' "*habitus*" (after Bourdieu, 1967, p. 344), and, as such – perhaps predictably - somewhat resistant to modification. As Taylor and Lelliott noted, "Even where teachers know the value of dialogic talk, they find it difficult to facilitate" (2015, p. 255). Citing research from Britain, Australia, and locally, Taylor and Lelliott noted too, that "this is true across a variety of settings" (2015, p. 255). They suggested that in some instances this type of dialogicality may even "run counter to cultural norms" (2015, p. 255). In the second of our interview sessions, I had, in fact, sought Ms M's opinion on suggestions that in some African cultures, children often are expressly discouraged from proactively coming forward with their views, being expected, rather, to wait until they are spoken to by an adult. I asked Ms M, "Is that just a stereotype, or do you think it has some ~", but before I had finished the question, she responded:

> Maybe it's still true. Maybe even from me as a teacher also.
>
> (Interview 2M, Lines 382-384)

One of my postgraduate students subsequently explained to me as follows:

> My culture disadvantaged me due to the fact that I was not allowed to ask my teachers where I did not understand, because in my culture a child does not question adults. Children just listen to what the elders have to say. I feared questioning my teachers even when some things were unclear. (Loide Amukoshi, personal communication, May 1, 2017)

Haneda (2016) writing of the "substantial body of research on classroom interaction [that] has shown the significance of dialogic classroom talk in fostering students' linguistic and cognitive development, mastery of content and engagement in learning," noted that, "despite growing support for dialogic pedagogies in educational research, large-scale studies of classroom discourse in schools have indicated that such learning and teaching practices are rarely observed" (p. 1). Reflecting on the dearth of more dialogically oriented pedagogies, Wells (2000) attributed this in part to "misconceptions … about the nature of knowledge" (p. 63). Where knowledge is perceived as "a commodity that is stored either in individual minds or in texts and other artifacts," this creates the belief that "like other commodities, it can be transmitted from one person to another" (Wells, 2000, p. 63). In terms of this 'transmissionary view' Wells suggests that classroom dialogue is "not surprisingly, seen as an unnecessary waste of time; all that students need to do is to read and listen attentively to the knowledge conveyed … and absorb and remember it for subsequent reproduction" (2000, p. 63-64).

Barnes, whose ideas around 'exploratory talk' I discuss in the next section, noted that the way teachers view knowledge influences their willingness or otherwise to encourage more dialogic forms of classroom talk in their lessons: "If they see their role as simply the transmission of authoritative knowledge, they are less likely to give their pupils the opportunity to explore new ideas" (2010, p. 7).

Sfard (2001), bringing in her metaphor of 'thinking-as-communicating', stressed "the *importance* [italics added] of mathematical conversation for the success of mathematical learning" (p. 13). "Putting communication in the heart of mathematics education," she wrote, "is likely to change not only the way we teach but also the way we think about learning and about what is being learned" (Sfard, 2001, p. 13). A core goal of post-1994 educational reform in South Africa has been precisely to help move teachers away from largely positivist views of what is to be taught/learned. In such views knowledge is seen as something external to the knower, and a teacher's job is perceived metaphorically as that of conveyor of knowledge; with learners the passive consumers thereof.

Amongst the over-arching principles informing South Africa's National Curriculum Statement (NCS) is that "an active and critical approach to learning, rather than rote and uncritical learning of given truths" be encouraged (DBE, 2011, p. 4). Language is an indispensible tool for such 'active and critical' engagement. The most recent curricular revision seems, however, to have perhaps compromised language teachers' role in supporting learners' language development *across* the curriculum, and hence their opportunities to use language as a tool for 'active and critical' engagement. As Table 2.2, below, shows, the original National

Curriculum Statement (NCS) (Grades R-9) for FAL included six 'Learning Outcomes' (LOs), whereas the Curriculum and Assessment Policy Statement (CAPS) (Grades 4-6) that replaced it includes four language skills.

Table 2.2: Comparison of 'Language Learning Outcomes' and 'Language Skills'

English First Additional Language			
NCS/RNCS (2002-2010)		**CAPS (wef 2011)**	
LO1	**Listening**	Skill 1	**Listening and Speaking**
LO2	**Speaking**		
LO3	**Reading and Viewing**	Skill 2	**Reading and Viewing**
LO4	**Writing**	Skill 3	**Writing and Presenting**
LO5	**Thinking and reasoning**		
LO6	**Language Structure and Use**	Skill 4	**Language Structures and Conventions**

Independently of the collapsing in CAPS of the explicit distinction between 'listening' and 'speaking' (in NCS/RNCS these were two distinct outcomes, LO1 and LO2), both of which are *as* important as the two skills more traditionally associated with becoming literate (reading and writing), the disappearance in CAPS of LO5 is concerning. The rationale for LO5: "*Thinking and Reasoning:* use of language to think and reason, and access, process and use information for learning" (DoE, 2002b; 2002c) was that language teachers help provide systematic and sustained support for learners' academic language development (Department of Education [DoE], 2002a). So, in the Grade 4 assessment standards under LO5 were included *use of language across the curriculum* (explaining concepts and using vocabulary of other learning areas; understanding and producing texts used in other learning areas) and *use of language for thinking* (answering and beginning to ask more complex questions) (DoE, 2002a, p. 71). The ability to understand and use academic language is critical to literacy and numeracy development. This makes it the more important, therefore, that mathematics teachers consciously take on responsibility for helping to develop their learners' metacognitive academic language proficiency to facilitate thinking and talking about mathematical concepts. This includes the vocabulary and the styles of reasoning associated with mathematics (*most especially* in contexts where there is are disjunctions between the classroom LoLT and learners' home language).

In specific reference to mathematics South Africa's NCS indicates that amongst the "essential mathematical skills" learners should develop is the capacity not simply "to listen" but also to "*communicate* [italics added], think, reason logically and apply the mathematical knowledge gained" (DBE, 2011, pp. 8-9). Here again Sfard's writing provides a useful articulation of the distinction between what she termed the *'acquisition'* and the '*participation'* metaphors (1998). Whereas the older (acquisition) metaphor conjures up images of "the human mind as a container to be filled with certain materials and about the learner as becoming an owner of these materials", in the newer, (participation) metaphor, "learning a subject is ... conceived of as a process of becoming a member of a certain community" (Sfard, 1998, pp. 5-6). Sfard was not here trying to set up a dichotomy, however. She argued instead for a place for both metaphors in educational theory and practice. "An adequate combination of the acquisition and participation metaphors," she wrote, "would bring to the fore the advantages of each of them, while keeping their respective drawbacks at bay" (1998, p. 11). In a later article she explicitly linked the participationist view of mathematics teaching and learning to sociocultural thinking. From a participationist perspective,

> ... all the uniquely human capacities [are seen to result] from the fundamental fact that humans are social beings, engaged in collective activities from the day they are born and throughout their lives. ... Although human biological givens are what makes this collective form of life possible, it is the collective life that brings about all the other uniquely human characteristics. (Sfard, 2006, p. 157)

Along lines similar to Sfard's counsel against dichotomizing 'acquisition' and 'participation' metaphors, Wells (2009) argued that, ultimately, what is needed is an "appropriate balance between "authority" and "equality"", with the onus being on the teacher to ensure that, no matter how 'collaborative', classroom discussions are "productive in achieving enhanced understanding" (page 28 of 31, online article).

Despite advocacy of a better balance between monologically- and dialogically-oriented pedagogies, it is the IRF pattern of talk (teacher initiation-learner response-teacher follow-up/ feedback), identified more than four decades ago by Sinclair and Coulthard (1975), that continues as the "predominant spoken mode for the exchange of meanings" in classrooms (Measures, Quell & Wells, 1997, p. 26); "the prototypical structure of classroom interaction" (Graesser, Gernsbacher & Goldman, 2003, p. 3); "the *unmarked*[32] pattern of classroom discourse" (Cazden & Beck, 2003, p. 170), the most prevalent (Ellis, 2012). South African classrooms are no exception where many teachers struggle to move away from a more teacher-centred habitus. (See, for example, Hoadley's Western Cape-based study (2005), and, more recently, Westaway's study of FP mathematics teachers in the Eastern Cape (2017)).

32 Contrary to popular usage of the terms 'marked' and 'unmarked', in linguistics dominant patterns are referred to as 'unmarked' where they are the *norm*. Unusual or irregular patterns are referred to as 'marked'.

Through their detailed analyses of classroom discourse, Sinclair and Coulthard (1975) were the first to provide systematic evidence of the prevalence of the three-part IRF exchange sequences. This pattern, they noted, was particularly apparent in teacher-fronted lessons (precisely the kinds of lessons predominantly observed in the present study). Mehan (1979a), in his analyses of classroom interaction, gave the pattern the alternative label of IRE (teacher initiation-learner response-teacher evaluation). The labels IRF and IRE are generally used interchangeably in the literature, though some writers, for example, Wells (1993), also sometimes use the term “triadic dialogue” (after Lemke, 1990, p. 8).

Lemke (1990) was amongst those who judged the traditional IRF/IRE triadic dialogue as having a straitjacketing effect on genuine learner participation. By so “heavily favour[ing] the power of the teacher” (1990, p. 11), Lemke saw it as reducing opportunities for learner-initiated communication, and in this sense, not really constituting dialogue at all. Measures, Quell and Wells (1997) concurred with Lemke’s assessment that if too much of a teacher’s time is spent using relatively closed IRF sequences to establish what children *already* know (i.e. operating mainly at the recall level), this tends to shut down dialogue and thereby compromise the process of learners’ ongoing knowledge construction. Writing specifically of discussion in (multilingual) mathematics classrooms in the South African context, Webb and Webb (2008) too note criticisms of the IRF cycle, particularly where it is used as a “a means of keeping control of the class … rather than a pedagogic tool” (p. 27). They note that IRF cycles are especially marked in classes where children are expected, but struggle, to “express their reasoning” through an L2 (Webb & Webb, 2006, p. 27). This, of course, is an entirely different matter than that relating to issues of classroom control.

Questions (which constitute the bulk of most teachers’ *initiating* moves in IRF cycles) form the bedrock of any teacher’s repertoire. Petty (1993) labelled them “one of the teacher’s most potent tools” (p. 146). In this sense then, IRF cycles are inevitable and essential in a classroom setting. Criticism of them can thus never be ‘blanket’. Even an apparently closed recall- type IRF cycle could be adjudged as having merit, not so much in terms of its seeking from learners something they already know, as in perhaps *reminding* them of this as a basis for moving forward. To then *take* learning forward, teachers need to remain alert to opportunities to explicitly incorporate learners’ responses into subsequent dialogue, and it is in this respect that Wells and his colleagues (Wells, 1993; 1996a; Measures, Quell & Wells, 1997; Nassaji & Wells, 2000) provide us with a more nuanced evaluation of the IRF sequence.

In distinguishing between 'monologic' (teacher talk) and 'dialogic' (teacher/learner talk) classroom interactions, Wells made a convincing case that "education requires *both* [italics added]" of these forms (2007, p. 263). In defence of teachers' frequent use of IRF sequences, Wells earlier observed that their rationale for a series of closed questions, particularly in the initial stages of a lesson, might not simply be to test whether or not learners know the 'right answers': rather, their purpose might be "to establish an agreed account" (1993, p. 27), as a prelude to moving forward. In a subsequent publication he and his colleagues argued that "the manner in which the [IRF] moves involve demanding, giving and validating information can be argued to be central to the notion of teaching and learning as a reciprocal process" (Measures, Quell & Wells, 1997, p. 26). Much depended therefore on the nature of the initiating question and on the *nature* of a teacher's follow-up (or feedback) on and/or evaluation of a learner's response. In the context of South African research, Brodie (2007) similarly noted that the merit or otherwise of an IRE/F sequence lay in the nature of a teacher's 'I' and 'E/F' moves for it is these that will "influence the depth and extent of learners' responses" (p. 4). Westaway (2017), in her investigation of three Eastern Cape FP mathematics teachers, observed, however, that the teachers participating in her study rarely provided either explicit 'evaluation' or explicit 'feedback' on learners' responses to questions:

> … There were few examples where [teachers] … evaluated or built on a response that the children provided. When a child answered a question correctly, the teachers typically moved onto the next question. Moving onto the next question is deemed to signify a correct answer. (p. 192)

The pattern Westaway describes is one of 'I+R+move on' to ask another question. It is somewhat short on any form of overt reciprocal evaluation or feedback element, and yet, as McTighe and O'Connor (2005) note, the ways in which teachers evaluate learners' verbal offerings "have the potential not only to measure and report learning but also to *promote it* [italics added]" (p. 10). McTighe and O'Connor went so far as to describe feedback as "the breakfast of champions" but expressed concern that "the quality feedback necessary to enhance learning is limited or non-existent in many classrooms" (2005, p. 16).

Two key ingredients for effective, cognitively 'nourishing' classroom exchanges are 'contingency' and 'dialogicality'.

- Contingency relates to the extent to which teachers provide constructive feedback and actively build on (that is, make contingent responses to) their learners' input, rather than simply moving briskly onto a next, predetermined, point or question. By being *responsive* in this way, teachers validate learner' thinking and encourage them towards further cognitively-oriented participation.

- Dialogicality relates to 'dialogue'. As the *New World Encyclopedia* explains, etymologically, 'dialogue' derives from the ancient Greek words διά (*dia* – 'through') and λόγος (*logos* – 'speech, reason') which - in combination - produce the word διάλογος (*dialogos* - 'a reciprocal conversation') (Dialogue, 2013, August)[33].

Contingency and dialogicality depend therefore on the degree to which learners' responses are used as the basis for *extending* discussion around a topic. Put differently, they are a function of teachers' 'uptake' of learners' verbal output. Teacher uptake conveys the message that learner verbal contributions are encouraged and constitute a valid (*and valued*) part of classroom proceedings.

Based on their analyses of classroom transcripts, Nystrand et al. (1997) were able to illustrate how contingency and dialogicality promoted a particular "mode of cognition (thinking and not just remembering) … treating students as thinkers" (1997, p. 28) rather than mere 'rememberers'. Contingency becomes especially important where a learner's contributions contain conceptual errors. It is through such errors that a teacher is able not only to identify where the learner's difficulty lies, but also – more significantly – gain insight into the nature of such difficulty, and provide opportunities for constructive mediation; mediation that provides the opportunity for engaging *thinking* (an infinitely more powerful and dynamic force than mere 'remembering'). Newer theories of second language teaching and learning embrace this point. Whereas older, behaviourist-oriented approaches attempted – through careful staging of learning and an abundance of drill and practice – to inculcate from the outset linguistic accuracy and so minimise possibilities for error; newer, communicative-oriented approaches believed that a second language is acquired through trial and error (Lightbown & Spada, 1993). In working to approximate the language forms produced by proficient users of a target L2, errors are a normal, indeed important, part of second language learners' *interlanguage*[34]. Errors provide evidence of learners' current levels of L2 knowledge and skill, and therefore

33 This etymological analysis of 'dialogue' was prompted by my seeing a similar analysis in Howe and Abedin (2013).

34 The term 'interlanguage', coined by Selinker, refers to a second language learner's emerging linguistic system (Bialystock & Sharwood Smith, 1985).

signal where a teacher needs to focus attention. In the context of the mathematics classroom, Abdulhamid and Venkat (in press) similarly note that "incorrect answers are intrinsic parts of all mathematics learning situations … natural stages in knowledge construction and thus, not only inevitable, but to be welcomed" (p. 5).

Differences in classroom discourse patterns construe "particular epistemic roles for … [learners], and these roles, in turn, engender, constrain, and empower their thinking" (Nystrand et al., 1997, p. 29). Here is how - from a teacher's side - Alexander (2012) articulated this *contingency* aspect:

> … it is mainly through and in response to the teacher's talk that the child's own talk is facilitated, prompted, inspired, probed or otherwise orchestrated; or indeed inhibited, restricted, ignored, prematurely terminated or persistently channelled along the narrow tramlines of recitation and factual recall. (p. 10)

It was in Alexander's comparative study of different pedagogical cultures in five countries (Russia, India, France, England and America) that I first encountered the term 'dialogic teaching' (Alexander, 2000). Through his analysis of the benefits of the dialogic questioning strategies used by some of the Russian primary school teachers participating in the study, he drew attention to some of the important and productive communication processes that may *actually* be at work under an – oft negatively-construed – IRF/E facade. He noted one Russian teacher's explicit distinction between the use of 'dialogue' and 'conversation' in her teaching. Drawing on Russian philosopher Bakhtin's notion of dialogue as a mixture of enquiry and conversation, he observed that it was the Russian teacher's dialogic pattern of questioning that distinguished dialogue from mere conversation. This pattern - in Alexander's estimation - made for an extremely productive blend of "questioning with the social ease of conversation" (2000, p. 520). In a much larger comparative study (the 2006 Progress in International Reading Literacy Study (PIRLS)), Grade 4 learners from the Russian Federation were ranked in first place (Mullis, Martin, Kennedy & Foy, 2007, p.37), an interesting validation perhaps of Alexander's contentions. By unfortunate contrast, South Africa's learners were ranked last in this 2006 PIRLS survey (and also in PIRLS 2011).

Alexander (2005) observed that although "classrooms are places where a great deal of talking goes on, talk which in an effective and sustained way engages children cognitively and scaffolds their understanding is much less common than it should be" (p. 2). In another publication, he further commented that, if, in our classrooms, "we want children to talk to learn – as well as learn to talk – then what they say probably matters more than what teachers say" (Alexander, 2008a, p. 24). In a second publication that same year, he identified *dialogic teaching* pedagogy as ideal for "harness[ing] the power of talk to stimulate and extend … thinking, and advance … learning and understanding" (Alexander, 2008b, p. 185).

In writing about the value of classroom discussion, Cirillo (2013) observed that the recitational IRE pattern and the more interactive patterns advocated by Alexander and like-minded thinkers "*need not be* [italics added] dichotomous" (p. 4). She noted that "talk formats operate on a continuum" with most classrooms operating "between recitation and discussion" (2013, p. 4). Much depends on the skill with which a teacher orchestrates the classroom discourse. Skilled teachers are able to perform a delicate balancing-act between leading classroom discussions while at the same time following up on and guiding in constructive ways learners' verbal contributions. "It is not," Cirillo argued, "just getting students to talk more that matters" (2013, p. 4). What *does* matter is increasing "the *amount of high-quality* talk": mathematically *productive* talk (as opposed to "irrelevant, hard-to-manage talk that serves no clear academic purpose") [italics in the original] (Chapin, O'Connor, & Anderson, 2009, p. 6).

2.3 THE COGNITIVE SIGNIFICANCE OF CLASSROOM TALK

Advocacy for more dialogic patterns of classroom talk (or 'languaging', see below) is not simply an effort to right some of the asymmetry discussed in the previous section. It is also fuelled by a growing body of theoretical, practical and research-based evidence which, as Boyd and Rubin (2006) noted, "all converge on the conclusion that engaged, elaborated student talk in the classroom enhances student learning" (p. 142), something Lyle (2008) attributed directly to the influence of Vygotsky. His ideas, she argued, have led to "an increasing body of research that supports the view that talk is the key to learning" (Lyle, 2008, p. 223). Barnes, whose work has contributed greatly to discussions around the cognitive significance of classroom talk (Barnes, Britton & Rosen, 1969; Barnes, 1976, 1990, 1992, 2008, 2010), similarly described Vygotsky as "one of the first psychologists to acknowledge the role of talk in organizing our understanding of the world" (2008, p. 7).

Vygotsky repeatedly highlighted the close links between language use and cognition, and the need therefore to see learning first and foremost as a collective social (intermental) activity ahead of any individual (intramental) achievement (see, for example, Vygotsky, 1997a). Language to Vygotsky was both a cultural and a psychological tool: a cultural tool in the sense that it may be used for "the development and sharing of knowledge amongst members of a community or society"; and a psychological tool insofar as it may be used for "structuring the processes and content of individual thought" (Mercer & Howe, 2012, p. 13). Drawing on Vygotsky's ideas, the work of Mercer (2000, 2013), Mercer and Littleton (2007) and Mercer and Howe (2012) reminds us of Vygotsky's arguments about the transforming power of 'interthinking' (a term coined by Mercer to describe the link between the *social* and *cognitive* aspects of joint talk). (See Section 2.5.1 for further discussion of the 'Thinking Together' approach developed by Mercer and his colleagues, and see Chapter 5 for a more detailed discussion of Vygotsky's seminal thinking.)

In line with Mercer's use here of the present continuous verb form 'Think-<u>ing</u> [Together]' for expressing an action or process underway; one not yet, nor indeed, by definition in the present context, that is, ideally, 'continuous'/ 'never-ending'[35], I briefly bring in here another present continuous verb form, that of 'languag[e]-<u>ing</u>'.

Introduction of the term 'languaging' into discussions around L2 learning is generally attributed to Swain (1985). She, in turn (as with Mercer and colleagues, above), attributed her decision to use it to the influence of Vygotskian views regarding the centrality of language to meaning-making. "The capacity for thinking," Swain argued, "is linked to our capacity for *languaging* – the two are united in a dialectical relationship [italics added]" (2006, p. 95). She then explained that for her, languaging "serves to *mediate cognition* [italics added]"; it is "the process of making meaning and shaping knowledge and experience *through* language [italics added]" (Swain, 2006, p. 97; p. 98).

Reflecting on work by Becker, García and Wei (2014) explain that because "language can never be accomplished ... *languaging* is a better term to capture [that] ... ongoing process that is always being created as we interact with the world lingually [italics in the original]" (p. 8):

> We are all *languagers* who use semiotic resources at our disposal in strategic ways to communicate and act in the world. ... [in the sense that languaging is the] process of using language to gain knowledge, to make sense, to articulate one's thought and to communicate about using language [italics in the original]. (García & Wei, 2014, p. 10)

35 I do recognise that 'thinking' in not simply a verb (as in, for example, '*I am thinking about it*'). It can also be a noun (for example, '*This requires careful thinking*') and an adjective (for example, '*It represents a real thinking challenge*'). The same applies to 'languaging'.

In this chapter's final section I discuss an extension of 'languaging', that of '*trans*languaging'. The latter term owes much to García's advocacy for more fluid conceptions of what exactly constitutes 'a language'.

Research has shown that languaging in the home that involves numbers in the pre-school years is a strong predictor of children's future achievements in mathematics (see, for example, Levine, Suriyakham, Rowe, Huttenlocher & Gunderson, 2010; Chang, Sandhofer & Brown, 2011; Gunderson & Levine, 2011). So too are languaging styles in the home during the pre-school years implicated in children's overall literacy development. The work of, for example, Heath (1983), and of Hart and Risley (2003) testifies to this. Heath's ethnographic study demonstrated how the different patterns of language socialisation children bring into the classroom have the power to profoundly affect educational outcomes (1983). (See Section 2.4.4 for further brief mention of her work.) Hart and Risley's longitudinal study of the amount of talk, the amount of vocabulary growth, and the style of verbal interaction between parents and children across different socio-economic status groups showed that by age three children from professional homes had - on average – been exposed to more than 30 million more words' worth of cumulative verbal experience than children whose families were on welfare (2003). One might wonder how Hart and Risley arrived at this very specific level of difference, but in fact reference to their paper does reveal the calculational basis of their claims. They explained that it took "six years of painstaking [analytical] effort" before the first results of their longitudinal research began to emerge (2003, p. 7). They expressed themselves "astonished at the differences the data revealed … [about the] ever-widening gap" in children's cumulative verbal experience across the participating (low- and high-SES) income groups (Hart & Risley, 2003, p. 7).

Once in school most of a child's classroom languaging – particularly in the earlier years of schooling – is mediated through spoken, rather than written, language (though there is considerable multimodality at work also, perhaps most especially in mathematics lessons: for example, use of the chalkboard, charts, and manipulatives such as an abacus or blocks or dice). Alexander (2008a) characterised talk's significance in the following terms:

> Talk has always been one of the essential tools of teaching, and the best teachers use it with precision and flair. But talk is much more than an aid to effective teaching. Children, we now know, need to talk, and to experience a rich diet of spoken language, in order to think and to learn. … talk is arguably the true foundation of learning. (p. 9)

It follows, therefore, that the nature of the talk taking place in classrooms can fundamentally influence the nature of the learning taking place. O'Connor, Michaels, Chapin and Harbaugh (2017) cite several empirical studies which have demonstrated that the benefits gained from well-structured discussion-based pedagogies "transfer across subject domains and persist over years" (p. 5). They indicate that this applies not just in the case of 'mainstream' learners, but also for struggling learners, learners from marginalised communities, and – most importantly relative to the present study - L2 learners.

As Barnes put it, talk has the potential to provide learners with opportunities for "*working on* [their own] *understanding*" (2008, p. 3). Reflecting on some of his earlier lesson analyses, however, Barnes later commented on teachers' predominant use of closed questions soliciting information on things already taught: a practice he uncompromisingly labelled "right answerism": something that "has value in reinforcing memory but is not likely to advance understanding" (Barnes, 2010, p. 7). Closed questions, Barnes argued, afford scant opportunity for learners "to think aloud ... to talk their way into understanding" (Barnes, 2010, p.9). Barnes's observation about teachers' use of mainly closed questions echoes findings from a great many other studies, including the present one, as well as an earlier small scale investigation of a local Grade 5 teacher's use of questions (Robertson, 2008). Barnes (1990) distinguished this sort of closed, 'presentational' talk from another style of languaging, namely, 'exploratory' talk. Exploratory talk, he argued, is "hesitant, often incomplete, hypothetical, directed not to making confident assertions but to exploring the range of possible accounts and explanations. .... Exploratory talk seems to enact publicly the processes [of] ... bringing together of old knowledge and new experiences ... so that they modify each other" (Barnes, 1990, p. 73). He further noted that "exploratory uses of language ... are important because *they lead to understanding rather than mimicry* [italics added]" (Barnes, 1990, p. 73). By contrast, "presentational talk is concerned with getting right answers, with satisfying a teacher's criteria, and not primarily with reordering the speaker's thoughts. It is likely to be abbreviated and to focus more upon surface *conformity* [italics added] to the teacher's requirements than upon understanding" (Barnes, 1990, p. 73). In a subsequent publication Barnes continued his weighing up of the relative value of 'presentational' as opposed to 'exploratory' talk. Whereas 'presentational talk' offered "a 'final draft' for display and evaluation" (2008, p. 5), exploratory talk, "enables the speaker to try out ideas, to hear how they sound, to see what others make of them, to arrange information and ideas into different patterns" (Barnes, 2008, p. 4).

Barnes observed the importance of giving learners access to the "conversations" of the disciplines: to enable them to "become participants in those conversations, not mere listeners who parrot a phrase or two" (1990, p. 83). It is these 'conversations' - mainly through exploratory talk - that form the cornerstone of the 'Thinking Together' approach developed by Mercer and colleagues which I discuss in Section 2.5.1. Mercer and Littleton (2007) described exploratory talk as "a *distinctive social mode of thinking* [italics in the original] – a way of using language which is not only the embodiment of critical thinking, but which is also essential for successful participation in 'educated' communities of discourse" (p. 66).

Interestingly relative to the context of the present study, Barnes noted of his research into the language of secondary classrooms, that the subject areas where he and his team recorded learners being afforded the greatest opportunity for exploratory talk were in *mathematics* and science lessons (Barnes, Britton, & Rosen, 1969). The value of exploratory talk is, I argue, even greater in the earlier (primary level) grades where learning habits are being laid down, and where children's reading and writing proficiency is still relatively limited, and - oftentimes - painfully slow. Graven (personal communication, February 14, 2014) commented that encouraging children to communicate their mathematical thinking verbally rather than having them routinely work things out either on paper, or by coming up to work out solutions on the chalkboard, not only helps maintain a brisk pace but also helps learners remain focused on the task at hand. South Africa's Curriculum Assessment Policy Statement for Mathematics (CAPS) allocates ten minutes daily to 'mental mathematics' for IP learners as a means of increasing children's fluency and efficiency with number facts, calculation strategies and number concepts (DBE, 2011, pp. 34-36).

'Number Talks' (after Parrish, 2010; 2011) is one of the 'mental mathematics' strategies the SANCP team trialled with its NICLE teachers. Both Ms M and Ms P were part of this trial[36]. As Parrish explained, Number Talks create opportunities for children to "collectively reason about numbers" [through] "classroom conversations and discussions around purposefully crafted computation problems" (2010, pp. xviii; 5). The rationale behind these conversations is that they encourage children to engage in precisely the kind of exploratory talk advocated by Barnes

36 Materials from NICLE's workshop session on Number Talks (February 2014) can be accessed at http://www.ru.ac.za/sanc/nicle/nicle2014/nicle1-14/index.html

where they can try out "different ways of thinking and understanding" (2010, p. 7) about mental mathematics tasks.

Writing in relation to mathematics specifically, Cirillo (2013), having critiqued the predominance of the IRE format, described classroom discussion as "a *productive alternative* [italics added] to other more passive talk formats" (p. 1). It not only provides opportunities for learners to clarify their thinking, both for themselves and for their classmates, but it is also likely to contribute to increased motivation and facilitate a greater sense of learner agency (Cirillo, 2013). This makes more sustained and meaningful engagement possible. As Chapin, O'Connor and Anderson (2009) explained, their 'Project Challenge' research work in getting low-income, minority learners to talk out their mathematical thinking demonstrated the power of a discussion-based approach as regards pushing learners "beyond their incomplete, shallow, or passive knowledge by making them aware of discrepancies between their own thinking and that of others" (p. xviii). As noted, these authors have developed a set of what they term 'talk moves' to help facilitate more engaged, and thus effective, mathematics learning discussions. I return to their work in Section 2.5.2.

In conclusion, the central value of learner talk is that it affords learners the chance to engage verbally with their mental grapplings with mathematical ideas in public ways, and to observe, and listen to their peers doing the same. At the same time, however, such talk is of value too to their teachers. In helping to make children's mental and verbal grapplings *visible*, learner talk not only provides teachers with vital insight into the nature and quality of their learners' mathematical reasoning processes, but also – and probably more importantly – provides them with vital opportunities to respond formatively and proactively when potential learner misconceptions appear to be occurring (Chapin, O'Connor, & Anderson, 2009; Cirillo, 2013). Finally, learner talk is extremely important from a *language learning* perspective, most particularly in the case of the present study as regards helping Ms M's and Ms P's Grade 4 learners develop sufficient proficiency in their second (or additional) language: English, so as to access, and make meaning of, proceedings in their mathematics lessons.

2.4 SYNERGIES ACROSS LANGUAGE AND LITERACY DEVELOPMENT AND MATHEMATICAL DEVELOPMENT

Much of the professional and academic literature produced by the mathematics education community is focused on mathematical language and on the challenges this may pose for learners, most especially, but not exclusively, those learning their mathematics in and through an L2. As noted in the introductory chapter, having been given the opportunity to become part of the SANCP community, I quickly became aware of a number of synergistic possibilities across the literacy/ numeracy fields. In this section I explore literature relating to some of these possibilities. I see it as especially important to explore the relationship between literacy and numeracy in circumstances such as those existing in Ms M's and Ms P's mathematics classrooms where, as Bohlmann and Pretorius put it, "learners' proficiency in the LoLT" has profound implications for "their understanding of mathematics" (2008, p. 42).

Coming from a literacy teaching background, I foreground language and literacy development in thinking about the challenges facing mathematics teachers. I see these as overarching proficiencies, upon which all other proficiencies depend. In 2009 a Ministerial Task Team presented its final report on the implementation of South Africa's NCS (DoE, 2009). The report included a short section (just over one page) devoted to 'language policy'. Notwithstanding its shortness, some important observations were made, some of which I cite here. Firstly, it was noted that "the thorough development of a child's language skill is a reliable predictor of future cognitive competence" (DoE, 2009, p. 41). It was further noted that "while the Home Language plays the primary role in developing literacy and thinking skills … the Language of Learning (in particular English) is the one in which students must master educational concepts …" (DoE, 2009, p. 41). It was then acknowledged that "the majority of our learners undergo the majority of their schooling learning and being assessed in English, as their second language" which made it "crucial" that attention be paid "to issues of language, in particular First Additional Language, English" (DoE, 2009, p. 41). The final point I wish to cite from the Report is its recognition that in this country *success* in English "remains a strong predictor of student *success* [italics added] at school" (DoE, 2009, p. 41).

It was this DoE Report that contributed to the country's next wave of curriculum transformation which culminated in the ushering in of the current National Curriculum and Assessment Policy Statement (CAPS), in terms of which much greater emphasis is placed on mother tongue ('home language') instruction for at least the Foundation Phase (Grades 1-3). It was noted (in Section 1.2 of the introductory chapter) that by the time children enter Grade 4 it is expected that they should be "reasonably proficient" in their first additional language (English) but that - in reality – many still do not "communicate well" in this language (English) (DBE, 2016, p. 12). The DBE therefore placed the onus on Intermediate Phase teachers to simultaneously support children's ongoing SLA *and* their content learning. Hence, there is the implicit expectation that teachers in Ms M's and Ms P's position not only attend to their teaching of mathematics, but contribute also to supporting their learners' language and literacy development in English.

Language development and literacy development although related, are separate aspects in the learning process. In the following four sections I first highlight some of the literature dealing with SLA and then move on to literature relating to literacy development in and through an L2.

2.4.1 SECOND LANGUAGE ACQUISITION

The literature on SLA is vast. For the purposes of the current section I focus mainly on two key contributors: Krashen (1981; 1982; 2009) and Skehan (2001; 2003).

Krashen's views on SLA are widely cited in the literature. A useful starting point in thinking about his theory of SLA is the distinction he makes between 'learning' and 'acquisition' (1981; 1982). Krashen argued that acquisition is a more powerful route into achieving second language proficiency. Taking an innatist (or nativist) line, he contended that the most effective SLA was that which echoed essentially those same circumstances and processes occurring in first language acquisition.

Together with Terrell (an educational theorist and linguist), Krashen developed what they termed a 'natural approach'; a comprehension-based language learning methodology in which the initial emphasis was on "the acquisition of the ability to *communicate messages using the target language* [italics added]" rather than native-like grammatical accuracy. "In the long run," they claimed, "students will speak with more grammatical accuracy if the initial emphasis is on communication skills, since real communication results in receiving more comprehensible input" (Krashen & Terrell, 1995/1983, p. 58).

Krashen's SLA ideas involve five main hypotheses, two of which he regarded as centrally important: (1) his "Input Hypothesis", and (2) his "Affective Filter Hypothesis" (2009, pp. 21; 30-33). 'Comprehensible input', for Krashen, lies at the heart of SLA. Equally important, though, are affective aspects relating to the provision of a supportive, natural and non-threatening setting so that learner's affective filters remain lowered (2009). These two elements, coupled with an authentic need to communicate, Krashen argued, are all that is needed to propel a language learner - in largely unconscious ways - towards acquiring the target language (2009). He contrasted this largely unconscious trajectory with the more conscious forms of learning that take place in language classroom situations, arguing that while the latter may provide a learner with knowledge *about* a particular language, they are less effective in terms of learning *how* to actually use that language (2009). Krashen was amongst those who believed that (in circumstance such as, for example, Ms M's and Ms P's) actually using the L2 as the LoLT constitutes the best way of acquiring that language. This is because in such a circumstance learners *would* then be using the L2 for genuine communicative purposes. In relation to Ms P and Ms M's learners, some English acquisition will inevitably occur through exposure to, for instance, environmental print, and perhaps radio and television programmes. It is, however, their classrooms that constitute the children's prime place for communicating in English.

According to Krashen and Terrell (1995/1983), acquisition of an L2 passes through the same broadly predictable stages as occur in L1 acquisition. Their five stages of SLA are outlined in the following Table, together with approximate acquisition time frames (depending on how close to optimal circumstances are) and suggestions for teacher support/ input appropriate to each stage. The input (i) to which L2 learners are exposed, Krashen argues, should be just slightly beyond their current levels of understanding ('i+1') (2009, p. 21) so that there is some cognitive challenge attached to making meaning of the input, but not so much that learners feel overwhelmed and possibly then give up. Though Krashen (2009) makes no reference to Vygotsky's ZPD idea (1930), there are clear similarities here. Linking this directly to Vygotsky's ZPD construct, however, teachers' awareness of where their L2 learners are in terms of SLA development can aid decision-making relative to how best to linguistically challenge *and* mediate content learning requirements.

Table 2.3: Stages of second language acquisition

<table>
<tr><th colspan="2">STAGE</th><th>Time frame</th><th>Learners’ verbal/ non-verbal linguistic attributes</th><th colspan="2">Helpful teacher input (verbal and other)</th></tr>
<tr><td rowspan="5">↑ ↑ ↑ SLA LEARNING CONTINUUM ↓ ↓ ↓</td><td>Pre-production (silent, receptive phase)</td><td>0-6 months</td><td>L2 comprehension is compromised by limitations in number of L2 words in receptive vocabulary. Little L2 verbalisation (mostly ‘parroting’). Non-verbal responses used instead (gestures such as nodding ‘yes’ or shaking head to indicate ‘no’, and drawing and pointing).</td><td rowspan="3">Providing a teaching environment that is L2 input-rich and non-threatening.</td><td>Introducing appropriate vocabulary items.
Not pressing learners to produce verbally, allowing them instead to respond through use of gesture.
• Show me …
• Circle the …
• Where is …?
• Who has …?
Using gesture and concrete objects to demonstrate points.</td></tr>
<tr><td>Early production</td><td>6-12 months</td><td>Size of L2 receptive vocabulary has increased, but L2 comprehension remains a challenge. Able to respond in L2 in short, simple phrases or sentences, using key words, familiar phrases and present-tense verbs.</td><td>Making judicious use of L1/L2 code-switching.
Using ‘yes’/ ‘no’/ ‘either’/ ‘or’ questions, or questions requiring simple (one- to two-word) answers.
• Who …?
• What …?
• Which is …?
• How many …?
Modelling appropriate L2 academic language.</td></tr>
<tr><td>Speech emergence</td><td>1-3 years</td><td>Larger L2 vocabulary facilitates improved L2 comprehension. Able to communicate using short phrases and simple sentences. Make some grammar and pronunciation errors; may struggle with L2 idioms and jokes.</td><td>Continuing strategic use of code-switching, but increasing L2 emphasis.
Asking questions requiring phrase or short-sentence answers.
• Why …?
• How …?
• Explain …</td></tr>
<tr><td>Intermediate fluency</td><td>3-5 years</td><td>Moderately good L2 comprehension. Able to use and produce more lexico-grammatically appropriate academic-type language in L2.</td><td colspan="2">Cutting back on L1 use in favour of L2.
Asking questions requiring more than a sentence response
• Why do you say ‘x’?
• What would happen if …?
• Why do you think …?</td></tr>
<tr><td>Advanced fluency</td><td>5-7 years</td><td>Near native-like comprehension and usage of the L2.</td><td colspan="2">Asking questions that take L2 proficiency for granted.
• Decide if …
• What do you think of …?</td></tr>
</table>

(Synthesised from Krashen and Terrell (1995/1983); Hill and Björk (2008); Murray (2011))

I discuss, in Section 2.4.4, literature relating to Cummins's distinction between BICS and CALP (1979; 2000). Krashen's estimate that it takes 5-7 years for L2 learners to develop 'native-like' competence in L2 represents an interesting parallel with Cummins's research-based findings on the time it takes (5-7 years) for L2 learners to develop their *proficiency in academic language*. Based on my observations of the Grade 4 learners in Ms M's and Ms P's mathematics lessons, I would estimate that, in most instances, the children's L2 proficiencies appear to lie somewhere between the 'early production' and 'speech emergence' stages of the above SLA developmental outline. Both groups of children are in their fourth year of formal *exposure* to English. As noted in the introductory chapter (Section 1.8), however, whereas English has been the LoLT for Ms M's learners right from Grade 1, for Ms P's learners it only became *their* LoLT from Grade 4. It is interesting to note the DBE's weekly instructional time allocations for HL and FAL (Table 2.4, below) and to then relate these to Ms M's and Ms P's Grade 4 settings.

Table 2.4: Weekly allocation of instructional time for language in FP (hours/week)

	Grade R	Grades 1-2	Grade 3
Home language	10	7-8	7-8
First Additional Language	-	2-3	3-4

(DBE, 2011, p. 6)

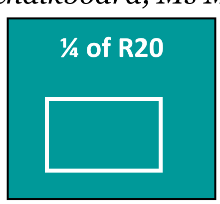
Consistent with CAPS policy, and as Table 2.4 shows, the greater time allocation is to HL. What this means is that, on entering Grade 4, Ms M's learners would as *designated* English Home Language learners (which they are not) have had – in principle – a maximum of 8 hours of English instruction per week through Grades 1-3. If one assumes a school year comprising 43 weeks (http://www.gov.za/about-sa/school-calendar), this amounts to a total of 3096 hours (129 full days) of English tuition in the course of FP. The equivalent figures for Ms P's Grade 4 learners, as EFAL learners, would be a maximum of 3 hours of English instruction per week in the first two years, and four hours in the third year: a total of 430 hours (just short of 18 full days). These figures stand in stark contrast to the figures Krashen and Cummins provide regarding how long it takes to develop BICS-, let alone CALPS-type L2 proficiency, and are perhaps the more disquieting by virtue of the fact that Krashen and Cummins were in all likelihood envisaging teaching/learning circumstances somewhat closer to optimal than is the case for many South African schools, with considerably greater opportunity for interacting with native speakers of the L2.

Despite criticism – from, for instance, Skehan (2001; 2003) - that his SLA model is overly simplistic, Krashen has not significantly modified his earlier views. In the 2009 internet version of his 1982 text, for example, he explained that this newer version contained “only minor changes” (unpaged). He then commented on how “gratifying” it was “to point out that many of the predictions made in [the 1982 text] were confirmed by subsequent research. I have changed my position on only one issue” (2009, unpaged). The issue in question was his acknowledgement of the importance of meta-cognition for learners’ ongoing learning development.

The following extract from one of Ms M’s observed lessons (Lesson 13M) gives some indication of the amount of L2 input her Grade 4 learners receive from her. The children’s responses suggest that, for many, such input is not entirely either linguistically *or* mathematically ‘comprehensible’. It is interesting to note, relative to Krashen’s comment above about the importance of metacognition (of being consciously aware of one’s own cognitive processes), the instances of *modelling* of metacognition that Ms M provides. In this extract she was trying to get her learners to work with fractions of money. She wanted them to tell her how much change she would get from R20 were she to spend a quarter of it (Lesson 13M). In talking through (modelling) a strategy (drawing a diagram) that she could use for working out what her change would be, we see her using metacognitive-type words/ phrases such as ‘maybe’, ‘I wonder’, ‘let’s see’, and speculative comments, for example her suggestion: ‘Let's try and find out if it's going to help us. I don't know’ (Lesson 13M, Turn 151). Some *modelling* of metacognition featured in Ms M’s teaching. I discuss this further in Chapter 8 (Section 8.3.5).

The shaded block indicates a chorused, rather than individual, response from the learners.

Turn	**Learner/s**	**Ms M**
91		Because of these shopping cards, maybe sometimes you don't know money. Because your parents, they just swipe with the card. But if you are sent to the shop and then you know, this is what I'm going to buy, this is what I'm expecting as my change so that I can count. Because you know, I'm buying a loaf of bread; I'm buying this; then how much do I have? How much is my change going to be? So if they don't send you to the shop, how will you be able to count money? How will you be able to count money? Because ~. You won't be able to. For instance, “If I buy three of these, what's my change, Ms M?” I have a twenty rand. This is my money. In my dreams I have it, right?
92	Yhu! [*impressed exclamations from several children*]	

Turn	**Learner/s**	**Ms M**
93		… And then how much did I spend from my twenty rand? I only spent what? One quarter. [*Teacher writes '¼ of R20' on the chalkboard*.]
94	One quarter.	
95		From my twenty rand, I spent one quarter only. How much did I spend? I had twenty rand and I only spent one quarter of twenty rand. Now, I want to draw a diagram. Maybe this is going to assist me to find out. … Before I spend one quarter of the twenty rand, I want to know how much is it.
96-124	*Learners call out a range of suggestions as to how much it might be:* one rand; seven rand; one rand, forty; fifteen rand; five rand; four rand; two rand, ninety nine; eight rand; fifty rand.	*[Ms M repeats each child's suggestion, forbearing any indication of whether it was right or wrong.]*
125		Heh! It's becoming a sort of a game.
126-146	*Several learners laugh, and continue calling out suggestions:* fifteen rand; nineteen rand; nineteen rand, ninety; nine rand; five rand*; eventually honing in on the correct answer.*	
147		I wonder how much is it exactly?
148	Five rand.	
149		Don't even raise your hands. Because you are just guessing. Just guessing out any amount, you give me. … Now your hand is up again. You want to give me another one? Hayi [*'No' in isiXhosa, though Ms M does then allow the learner to give an answer*.]
150	Five rand	
151		Five rand. Now, let's see if this diagram is going to help us. Maybe we find out, how much did Ms M spend exactly. Let's try and find out if it's going to help us. I don't know. [*Under the '¼ of R20' on the chalkboard, Ms M draws a rectangular block*.]  *[After some further turns, Ms M divides the block into 4 equal sections.]* (Lesson 13M, Turns 91-151)

What we see in the above transcript extract is plenty of input from Ms M, and repeated efforts from her to make this input comprehensible. We also see her withholding judgment on her learners' offerings so as to keep the affective filter lowered thereby encouraging more of her learners to participate. Evident also here (Turns 96-146) is the learners' joining in in what could be called 'playing school', calling out random answers that give scant evidence of Ms M's *mathematical* input having become comprehensible to them, a point I revisit in Chapter 8. I use the term 'playing school' in relation to the way in which learners can be seen here to be acting out their part in providing 'appropriate' responses (amounts of money) albeit that the amounts they suggest make no *mathematical* sense. Even Ms M acknowledged that the children were playing 'a game' (Turn 125). Her learners' talk approximated form-appropriate talk ("I must say an amount of Rands"), but it was *not* talk that provided evidence of sense-making and genuine thinking about what might be a sensible amount of Rands given the question (for example, "Well, a quarter means something is divided by 4, so ~ if ~ I divide R20 into 4 bits, how many Rands would each bit be? 20 divided by 4 equals ..... ?").

Returning to the literature on SLA, both the 'Input' and the 'Affective Filter' hypotheses are generally well-accepted, although Murray (2011) questioned Krashen's downplaying of the role of conscious, explicit *learning* in SLA (as opposed to his insistence that SLA is largely a result of unconscious *acquisition*). This she saw as a false dichotomy, arguing that "both conscious and unconscious processes are involved in learning a language" (Murray 2011, p. 2).

Skehan's main objection to Krashen's ideas was the insistence that "comprehension [necessarily] precedes production" (Krashen & Terrell, 1995/ 1983). Skehan disagreed with this emphasis on the "comprehension-driven" (2001, p. 75) receptive skills (listening mainly, but also reading) as the main mechanism for SLA. He cited several studies that indicated that input on its own (no matter how comprehensible and well-scaffolded) is inadequate. He noted therefore that while "initially, Krashen ... was very influential in arguing for both the necessity *and sufficiency* [italics in the original] of input, ... evidence from a number of sources suggested that input alone is not sufficient" (Skehan, 2003, pp. 1-2).

Skehan (2001), in tandem with the many other language theorists who support an interactionist view of SLA, argued that in order to *learn* a language, learners must *use* the language. In fact, referring back to the information contained in Table 2.3, it is essential to note Lucas, Villegas and Freedson-Gonzalez's point (2008) that teachers need to "understand that they do not serve [L2 learners] well by allowing them to be indefinitely silent. ...

[Learners] should be encouraged to cultivate their ability in English by *using* it" [italics added] (p. 364). As Huizenga argues, merely talking *to* learners is not enough: teachers, particularly language teachers, need also to talk *with* learners, and help them also to learn how to "interject ... ask questions ... request clarification" (1990, p. 151).

The productive skills (opportunities to speak, in the first instance, but subsequently also to write), Skehan argued, are *equally* essential if SLA is to be effective (2001). Such output, Swain and Lapkin (1995) point out, forces learners "into a more syntactic processing mode than might occur in comprehension" (pp. 372-373). It "set[s] 'noticing' in train, triggering mental processes that lead to modified [and thus, potentially increasingly *comprehensible*] output" (Swain & Lapkin, 1995, p. 373). I noted in Section 2.2 of this chapter Webb and Webb's observation that IRF cycles were particularly prevalent where learners were struggling "to express their reasoning" in English (2006, p. 27). Taking Swain and Lapkin's point, above, about the value of output for SLA, and looking at transcript extracts of the IRF sequences taking place in Ms M's and Ms P's observed lessons, it is evident that their learners' English output could best be described as 'syntactically limited'. The one-word answers that constituted the children's participation in the various IRF cycles generated by the two teachers provide scant evidence of syntactic processing, or of *semantic* processing (as witnessed in the 'guessing game' that took place in Turns 96-146 of the Lesson 13M extract above, which suggested that Ms M's learners were applying little mathematical 'reasoning' to the problem she had posed them).

As Murray (2011) explains, Skehan's interactionist arguments support the view that "comprehension and production of language are two different processes" (p. 9). The process of producing comprehensible L2 output clearly presents more of a challenge. It calls for more active management of, and control over the lexicogrammar (vocabulary and syntax) of the L2 (in other words, a much stronger focus on form). So, whereas Krashen contended that the grammatical aspects of a language would more or less emerge as L2 speakers worked at becoming more communicatively confident and competent (Krashen & Terrell, 1995/1983), the interactionist view is that the learning of a second language's grammar demands much more explicit attention. As such, interactionist SLA theory argues that L2 learners need not just plenty of *exposure* to the LoLT but also plenty of opportunity to practise *using* it so as to build up their proficiency and, hence, confidence in using it (Murray, 2011). This is where the primarily monologic patterns of classroom talk observed in Ms M's and Ms P's lessons become

– from a language learning perspective - particularly problematic. They also then become problematic from a *mathematics* learning perspective. This said, for the purposes of communication in a mathematics classroom, lexical and grammatical correctness is not a central issue. Rather, a more socio-culturally oriented line would be that evidence of being able to use the L2 appropriately in terms of being able to comprehend whatever mathematical text is being communicated, and to *be* comprehensible in responding to it, is what is important. This fits with Hymes's idea of 'communicative competence' (1972) (of which lexical and grammatical correctness is but one part). Lexical and grammatical correctness in a language is, in this sense, less important than learners being able to comprehend input in an L2, and subsequently convey such comprehension via this L2. Important from an interactionist view of SLA, therefore, is the feedback learners receive on the extent to which they are (or are not) communicating effectively in the L2. This is part of what the interactionist view of SLA terms 'negotiation of/for meaning'.

In bridging the 'divide' between Krashen's views and those of the interactionists, Donato (1994) argued that "modifying interaction through the *negotiation of meaning* is a means of providing comprehensible input (after Krashen) to the learner's sub-conscious language processing mechanisms [italics added]" (pp. 33-34). Similarly, Pica (1994) noted that "when it comes to comprehension, negotiation appears to be a powerful commodity" (p. 505): important not just in terms of comprehending *input*, but also in relation to producing *output* that is comprehensible (Skehan, 2001). Negotiation of/ for meaning is one of the mechanisms whereby learners could exercise greater agency over ensuring that they make sense of, and are thus more able to participate more meaningfully in, classroom proceedings. In acknowledgement of the importance of negotiation of meaning for SLA, the curriculum designers of South Africa's pre-CAPS First Additional Language Curriculum (Revised NCS) included it amongst the Grades 2 and 3 Assessment Standards for Speaking (LO2). The curriculum required that learners be explicitly taught *how* to negotiate meaning, *how* to ask for clarification (for example, 'I don't understand. Please say it again'; 'Can you explain it again, please?') (DoE, 2002a, p. 27).

As I describe in Section 8.3.10, however, most of the 'negotiation' taking place in Ms M's observed lessons was of an essentially 'one-way' sort. And, in the case of Ms P, her strategy for 'negotiating meaning' was mainly through her extensive use of her learners' L1, rather than English (see Section 9.3.1). However useful this may be as a strategy for mathematical meaning-making (clearly Ms P's top priority in this instance), from an SLA perspective it reduces her learners' exposure to English as LoLT, and thus their overall opportunities for acquiring proficiency *in* it. The challenge, not just to Ms M and Ms P, but also to all of us engaged in trying to understand and contribute towards solving such L1/L2 educational dilemmas, is that we are required to develop both the linguistic expertise necessary for us to become *second language*, as well as *subject-specific* teachers. Yet there is little evidence of a focus on linguistic expertise in pre- or in-service mathematics teacher education programmes.

2.4.2 COGNITIVE DEMAND IN MAKING MEANING

Writing of the USA situation, Kim and Suarez-Orozco (2014) note that proficiency in the LoLT "is one of the strongest predictors of academic performance [amongst non-native speakers of English]" (p. 229). They note too the "challenging and time-consuming" nature of academic tasks for L2 learners: "Even with much effort and time invested, learning in a language that they are not able to fully understand can be ineffective and frustrating for students …and may compromise their cognitive investment" (Kim & Suarez-Orozco, 2014, p. 231). In this section I briefly highlight just some of the cognitive investment expected of learners (particularly L2 learners) as they tackle academic tasks.

I included in Section 1.4 of the introductory chapter discussion of Kilpatrick, Swafford and Findell's five-stranded visual representation of the key components of mathematical proficiency (National Research Council, 2001). Like Kilpatrick and colleagues, Scarborough (2002) too chose the powerful visual metaphor of a multi-stranded rope to represent her model of the key components that contribute towards reading proficiency. (Relative to these authors' respective choices of a rope metaphor; and, on an etymological note, I was fascinated to find that it was the Latin word '*plectere*' ('to weave, braid, twine, entwine') that, with the addition of the prefix '*com-*' ('with, together'), produced our English word 'complex'.)

Figure 2.1 is my modified version of Scarborough's original diagram. Whereas she positioned her image sideways so as to emphasise the 'bottom up'/ 'top down' aspects of her reading model, I have chosen to re-position the image vertically so as to convey the foundational status of each of the various strands, starting at the base and then becoming ever more closely intertwined as a learner's proficiency increases. I have also added in more oral- and mathematically-oriented emphases.

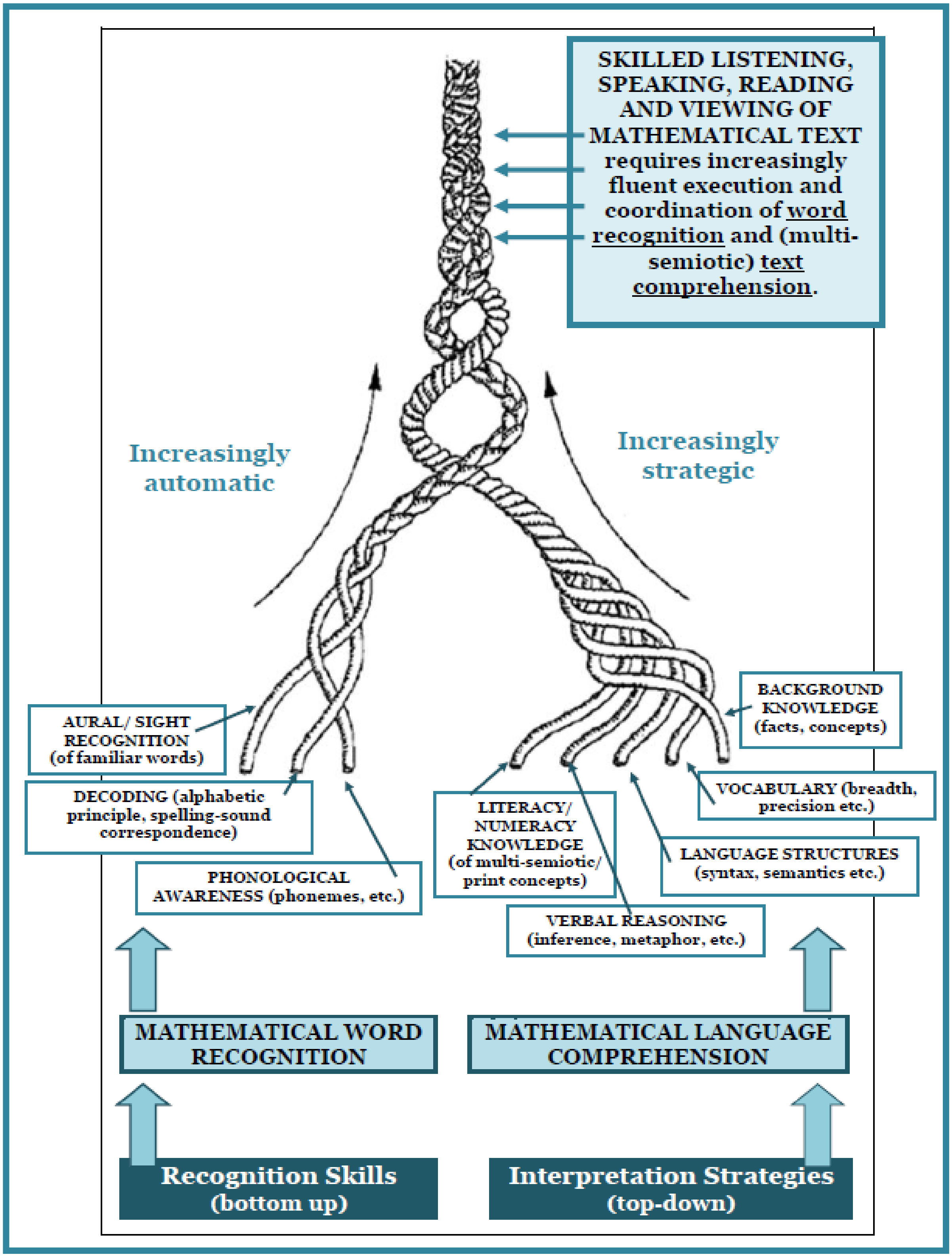


Figure 2.1: **Adaptation of Scarborough's "rope" model of reading** (2002, p. 98) **to show the elements of skilled listening, speaking, reading and viewing within a mathematics education context**

I see clear parallels between the National Research Council's rope image and Scarborough's, albeit that - for me - the Scarborough image does greater justice than does the National Research Council's image to the *increasingly complex intertwining nature* of these various components as levels of cognitive (academic) demand (and hence proficiency requirements) grow. Reverting to the parallels, though, I see Kilpatrick and colleague's 'procedural fluency' strand, for instance, as similar to Scarborough's *bottom-up skills* strands. I see also their 'conceptual understanding' strand as similar to Scarborough's *top-down strategies*. Their 'adaptive reasoning' and 'strategic competence' strands I would also see as falling within the ambit of these top-down strategies, and perhaps even their 'productive disposition' strand. I use the word 'perhaps' here because, as Graven (2015b) highlighted, mathematics learning dispositions are more to do with attitudinal factors than skills and/or strategies as such, foregrounding as they do, "sense making, steady effort, resilience, confidence and a love of mathematical activity and engagement" (p. 1).

'Sense making' inevitably demands more effort, resilience and the confidence that these *will* eventually 'pay off' where learners have first to unpack text in L2 before then accessing and thence processing its mathematical content. La Russo et al. (2016) observe that aspects of academic language "have been shown to increase processing burden" [during reading] (p. 204). Similar to La Russo et al's 'processing burden' point, Cunningham and Stanovich - focusing also on reading comprehension – earlier described how "slow, capacity-draining word recognition processes require cognitive resources that should be allocated to higher-level [cognitive] processes" (1997, p. 934). In a subsequent article Cunningham and Stanovich (1998) then referred to the "reciprocal and exponential" (p. 1) Matthew Effects[37] of different reading practices. Stanovich had previously explained this thus:

> Children who are reading well and who have good vocabularies will read more, learn more word meanings, and hence read even better. Children with inadequate vocabularies – who read slowly and without enjoyment – read less, and as a result have slower development of vocabulary knowledge, which inhibits further growth in reading ability. (1986, p. 381)

As I have tried to show through my adaptations to Scarborough's 'rope' model, all of the skills and strategies outlined here apply equally in the case of learners' *oral* processing burdens.

37 This term is of Biblical origin: "For unto every one that hath shall be given, and he shall have abundance: but from him that hath not shall be taken even that which he hath" (Matthew, Chapter 25, Verse 29 [King James Version]). Sociologist, Robert Merton, is credited with having brought the term into modern day coinage when he used it to describe the cumulative social and economic advantage of wealth and status ('the rich get richer/the poor get poorer').

This is most especially where – as in the case of Ms M's and Ms P's learners – much of this processing is needing to be done through an – as yet – inadequately mastered L2. In the final section of this chapter (Section 2.5.3) I review some of the literature around the question of how to reconcile the constraining effects of learners' limited L2 proficiency with the need to provide them with appropriate levels of cognitive challenge. In this next section, however, I consider some of the literature relating to the fact that in the case of learners such as those in Ms M's and Ms P's mathematics classrooms, two languages are at their disposal, albeit that often their L1 would seem to have been accorded a somewhat lesser 'official' status.

2.4.3 BI- AND MULTILINGUALISM

South Africa's post-apartheid LiEP document states that in terms of the country's new constitution "the Department of Education recognises that our cultural diversity is a valuable national asset and hence is tasked, amongst other things, to promote multilingualism" (DoE, 1997, p. 1). This 1997 LiEP is seen to be "an integral and necessary aspect of the new government's strategy of building a non-racial nation in South Africa" (DoE, p. 1).

South Africa's LiEP document states that "the right to choose the language of learning and teaching is vested in the individual," but has "to be exercised within the overall framework of the obligation on the education system to promote multilingualism" (DoE, 1997, p. 1). In practice, and as noted in the introductory chapter (Section 1.6) the right to choose which of South Africa's eleven official languages is exercised by schools' governing bodies, and, this has – nation-wide – resulted in an overwhelming 'vote' in favour of English from Grade 4 onwards (as shown in Tables 1.2 and 1.3).

Amongst the main stated aims in the LiEP document is the pursuit of a "language policy most supportive of general conceptual growth amongst learners, and hence [the establishment of] … *additive multilingualism* [italics added] as an approach to language in education" (DoE, 1997, p. 2). This is where the issue of 'bilingualism' enters into the present discussion.

"Bilingualism," Mackey (2000) notes, "is not a phenomenon of language; it is a characteristic of its use" (2000, p. 22). The terms 'additive' and 'subtractive' bilingualism are attributed to Lambert (Baker, 2011, p. 72). Baker (2011) explains the difference: additive bilingualism is where children learn and use "a second language at no cost to their first language;" subtractive is where children's opportunities to use their first language are restricted, posing the risk of its "being *replaced* by the second language" (p. 4).

May, Hill and Tiakiwai (2004) (in their executive summary for a report on bilingualism commissioned by New Zealand's Ministry of Education) make their views on the difference between additive and subtractive approaches very clear:

> … existing research points unequivocally to the cognitive, social and educational advantages of bilingualism when an additive approach to bilingualism is taken. An additive approach to bilingualism presupposes that bilingualism is a benefit and resource, both for individuals and the wider society, which should be maintained and fostered. In contrast, when a subtractive view of bilingualism is taken – one that presupposes that bilingualism is a problem and/or an obstacle to be overcome – negative cognitive, social, and educational consequences invariably ensue. This latter context occurs most often when bilingual students are required to learn an additional language, such as English, at the specific expense of their first language. (p. 1)

Contrary to the premises outlined in South Africa's 1997 LiEP document, beyond the FP it is the latter, *subtractive* approach that seems to be the default model in the majority of South African classrooms, this notwithstanding the document's expressed commitment to a "language policy *most supportive of general conceptual growth amongst learners* [italics added]" (DoE, 1997, p. 2). The perceived (and real) value of English has served to erode the status of learners' mother tongues, an erosion which, as Cummins (1994) argued, risks undermining "the self-confidence … essential to students' academic progress" (p. 53).

Cummins and Swain (2014/1986) note that "it is certainly more difficult to learn initial academic skills through the second language than through the first" (p. xv). The principle behind an additive approach, therefore, is that initial literacy development is done mainly through learners' mother tongue while a simultaneous start is made on the acquisition of an additional language.

In relation to the present study, the language practices in Ms M's Grade 4 class could probably be adjudged as being closer to a subtractive model of bilingualism. As Luckett (1993) observed, a 'straight-for-English' policy almost inevitably produces a situation of subtractive bilingualism. In Ms P's Grade 4 class, practices are closer to an additive one. *All other things being equal*, additive bilingualism is seen to offer "learners the best chance to develop cognitively and to succeed academically" (De Klerk, 2002, p. 2). Bohlmann and Pretorius (2008) echo this. "Being taught in the home language," they write, "confers linguistic, cognitive and affective advantages” (p. 52)[38]. They do, however, go on to comment that, “Whatever the language policy at schools, it will only be as good as the quality of education that undergirds it” (2008, p.52).

An important aspect of ‘undergirding’ in relation to bilingualism and literacy development would be how well learners’ L1 linguistic proficiencies (what Cummins (1976, p. 1) described as their “threshold level[s] of linguistic competence”) have developed. Cummins and Swain (1986) emphasised that, while “sufficient exposure” to L2 was essential, “equally or more important, [was] … the extent to which students are capable of *understanding* [italics added] the academic input to which they are exposed” (p. 80). This, they argued “is directly related to the conceptual attributes which have developed as a result of interaction in their L1” (Cummins & Swain, 1986, p. 80). Cummins hypothesised that once learners had reached a threshold level of conceptual and linguistic competence in L1, they would be better placed to *draw on* these skills and knowledge to make metacognitive and metalinguistic transfers across and between the L1 and the L2. Simply stated, a subtractive approach speaks of an inadequate appreciation then of the importance of the L1 in L2 learning circumstances: “To insist that no use be made of the L1 in carrying out tasks that are both linguistically and cognitively complex,” Swain and Lapkin (2000) argue, “is to deny [learners] the use of an important cognitive tool” (pp. 268-269). I am inclined to go even further than this and replace the word ‘important’ here with ‘essential’, for, as Cummins explains, “conceptual knowledge developed in one language helps to make input in the other language comprehensible” (2000, p. 39). In other words, there develops a ‘common underlying proficiency' (CUP) from which learners can draw. Further, such CUP, he argued, “should be conceived not just as linguistic proficiency but also in conceptual terms” (Cummins, 2005, p. 4). He subsequently explained it thus:

> Although the surface aspects (e.g. pronunciation, fluency etc) of different languages are clearly separate, there is an underlying conceptual proficiency, or knowledge base, that is common across languages. This common underlying proficiency … makes possible the transfer of concepts, literacy skills, and learning strategies from one language to another. (Cummins, 2009, pp. 166-167)

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38 Writing of these advantages, Indian polymath, winner of the 1913 Nobel Prize for literature, and fierce critic of the British raj, Rabindranath Tagore (1861-1941) expressed it thus: “It was because we were taught in our own language that our minds quickened” (translated (1992) from Tagore’s 1911 text).

Figure 2.2 below is a diagrammatic representation of Cummins's linguistic interdependence hypothesis (sometimes referred to as his 'Dual Iceberg Model'). I have annotated it to reflect the L1/L2 circumstances in Ms M's and Ms P's classrooms.

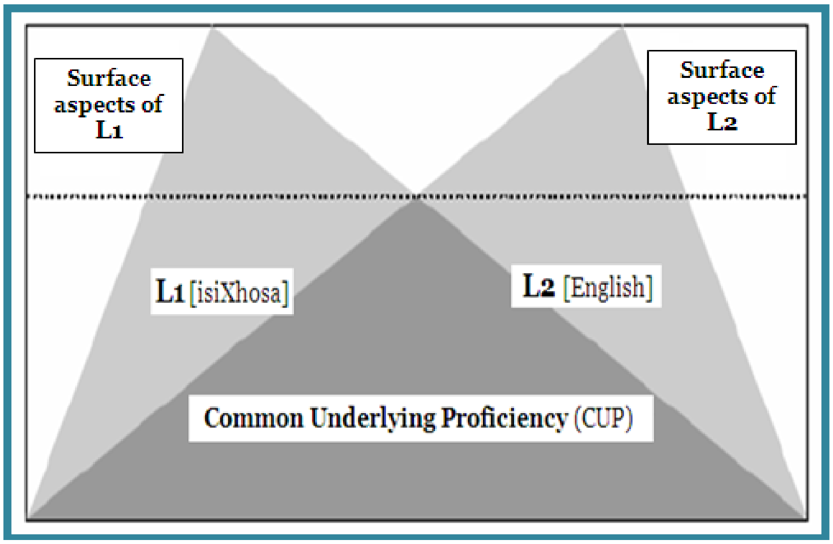


***Figure 2.2:* Cummins's 'Dual Iceberg' representation of the linguistic interdependence hypothesis** (adapted from Cummins, 1984, p.24)

Cummins (2009) argued that while CUP develops "even across quite dissimilar languages", the scale of proficiency overlap, and transfer will almost certainly differ depending on whether the languages involved are cognate or non-cognate (2005, pp. 4-5). So, in a South African context, isiZulu and isiXhosa are cognate languages in that they share a common linguistic ancestry. IsiXhosa and English by contrast are *non*-cognate languages. This means that when learners such as those in Ms M's and Ms P's classrooms are traversing the L1/L2 divide, while there is less familiar *lexico-grammatical* common ground from which they could draw, this need not undercut whatever common *conceptual* ground may already be in place.

Notwithstanding the greater relative challenge learners such as those in Ms M's and Ms P's classrooms may face, there is, on the positive side, growing acceptance worldwide of cognitive advantages inherent in becoming bilingual. Writing of such advantages, Wei (2000) noted that research suggests bilingualism offers "the possibility of more awareness of language and more fluency, flexibility and elaboration in thinking" than does monolingualism (pp. 20-21). Much depends on attitudes towards bilingual language users, but "real changes in attitudes towards bilingualism will not happen until people recognise, or better still experience, the advantages of being bilingual" (Wei, 2000, p. 19).

So, for instance, writing of bilingual Year 4 mathematics learners in Australia (the same year as the learners in the present study), Clarkson (2006) noted that, "until the early 1970s, it was often assumed that being bilingual offered no advantage for school learning. Indeed it was seen as a hindrance," a position he labelled 'naive' (p. 192). On the basis of his research, Clarkson concluded that "teachers who acknowledge …, affirm …, and encourage … [L2 learners' use of L1], while steadily building the students' competence in English, will be enhancing their students' long term mathematical performance" (2006, p. 213).

Swiss linguist, Professor François Grosjean, has advocated being "careful in interpreting the word "bilingual" when we see it or hear it" (2010, p. 4). For him, bilinguals are people "who use two or more languages … in their everyday lives", with an emphasis on "regular use of languages" rather than on "fluency" (p. 4). Taken in this sense, then, many learners in both Ms M's and Ms P's mathematics classrooms might qualify for the label 'bilingual' despite their limited proficiency in English (that is, they use it regularly in class, even while not fluently). They may thus, also, ultimately, be in line to reap the kinds of cognitive advantage identified above. Useful as Grosjean's 'gentler' definition of bilinguals might be from an identity perspective, I find Cummins' emphasis on *proficiency* in a second language, particularly cognitive academic proficiency, to be more helpful for apprehending the nature of the sense-making challenges encountered by so many South African learners. Cummins's distinction between everyday use of a language and classroom use is the focus of the next section.

2.4.4 THE DISTINCTION BETWEEN BICS (Basic Interpersonal Communicative Skills) AND CALP (Cognitive Academic Language Proficiency)

As Gibbons (2003) observed, and as noted in Section 1.5 of the introductory chapter, learners "have to learn to use language for a range of purposes and in a range of cultural and situational contexts" (p. 250). She described this in terms of their traversing a 'mode continuum' from commonsense understandings of things to more specialist understandings of things (in the present instance, school mathematics). In moving along the continuum, they need to learn to move between - and distinguish between – "more spoken-*like* [and] more written-*like* [italics in the original]" discourses, or styles of language (Gibbons, 2008, p. 34). Some key points of difference in these linguistic styles are presented below in table format.

Table 2.5: A comparison of characteristics typical of spoken and written language

More spoken-*like* ←←Mode continuum→→	More written-*like*
SPOKEN LANGUAGE	**WRITTEN LANGUAGE**
Interactive: involves turn-taking, often in a face-to-face setting	Non-interactive: has a monologic organisation
Context-dependent (language *per se* is not the only means of communicating meaning; gestures and other contextual clues may augment the 'message')	Context independent (language, plus in some instances, illustrative material, is how meaning is communicated)
Dynamic in structure, and responsive to unfolding contextual circumstances	Static (finalised) in structure
Largely unrehearsed, and thus characterised by spontaneity (false starts, incomplete sentences, reiterations, hesitations, and so on)	Rehearsed (through planning, drafting, rewriting) and thus more 'polished' than spontaneous
Uses an everyday lexis	Uses a formal lexis
Frequently uses non-standard grammar (which may then make it more grammatically intricate)	Uses standard grammar (which is likely then to make it more grammatically simple)
Relatively lexically sparse, using mainly 'high frequency'[39] words	Relatively more lexically dense

Adapted from Eggins (2004, pp. 91-94) and Gibbons (2006, p. 33)

Eggins (2004) notes that these linguistic differences "are not accidental, but are the functional consequences of the situated differences in mode" (p. 94). During my periods of observation at Ms M's and Ms P's schools, I frequently arrived either shortly before the start of the school day, or else towards the end of the mid-morning break-time. I would make my way to the classroom through groups of children either sitting and chatting, or teasing one another as they waited in line to buy packets of crisps, brightly-coloured sherbet straws, and such like from the school tuck-shop. Some others were engaged in taking turns to nimbly skip back-and-forth across a frayed skipping rope, or playing 'catch' with an empty plastic cool-drink bottle. Noisy and exuberant would be a good way of describing the activities; all of the learners were communicating in their L1, isiXhosa. I do not recall a single instance of hearing any of the children speaking in English to one another during these times. Once in the classroom, the noisy exuberance – as expected – abated. It was now time to 'talk maths'. But how do children learn to 'talk maths'? And most particularly, how might such more academically-oriented talk be affected by the fact that – officially, at least - such talk ought to be in and through the medium of an L2 (English)?

39 'High frequency' words are especially significant in the case of the literacy development of learners such as Ms M's and Ms P's Grade 4s. Because, as Nation and Waring (1997) note, not all words are "equally useful" (p. 8), ensuring that L2 learners "know the 3000 or so high frequency words of the language … is an immediate and high priority" (p. 11).

I referred in Section 2.4.2 to La Russo et al's point (2016) about the literacy challenge that academic language poses. They noted too the varied ways in which 'academic language' is conceptualised, often conflated simply with academic vocabulary. In my discussion of Halliday's conception of the mathematics register (see Chapter 7, Section 7.7) I emphasise that the academic language of mathematics involves much more than just vocabulary. The focus of La Russo et al's 2016 article was on the literacy challenges that academic language pose for deep reading comprehension (that is, reading comprehension that involves, for example, drawing inferences, evaluation, critical reflection, as opposed to simply literal retrieval of the surface meanings of a text). They cited research showing how such language adds to children's "processing burden" (p. 204). This 'processing burden' I argue holds equally true in relation to comprehending academically-oriented *talk* taking place in mathematics classrooms. And yet, as Probyn (2016) noted, "there has been little attention given to the question of classroom discourse, in particular the kind of public talk that structures and chains knowledge into clear conceptual frameworks; that is contingently responsive to students' contributions to the construction of meaning; that provides a bridge between everyday language and academic language" (pp. 12-13).

I find the work of Cummins (1979; 1981; 2000) especially helpful for conceptualizing the differing language processing burdens of different styles of language use. Cummins highlighted the distinction between what he termed *basic interpersonal communicative skills* (BICS) (the 'everyday' or 'social (Skuttnab-Kangas & Toukamaa, 1976)) and the *cognitive academic language proficiency* (CALP). Cummins likened these two 'language registers' to Gee's (1989) conception of primary and secondary discourses (see Section 1.5 of the introductory chapter):

> Primary discourses are acquired through face-to-face interactions in the home and represent the language of initial socialization. Secondary discourses are acquired in social institutions beyond the family (e.g., school …) and involve acquisition of specialized vocabulary and functions of language appropriate to those settings. (Cummins, 2008, p. 75)

It was the children's primary discourse (L1 'everyday' BICS) that I was overhearing as I made my way to Ms M's or Ms P's classroom. It is grade-appropriate competence in mathematical CALP (and L2 CALP, at that) that is the ultimate goal inside their mathematics classrooms. Table 2.6, derived from a mathematics curriculum developed by the Russian psychologist Davydov, provides a mathematical illustration of a transition from everyday BICS-type language towards mathematically-appropriate CALP-type language. Setting aside, for the moment, any additional challenge involved in a simultaneous transition from L1 to L2, the Table provides examples of how everyday comparisons of quantity might gradually move towards more formalised, mathematical, and symbolic (algebraic) representations of quantity. (Included in colour are the isiXhosa equivalents of the first two of these forms of representation.)

Table 2.6: Progressing from everyday descriptions to abstract representations (after Davydov)

Children's existing words for quantity	**same** [iyafana]	**bigger** [inkulwana]	**smaller** [incinanana]
↓	↓	↓	↓
More precise comparative language	**equal** [ziyalingana]	**more than** [inkulu kune]	**less than** [incinane kune]
↓	↓	↓	↓
Abstract symbolic representation	**a=b**	**a>b**	**a<b**

(Adapted from Renshaw & Brown's written description, 2007, p. 533)

In discussions around the BICS/ CALP distinction, Cummins made the important point that although BICS provides the route *into* CALP, BICS and CALP are "conceptually distinct" and thus not "reducible one to the other" (1999, p. 2). If teachers are not aware of the differences between "the surface or conversational aspects of children's language and the deeper aspects of proficiency that are more closely related to conceptual and academic development" (Cummins, 1994, p. 37), the risk is that they may take a learner's BICS as evidence of overall linguistic proficiency. They may then fail to adequately provide for the ongoing development of that learner's CALP. This, Cummins argued, has contributed to a deficit discourse whereby a disproportionate number of L2 children have been diagnosed as "learning disabled" (1999, p. 5). Far from their circumstances being related to problems of cognitive capacity, however, it probably has everything to do with the fact that such L2 children have been linguistically compromised, having been given neither the necessary support nor sufficient time to properly develop their CALP (Cummins, 1994; 1999; 2008). As Wong Fillmore (2009) explained: "CALP is harder to learn in a second language if it is underdeveloped in the first" (p. 3).

Cummins's research findings indicate that, whereas it is possible that learners may achieve everyday conversational fluency (BICS) in L2 within two years, developing CALP to the same level as a native-speaker in L2 could take between 5 and 7 years (n.d., p.1). Research by Collier and Thomas echoes this finding of a 5 to 7 year timeframe (Collier, 1995), as does Hakuta, Butler and

Witt's research (2000), and that also of Demie (2013). The consistency of such findings highlights the enormous challenge L2 learners face if they are to keep pace with curriculum demands. Macdonald's metaphor of 'swimming up the waterfall' (1990; 2002) comes again to mind. Important too to note here is that the time-frame findings cited above were in all likelihood derived from teaching/ learning contexts rather different from the dysfunctional circumstances that a range of research (for example, Fleisch, 2008; Graven, 2014a) has indicated is prevalent in many of South Africa's schools.

Cummins (2008) presents his BICS/CALP distinction as "two intersecting continua" (page 5 of 14, online article) to illustrate how the cognitive demands of a [language] task might be categorised. In Figure 2.3 below is Cummins's quadrant diagram. (I have switched around his vertical and horizontal axes.) In terms of the two continua, the difficulty of a task is a function of (a) the extent to which it is embedded in more concrete and familiar territory where plenty of contextual clues are likely; and (b) the level of cognitive demand. "Effective instruction for [L2 learners]," Cummins suggested, "should focus primarily on context-embedded and cognitively demanding tasks" (2008, page 5 of 14, online article). That would be Quadrant 2 in the Figure. Ultimately, however, the aim is to help learners towards being able to "manipulate and interpret cognitively demanding context-reduced text" (Cummins & Swain, 2014/ 1986, unpaged, online e-book): that is, to help them move into Quadrant 4. The work done in Quadrant 3 serves to prepare learners for this transition to more linguistically and cognitively demanding activities. In Vygotskian terms, this is where the mediation by a more knowledgeable other would mainly happen. While there is considerable merit, most especially for younger learners, in starting off in Quadrant 2, it would be counterproductive to remain here for any length of time. Almost *nothing* would be gained from time spent in Quadrant 1.

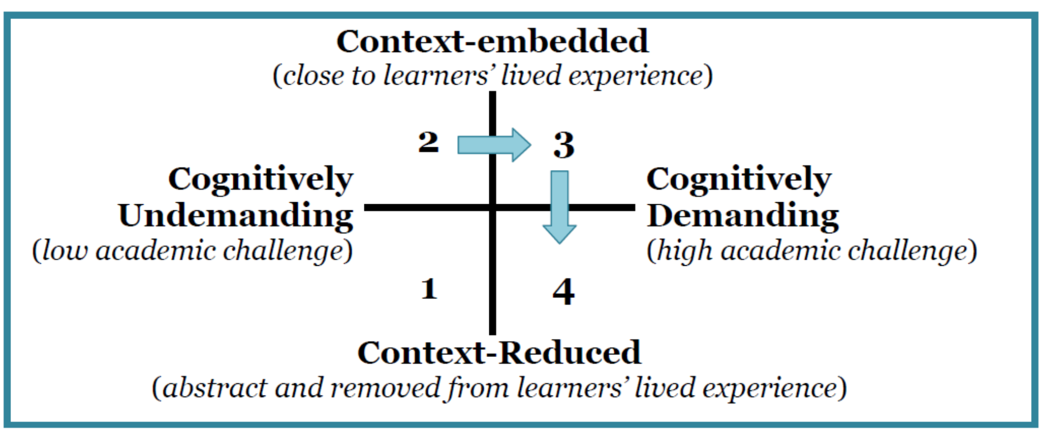


Figure 2.3: **Cummins's quadrant diagram** (adapted from Cummins, 1984, p. 12)

In Section 2.5.3 I refer to Mariani's framework (1997). He, like Cummins, chose to use a quadrant diagram to explain his thinking. Staying with Cummins's work though, I have taken some data from the first of Ms M's observed lessons and from a subsequent interview with her to contextualise some of the above discussion of Cummins's notions of BICS and CALP and to illuminate their relevance to this study. In the interview excerpt below, Ms M is explaining to me her challenge in pushing her Grade 4s to, as she termed it, "grow mathematically" through the use of CALP-type "mathematical language". Ellipsis dots [...] indicate where text not directly relevant to the present point has been omitted.

> **Ms M:** It's difficult for them to understand a concept. It's so difficult. The concept is not there. The language is not there. [...]
>
> **SAR:** Can you talk to me a little bit about when you say 'a concept' what you mean by that? [...]
>
> **Ms M:** Ah. What fraction is shaded, maybe? They should know what a fraction is. If I say one fraction is shaded, one of them will write: 1. Is one a fraction? How does a fraction look like? Or, if I say, "What are the factors of four?" or "What are the multiples of six?" 'Multiple' - if you don't know the word 'multiple', what does it mean? How can you give me the multiple when you don't even know the word 'multiple'? What does it mean? So you see? Then I have to use them [*referring to the terms 'fraction' and 'multiple'*], because this is mathematical language.
>
> **SAR:** And how would you distinguish between a concept and a vocabulary item?
>
> **Ms M:** Is it not the same maybe? Almost the same? It's almost the same. [...] And sometimes what I'll do, I'll explain in class maybe in their books at the back: "Write this." But it's just there to be there. Nothing else. They won't use it. And I don't like giving examples. [*She indicates dividing a cake into slices*.] [...] I think they should come to a stage where they know if I give this, [*she indicates numbers separated by a fraction bar (for example ½; ¾)*] this is what I mean, without being given any example. Otherwise they won't grow mathematically.
>
> (Interview 2M, Lines 140-167)

In Figure 2.4 below I have linked some classroom data to the above interview data to provide an example of Ms M seeking to help her Grade 4s "grow mathematically". The first 36 turns of this lesson (1M) drew entirely on BICS as Ms M established whether her learners preferred cake, or pizza (or some other few options mooted by learners). Turns 37-42 moved briefly into CALP territory, as Ms M wrote two fractions on the chalkboard (1/2 and 1/8) and got the learners to name these (a half, an eighth). Turn 43 marked the start of Ms M's asking the children to indicate whether they would prefer a half or an eighth of a cake, and why (a gentle transition from BICS to CALP type talk). Turns 69-78 then move exclusively into CALP territory as Ms M got the children to use the conceptual fraction chart pinned up at the back of the classroom to identify which was bigger, a quarter or an eighth. Turns 79-92 moved back to a mixture of BICS and CALP as Ms M then asked a few more learners whether they would prefer a half or an eighth of a cake. Then Turn 93 marked a jump away from the concreteness of dividing up the (hypothetical) cake towards getting the children to use mathematically appropriate CALP-type terminology to talk in abstract and symbolic ways about the relative sizes of different fractions of a whole.

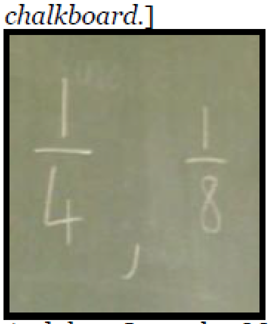
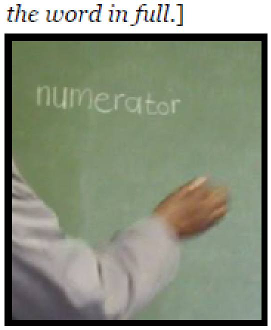
Symbolic to concrete to more abstract mathematical representation		
Moving from symbolic to concrete, everyday	**Labelling the symbolic**	**Using the symbolic to 'grow' them mathematically**
<u>**Ms M introduces the lesson focus**</u>: Lonwabo, we have done fractions for quite a long, long, long time – last term. I'm not going to draw anything on the chalkboard. But, if I'm saying to you that there's this cake, do you like cake? **(Lesson 1M, Turn 1)** [Turns 37 and 41, she *writes two fractions on the chalkboard.*]  And then, Lonwabo, Ms M is saying, "Lonwabo, would you rather have a quarter of a cake?" You tell Ms M that you like cake so much. Tell me - would you rather have a quarter of a cake or an eighth of a cake? And why? Which one? **(Lesson 1M, Turn 43)**	<u>**It takes Ms M twelve lesson turns to coax her learners towards correctly 'naming the parts':**</u> **Ms M:** Now what is going on about all those fractions? What is the same? What is common? ... [*Ms M points to each of the numerators.*] What do we call those ones? One, one, one, one, one – what do you call them? It begins with the letter 'n'. It begins with the letter 'n'. Letter 'n'. [...] It begins with letter 'n'. [...] It begins with letter 'n'. You've still forgotten? And then letter 'u'. Then I stop. [...] So I've written the first two letters of the word that I'm looking for. Akhona? **L:** Numerator. **Ms M:** Thank you. [*Ms M writes the word in full.*]  **(Lesson 1M, Turns 103-115)**	<u>**Ms M comments in the interview**</u>: "I think they should come to a stage where they know if I give this [*symbol of a fraction*], this is what I mean, without being given any example. Otherwise they won't grow mathematically." **(Interview 2M, Lines 165-167)**

Figure 2.4: **An illustration of Ms M's data showing movement from symbolic to concrete to abstract representation**

In the lead-in to Figure 2.4, I used the word' jump' advisedly. As Gibbons (2003) has explained, effective teaching and learning, particularly in L2 contexts, requires "*mediation* [italics added] across orders of discourse" (p. 250) to assist children in moving away from everyday ways of thinking and talking about things towards the increasingly formalised, abstract ways of thinking, talking (and writing) about mathematical ideas. In other words, they need help in traversing the 'mode continuum' (Gibbons, 2003, after Halliday).

I earlier (Table 2.5) listed some characteristics typical of spoken as opposed to written language. The qualities of the spoken listed there (for example, face-to-face interaction, spontaneity, lexical simplicity) sit well with Barnes's characterisation of 'exploratory talk' ("easy and impermanent" ... [a] tool for trying out different ways of thinking and understanding") (2010, p. 7). What the turns extracted from the lesson for Figure 2.4 show is time spent at the everyday BICS level talking about cake (and subsequently, but not shown here, pizza, pie, KFC, fish), and then a jump across to CALP-type naming of fraction parts, with little opportunity for learners to do any verbal wrestling (exploratory talk) with the notion of how big a slice of cake they might get relative to how many slices it is to be divided up into. Ms M did all the steering, and most of the talk. As I show in a later analysis of this lesson, learners' contributions were overwhelming one or two words in direct response to Ms M's questions (see Table 8.4, Section 8.3.3), and the classroom talk can be seen almost to leap from one pole of the mode continuum across to the other pole, with negligible time spent in the middle, *sense-making*, ground. (For example, connecting the everyday notion (and talk about the notion) that the more people you share the cake with, the smaller the piece of cake (which learners seem to know well), with the more abstract concept of the greater the denominator of a unit fraction, the smaller the fraction, could have enabled sense-making and a more seamless transition between BICS (talk about cake) to CALP (talk about relative size of unit fractions ¼ and 1/8 written on board).

Ms M's coaxing the Grade 4s towards correctly naming 'numerator' (and subsequently 'denominator') may suggest that the children's introduction to fractions and to these formal CALP-type mathematical terms was relatively recent. This was not the case however. So, for instance, in Turn 149 (extracted from the sixth of Ms M's observed lessons) we see her sharing with her Grade 4s something of her chagrin at their rate of mathematical acquisition.

Turn	Learners	Ms M
149		Grade 4s, you have been doing fractions since Term 2, now this is Term 3, and you are still busy with fractions. So, please, whatever we did last term, it's not that it's a new term, then we should just forget. "**Hayi** [*'No' in isiXhosa.*], it was for Term 2." No! It still continues to Term 3. We continue to Term 4. We still continue into Grade 5. It's not Grade 4, and then we are in Grade 5, and then have to forget about what we did in Grade 4. "Ah, no! We did it in Grade 3. I can't use Grade 3 work in Grade 4 Now we're having another phase in another grade." It doesn't work like that. It doesn't work like that. You have to understand whatever you learn, you build on to whatever. So there's nothing that we say, "This was for Term 1. Then we just forget. It has nothing to do with Term 2. Nothing to do with Term 3." (Lesson 6M, Turn 149)

In reflecting on why the rate of acquisition appeared so frustratingly slow in Ms M's estimation, one wonders whether, had more time been given for learners' participation in BICS-type exploratory talk, the rate of sense-making acquisition might have improved. Contextualizing this within Cummins's Quadrant diagram, it would seem that, having spent some lesson time in Quadrant 2 (context embedded, cognitively undemanding), little time was then spent in Quadrant 3 (still context embedded, but slightly more cognitively demanding), before the leap was then made into Quadrant 4 (both context reduced *and* conceptually more cognitively demanding). I take up this discussion more fully in Chapter 8.

There have been criticisms of Cummins's BICS/CALP distinction, which he himself listed in his 2008 article. These included that the distinction is an "oversimplification" of the issue; that it represents "an "autonomous" rather than an "ideological" notion of literacy"; and that it is a "deficit theory" (Cummins, 2008, page 8 of 14, online article). These are criticisms Cummins largely rejects, and I agree with his rejection of them. The issue of academic language proficiency highlighted in his work continues to focus attention on the importance of recognizing the differences between 'playground' and 'classroom' language. Academic language continues to be "widely cited as a literacy challenge", albeit that definitions of what exactly constitutes 'academic language' remain fluid; and a tendency persists for 'academic language' to be conflated simply with 'academic vocabulary' (La Russo et al., 2016, p. 204).

Work by, amongst others Halliday (1974, 1993); Schleppegrell (2004;2007; 2011); O'Halloran (2005; 2011); and Moschkovich (2015), much of it in specific relation to the language of mathematics, shows that the 'academic register' contributing to learners' CALP extends significantly beyond simply terminology. In Chapter 7 (Section 7.7) I discuss further some features of the mathematics register relative to Halliday's SFL work, but, in closing the present section, it is important to stress that Cummins does not conflate ‘academic language’ with ‘academic vocabulary’. For him, CALP has never simply been just about the words. CALP is “the ability to understand and express, in both oral and written modes, concepts and ideas that are relevant to success in school” (Cummins, 2008, page 5 of 14, online article). It involves the *language skills* with which to engage with content learning; the skills of using language in academic ways to ‘talk about’ (and hear, and think, and read, and write about) content: skills such as being able to use language to compare; to analyse and then synthesise; to make inferences; to evaluate. As was shown in Figure 2.4, however, Ms M ‘jumped’ from the everyday to the academic CALP-type terminology, with negligible exploratory talk in which the everyday was meshed with the academic.

As Heath (1982) wrote, “the *culture* children learn as they grow up is, in fact, "ways of taking" meaning from the environment around them” (p. 49). Children coming from homes in which there is the kind of “literacy orientation” (Heath, 1982, p. 55) culture described above are thus more likely to enter the classroom pre-primed to participate in the kinds of CALP-type linguistic activities identified here than peers who have not had the benefit of this kind of exposure.

2.4.5 SOCIO-ECONOMIC STATUS AND LEARNING OUTCOMES

As noted in the introductory chapter, Ms M and Ms P both teach at township schools and, as such, serve learners from lower down in the broader community’s socio-economic strata. Links between learners’ socio-economic status and inequalities in learning outcomes are well-documented and a source of concern world-wide not least amongst members of the mathematics education community. As with many educational concerns the root causes for such links are complex, multiple, and multi-faceted, and, as Valero and Meaney (2014) note, may be exacerbated by too narrow a gaze. For better or worse, however, my gaze in this thesis is upon language, and on how *access* to the kinds of language valued in the classroom setting, contributes to differential achievement across different socio-economic sectors.

Bernstein, as I discuss in Chapter 6, was amongst the earliest sociologists to highlight the link between social structure, socio-linguistic patterns, and patterns of unequal educational outcomes (see Section 6.2). Writing the foreword to the second volume of Bernstein’s *Class, codes and control* text, Halliday explained how Bernstein’s work had helped show how such patterns are - in part - a consequence of “the relative orientation of different social groups towards the various functions of language" (Halliday, in Bernstein, 2003/ 1973, p. xiv). As Bernstein himself remarked, "As a child progresses through a school it becomes critical for him to possess, or at least be oriented toward, an elaborated code if he is to succeed" (1964, p. 67).

Cummins's articulation of the different functions served by BICS as compared with CALP resonates with Bernstein's ideas insofar as it is the predominance of CALP-type language in the classroom that often undermines the ease with which certain groups of children can engage with classroom language. So, too, does the work of Heath (1983); Chall (2000), (and Chall and Jacobs, 2003); and Hart and Risley (2003), all of which speaks to the potential consequences of the different types of language exposure children experience during their periods of primary socialisation. Although perhaps 'dated', each of these latter three contributions to our understanding of the impact of socio-economic status on learning outcomes continues to be widely cited in current literature. For this reason I briefly discuss each below.

- Heath, a linguistic anthropologist, undertook a longitudinal ethnographic study (1983) through which she was able to demonstrate how different socio-cultural contexts conduce to different conceptions of literacy, and hence, different literacy practices. Some of these practices marry well with school practices, others less so, with consequential educational success or failure.
- Chall's work was mainly concerned with children's *reading* development, particularly as they progress from 'learning to read' to 'reading to learn'. As noted earlier, the phrase 'fourth-grade slump' is generally attributed to her. This 'slump' captures what often happens in Grade 4 when, in place of the carefully controlled and scaffolded texts of the earlier grades that learners have become accustomed to, they now encounter texts which are "more varied, complex, and challenging [both] linguistically and cognitively" (Chall & Jacobs, 2003, unpaged). This places considerable strain on learners' bottom-up recognition skills as well as their top-down interpretation strategies (see Figure 2.1, Section 2.4.1). As noted earlier, this strain is most acutely felt by "low-income children" (Chall & Jacobs, 2003, unpaged). There is the problem – identified by other writers also - that "the later one waits to strengthen weaknesses, the more difficult it is for the children to cope with the increasing literacy [and – I would add – numeracy] demands in the later grades" (Chall & Jacobs, 2003, unpaged).

- I made mention earlier in this chapter of Hart and Risley's longitudinal study in my discussion of the cognitive significance of classroom talk (Section 2.3). I reiterate here their study's startling finding regarding the differential in word exposure: namely, that by age three, children from middle-class professional homes had experienced 30 million more words' worth of word exposure than their working class and welfare family counterparts. In their analyses Hart and Risley also looked also at the nature of these family verbal interactions, and noted that middle class children experienced significantly more encouraging, affirming verbal interactions than did the children from working class and welfare families (2003). Hart and Risley calculated that the ratio of encouraging to discouraging verbal interactions children from professional homes experienced was roughly 32:5; while for children from welfare homes this was closer to 5:11 (2003, p. 8). "Cognitively, experience is sequential," they wrote. "Experiences in infancy establish habits of seeking, noticing, and incorporating new and more complex experiences, as well as schemas for categorizing and thinking about experiences" (2003, p. 9). In comparing the different groups of children participating in the study at the pre-school stage with their subsequent developments in vocabulary and language proficiency by Grade 3, Hart and Risley reported: "We were awestruck at how well our measures of accomplishments at age three predicted measures of language skill at age nine–ten" (2003, p. 8). They also (as I noted in Section 2.3) remarked on the widening performance gap between the different socio-economic groups as children progressed through the early grades, prompting perhaps the title (*The early catastrophe*) for one of their reports on their study.

Moving to more local (and recent) analyses, I noted in Tables 1.6 and 1.7 (Section 1.9 of the introductory chapter) this same widening of gaps in the Language and Mathematics ANAs scores across the different South African school sectors (quintiles).

Although writing considerably earlier, and not in relation to local circumstances, Bronfenbrenner's review of research on links between family and school indicated that several findings showed that "children from homes or classrooms affording greater opportunities for *communication* [italics added] and decision-making not only exhibited greater initiative and independence after entering high school, but also received higher grades" (1986, p. 272). He then went on to add that, "The effects of family and school processes were greater than those attributable to socio-economic status or race" (Bronfenbrenner, 1986, p. 727). While not to gain-say Bronfenbrenner's important point here, the kind of poverty experienced by many of South Africa's learners inevitably impacts negatively on their capacities to fully exploit their schooling opportunities. In a recent 'Poverty Trends Report' Statistics South Africa put the percentage of South African children "living below the poverty line" at 55.7% (2014, p. 29). As I discuss further in Chapter 9, poverty was particularly, and poignantly the case with some of Ms P's Grade 4s, so much so that, in referring to some of the social problems her learners faced, Ms P remarked: "… the kid when he or she is in the class, she's not thinking of what you are teaching. She is thinking, 'What am I going to eat at home?'" (Interview 3P, Lines 99-101).

2.5 LEARNING TO TALK/ TALKING TO LEARN

Considerable attention within the foregoing body of literature has focused on the importance of more communicative and interactive approaches to teaching, and on the use of talk as a key mechanism for enhancing learners' ability to make mathematical meaning. So how do children develop their capacity for the kinds of oral interaction valued in the mathematics classroom? For Mercer (2013) educational achievement depends on how well children have been "induct[ed] into ways of using language for explaining and reasoning" (p. 153). This induction process is, however, easier said than done. I noted in the introductory chapter the risk that talk's vital role in learning is either overlooked or taken for granted. I argue that for many learners explicit attention needs to be given to inducting them into *how* to talk in the classroom context. In the following two sections I discuss two initiatives geared towards providing this sort of explicit direction: 'Thinking Together' (UK), and then 'Talk Moves' (USA). I then end my discussion around 'Learning to talk/ Talking to Learn' with two final sections in which I look, respectively, at these.

2.5.1 'THINKING TOGETHER'

The focus for 'Thinking Together' is on enhancing learners' thinking skills through reciprocal verbal engagement around learning tasks. Its premise is that joint "engagement in reasoned dialogue improves individual children's reasoning" (Mercer & Littleton, 2007, p. 133).

Having been primarily driven by their "allegiance" to Vygotskian thinking, the developers of the 'Thinking Together' approach describe it as "represent[ing] sociocultural theory in action" (Mercer & Littleton, 2007, pp. 5- 6). Mercer and Littleton explain that, because Vygotsky provided "little empirical evidence", the 'Thinking Together' team members were interested in putting "Vygotsky's ideas to the test" (2007, p.5) in the design and implementation of various interventions. After reviewing the trialling of several such interventions they announced: "Vygotsky was right!" (Mercer & Littleton, 2007, p. 133).

While Mercer and Littleton acknowledge that a range of other factors help shape the ways in which children's intellects develop, they believe the various studies carried out by different members of the 'Thinking Together' team have produced sufficient empirical evidence to unreservedly endorse the Vygotskian view that "through the mediation of the cultural tool of language, social interaction shapes intellectual development" (2007, p. 133). Examples from such studies are reported in and by Wegerif, Mercer, and Dawes, 1999; Fernandez, Wegerif, Mercer and Rojas-Drummond, 2001; Rojas-Drummond and Mercer, 2004; Mercer, Dawes, Wegerif and Sams, 2004; Mercer and Sams, 2006; Webb and Treagust, 2006; Webb and Webb, 2008; and Mercer, 2008. These articles represent studies done not just in Britain, but in Mexico and South Africa also.

Before outlining some principles relating to the 'Thinking Together' approach I briefly share aspects from three studies involving schools in South Africa's Eastern Cape Province (Webb and Treagust, 2006; Webb and Webb, 2008; and Webb, 2010).

Working within a sociocultural framework, Webb and Treagust noted that "the social experience of language use is seen as a major shaper of cognition" (2006, p. 381). Based on their assessment that "the educational and developmental potential of classroom conversation … is being squandered", they set up an intervention study which involved inducting a sample of science teachers and their Grade 7 learners into the use of exploratory talk in second-language science classrooms in the Eastern Cape Province. The intervention was modelled on those developed by Mercer and colleagues.

Research site visits prior to the setting up of Webb and Treagust's intervention had indicated that the default pattern of classroom interaction was teacher dominated, with limited and circumscribed verbal contributions from learners. One-day workshops were then set up for participating science teachers, teaching materials were developed, and participating learners' reasoning and problem solving abilities were tested using Raven's *Standard Progressive Matrices* pre-test.

After their trialling of more discussion-oriented approaches, Webb and Treagust administered the Raven's post-test, and reported "a clear and statistically significant improvement in the mean scores of pupils who participated in classroom discussion initiatives" (2006, p. 397).

Along with other such 'Thinking Together' interventions, Webb and Treagust's findings provide support for the sociocultural view that "reasoning is embedded in a social practice" (2006, p. 383).

Webb and Webb (2008) report on work done with mathematics teachers enrolled in an in-service Bachelor of Education (Honours) programme. Part of the programme involved emphasizing to participating teachers how valuable it was for mathematics learning that learners engage in exploratory dialogue. One thing in particular that Webb and Webb's study highlighted was the importance of code-switching. As Webb and Webb observed, "when teachers do not emphasise the use of 'English only', informal discussion increases" (2008, p. 31). Drawing on Cummins's BICS/CALP concepts, they noted further that "without a culture of informal talk using BICS, there is little possibility of developing mathematical discourse in CALP" and movement along the everyday/ more mathematically abstract continuum is thereby "truncated before it is even begun" (Webb & Webb, 2008, p. 31). Webb (2010) subsequently designed her doctoral study around inducting mathematics teachers into the principles and practices of dialogic teaching. Amongst her findings was "a statistically significant increase in reasoning competence [and] numeracy skills" in those classrooms where dialogic teaching had been most effectively implemented (Webb, 2010, p. 293).

Mercer and Littleton describe dialogues as "cultural artefacts" (2007, p. 6). This, they argue, is because dialogues "embody participants' practical knowledge about how to talk in a particular kind of situation" (2007, p. 6). As numerous studies have shown (including those cited above), dialogue is not foregrounded in the culture of many classrooms. Teachers' voices predominate, and learners are either passive listeners or occasional respondents to fairly low-order levels of teacher questioning. The work of Mercer and his colleagues over several decades has sought to disrupt this culture through alerting the education community to the power of dialogue in helping to develop children's powers of reasoning.

There are clear parallels here with the earlier discussion (Section 2.4.1) around theories of SLA. In the same way that Skehan (2001; 2003) and other's rejected Krashen's arguments that SLA is largely a matter of plenty of exposure to comprehensible input in an appropriately supportive environment (1981; 1982; 2009), so too advocates of more dialogical interactions in the teaching/ learning environment point to the desirability of learners playing much more active and *productive* roles in the construction of their understanding of whatever it is that is being taught (an L2 or school mathematics, or, in the case of Ms M's and Ms P's Grade 4s, both). Passive comprehension - assuming it *does* happen - is not the same as putting one's comprehension to the test by engaging with others (peers and mentors), and opening up possibilities for challenges, modifications, and extensions to this comprehension.

In an article on the teaching of thinking skills, Wegerif, a former doctoral student and subsequent colleague of Mercer's, wrote, "experimental evidence, as well as Vygotskian theory, suggests that the quality of individual thinking reflects the quality of collective thinking and vice versa" (2004, p. 155). On his university's profile webpage (Exeter) he explains that essentially his research work revolves around "the idea of dialogue … and looking at [how] groups … think together, … solve problems together, … and how this impacts individual cognitive abilities" (n.d., unpaged). For him, "learning to think is about being drawn into dialogues" (Wegerif, n.d., unpaged). Wegerif (2014) subsequently explained it thus.

> In a dialogue voices are both separate and united; participating in each other. … [D]ialogues are a form of 'shared inquiry' and a way of helping in the 'collaborative construction of knowledge'. (pp. 55-56)

Barnes (2008), in articulating his ideas around learners being more *actively* (and collaboratively) engaged, explained that active learning involves amongst other things, "new ways of thinking" (p. 2) as learners work "to interrelate, to reinterpret, to understand new experiences and ideas" (p.2); and for Barnes talk provides one of "the readiest ways" of doing so (p. 4). I noted earlier in this chapter (Section 2.3) Barnes's distinction between 'presentational' and 'exploratory' talk. Mercer and his 'Thinking Together' colleagues distinguished two additional categories of talk, as Wegerif (2011) explained.

There is *disputational talk*. Here "children try to defeat each other and be the winner … they are not trying to learn from each other" (Wegerif, 2011, p. 184). Then there is *cumulative talk*. With this form of talk, as Wegerif described it, participants are trying to safeguard a group identity: participants "do not want to challenge each other since that might disrupt the harmony of the group … there is no incentive to challenge ideas or explore reasoning … [rather, children] seek to agree with each other to maintain the feeling of belonging to the group" (2011, p. 184). An alternative line here is that what is happening through cumulative talk is that children are in the process of *building up mutual (or common) understandings*, essential platforms from which to then venture into the sorts of 'new' directions and narratives that would better align with Barnes's notions (1996, 2010) of more exploratory forms of talk.

It is *exploratory talk* that the ‘Thinking Together’ researchers have focused on developing in learners, a form of talk, Wegerif explained, that “involves engaging critically with each other’s ideas within a shared relationship” (2011, p. 184). He noted that what seems to be most essential to this type of dialogic talk “is *identification with dialogue itself*” [italics added]) (2011, p. 184). I discuss in the chapter on Vygotsky (Chapter 5, Section 5.6), Mercer’s idea (2002) of an IDZ (‘intermental development zone’) as an addition to, or extension of, Vygotsky’s notion of a ZPD. This zone Mercer described as “a dynamic frame of reference which is reconstituted constantly as … dialogue continues [between teachers and their learners]” (2002, p. 6).

Mercer and his colleagues developed their ‘Thinking Together’ ideas in language contexts rather different from those prevailing in a majority of South African classrooms insofar as a majority of children participating in their project classes were native speakers of the LoLT. In response to an e-mail enquiry from me, Mercer agreed that “mother-tongue education would be likely to provide a more encouraging basis for developing children's language for learning but of course you have to deal with the situation you find” (e-mail communication, August 28, 2014). In Section 2.5.3 I briefly talk about some ideas from Hill and Miller (2013) (and their associates) for ensuring that even in L2 situations, cognitively stimulating verbal interaction is made feasible. To return, though, to discussion of the ‘Thinking Together’ approach, Mercer and Littleton (2007) noted that “the norms or ground rules for generating particular functional ways of using language in school … are *rarely made explicit* [italics added]” (p. 66). An initial step in the development of a capacity to engage in exploratory (dialogic) talk, and learning how to “interthink effectively”, therefore, needs to be the establishment of “ground rules” (2007, p. 70).

In an earlier publication, Mercer (2002) had stressed the importance of grounds rules. These facilitate for learners “legitimate opportunities to express their uncertainties and reveal their confusions, and to request information and explanations from others who are more knowledgeable” (p. 9). As Mercer and Littleton (2007) subsequently explained ground rules are not things that are pre-defined and imposed externally by members of various ‘Thinking Together’ research teams. Rather they would need to be jointly negotiated by the learners and their teacher(s) within any one particular context. Imported into Table 2.7 below are two sample sets of such rules. These were generated by two of the project classes that participated in a ‘Thinking Together’ programme.

Table 2.7: Some ground rules for effective interthinking

Year 4: Ground Rules for Talk	Year 5: Our Talking Rules
We have agreed to: • Share ideas • Give reasons • Question ideas • Consider • Agree • Involve everybody • Everybody accepts responsibility	We share our ideas and listen to each other. We talk one at a time. We respect each other's opinions. We give reasons and explain our ideas. If we disagree we ask 'why'? We try to agree in the end.

(Mercer & Littleton, 2007, p. 71)

Mercer and Littleton (2007), using the same pre- and post-intervention testing processes as was described above in relation to Webb and Treagust's intervention (2006), explained that results showed that the 'Thinking Together' interventions impacted "positively on [children's] collective problem-solving and curriculum learning" (p. 133). They were able too to provide evidence of children's improved attainments in mathematics, science and English (Mercer & Littleton, 2007). On the final page of their 2007 text, Mercer and Littleton implicitly echo the sorts of arguments Cummins made in relation to developing children's BICS and CALP (see Section 2.4.3) and those of Bernstein also (see especially Section 6.2 for my discussion of these):

> Without guidance, instruction and encouragement from a teacher, many children may not gain access to some very useful ways of using language for reasoning and working collaboratively, because those ways with words are simply not a common feature of the language of their out-of-school lives. (p. 143)

I close off this subsection by brief reference to Mercer's view that in anthropological and psychological work on cognition, and in particular on the concept of a 'social brain', insufficient cognizance has been taken of "the social nature of human cognition" (2013, p. 148). Mercer (2013) recommends that even greater attention needs to focus on Vygotsky's work on the links between 'collective' and 'individual' thinking (and on how Vygotsky explains in sociocultural terms the transitions from 'intermental' to 'intramental' cognition). I discuss aspects of Vygotsky's thinking around this transition in Section 5.3. Referring to his and his colleague's sociocultural concept of 'interthinking', Mercer argues that "through the use of language and other modes of representation, we can link our individual minds to create a powerful problem-solving tool" (2013, p. 151).

2.5.2 'TALK MOVES'

As noted in the introductory section of this chapter, much of the research on classroom dialogue emanates from the USA. Chapin, O'Connor and Anderson have written extensively about how to help children engage in academically productive talk during mathematics instruction. They developed what are referred to as 'Talk Moves' as tools that mathematics teachers can teach their learners to use, so facilitating *learning through discussion*.

In the preface to their book, *Classroom discussions: Using math talk to help students learn* (2009), Chapin, O'Connor and Anderson explain that their 'talk moves' work was in part informed by their research findings from 'Project Challenge'. This was a mathematics education intervention project they had implemented that targeted Grades 4-7 learners and their teachers in a low-income Boston school district (1998-2002). Through involving these teachers and their learners in a reform-based mathematics curriculum, they had hoped to help the children become

> … robust learners of mathematics: learners able to think deeply and insightfully, learners who would not give up when a problem was difficult, and learners who would legitimately come to think of themselves as mathematically able. (2009, p. xv)

Learners who participated in Project Challenge – most of whom were not native speakers of English – subsequently showed remarkable improvements in their mathematics achievements, even, in some instances, out-scoring children from more affluent and well-resourced schools. Cirillo (2013) reports that three years into the project the class mean for participating learners had "reached the 90th percentile" (p. 2). Commenting on the learners' improvements, Chapin, O'Connor and Anderson put this down in large measure to their project's carefully planned and scaffolded use of classroom talk. "It enabled," they wrote, "these low-income students … to become mathematically articulate" (2009, p. xix). Chapin, O'Connor and Anderson then introduced a range of "discourse-based tools", emphasizing how these might contribute towards a capacity to engage in academically productive talk, and – in so doing - to the more effective meeting of social, cognitive and curricular objectives.

As with the 'Thinking Together' approach, Chapin, O'Connor and Anderson emphasise the importance of - early on - creating a supportive climate in the mathematics classroom, one in which learners "can talk about their mathematical thinking without fear of ridicule" (2009, p. 7). This point struck a particular chord with me in light of some incidents I had observed both in Ms M's and in Ms P's Grade 4 classrooms. Ms M quite frequently had to warn children not to laugh at each other's mistakes. So, for example in the second of her observed lessons, a child offered a wrong answer and a ripple of laughter from his classmates started to spread, which Ms M quickly stilled: "Uh-Uh. No laughing. No laughing" (Turn 50). And then later, she intervened: "UhUh. UhUh. No laughing, Grade 4s" (Turn 94). And, when again in this same lesson a child's error caused another outbreak of laughter, Ms M cut this short: "Why are you laughing? Hmmm? How would you feel if somebody else can laugh at you? Huh? Will you be happy? Andile, will you be happy?" (Turn 102). The offending child shook his head. Ms M then instructed him: "Well then stop laughing. Then stop laughing" (Turn 104).

A fear of ridicule was also something I tangentially explored with Ms P in one of our interviews. In the following interview excerpt, I had asked her if she saw it as a problem that her learners spoke so little during the observed mathematics lessons. She indicated that she did see it as a problem, but then (unprompted) explained as follows:

> **Ms P:** They are scared.
>
> **S-AR:** Scared?
>
> **Ms P:** Scared of each other. Because they like to laugh at each other. [...] And what I noticed is that the one who speaks softly there, is the one who laughs at others. [...] Because now he does not want to make a mistake there, and be heard by the others, because he used to laugh to others, now he doesn't want anyone to laugh at him.
>
> (Interview 2P, Lines 285-298)

I noted earlier (Section 2.2) changes in attitude towards 'mistakes'. In second language teaching, errors are seen to provide valuable insight into learners' stages of L2 development; in mathematics learning situations, they are seen as "not only inevitable, but to be welcomed" (Abdulhamid & Venkat, in press, p. 5). SANCP has gone so far as to produce classroom posters for participating teachers to display in their classrooms: "Mistakes are your friends" (M. Graven, personal communication, January 11, 2017). As McInerney and McInerney argue, dealt with in "a motivationally favourable way" working with mistakes can, be "more advantageous than spending time re-examining work well done" (2006, p. 401).

Like the 'Thinking Together' approach, Chapin, O'Connor and Anderson's 'Talk Moves' approach starts with the establishment therefore of "ground rules for respectful and courteous talk" (2009. p. 11), which would I am sure include not laughing at other's mistakes. Core to the 'rules' outlined by Chapin, O'Connor and Anderson (2009) is the requirement that learners genuinely and sincerely listen to their peers' contributions; that they make sure that when they themselves speak others can hear what they say; and the assurance that every member of the group is welcome - indeed expected - to contribute to the discussions in their mathematics lessons.

Chapin, O'Connor and Anderson outline five 'Talk Moves', and provide illustrative vignettes for each. In the following Table I pull together key aspects of each move.

Table 2.8: Chapin, O'Connor and Anderson's 'Talk Moves'[40]

Talk Move	Description	Special advantage(s) of the move
Revoicing	Where teachers try to bring clarity to a learner's contribution by saying it again, but in a clearer way. They try as far as possible to at the same time retain at least some of the learner's contribution so that his/her 'voice' is not lost. Teachers then ask the learner to confirm that the revoicing indeed reflects the idea that he/she had been trying to articulate.	"Deep thinking and powerful reasoning do not always correlate with clear verbal expression" (p. 13). Revoicing is thus both a matter of showing respect for a learner's effort to respond, plus helping to ensure that his/her classmates are able to make sense of what has been said. "Revoicing provides more "thinking space" and can help all [learners] track what is going on mathematically" (p. 14).
Repeating	Where teachers ask a learner to repeat in his/her own words an explanation or a line of reasoning offered by a classmate.	Firstly "it gives the rest of the class another rendition" (p. 15) of the first learner's contribution, (especially helpful to helping L2 learners); secondly, it alerts learners to the fact that it is expected that what they say *will* be carefully listened to by their peers.
Reasoning	Where teachers ask a learner to apply their own reasoning to that of a classmate. In other words, to do some form of mini analysis on their classmate's reasoning in order to decide whether or not they agree with what has been suggested, and why.	It helps get learners to make explicit their own reasoning, and to then work at justifying why they think as they do.
Adding on	Involves teachers enquiring whether anyone else wishes to add something to a classmate's contribution.	It may help not just to increase the level of learner participation in any one discussion, but also encourage learners towards getting into the habit of "weigh[-ing] in on what [their classmate(s) are] considering" (p. 16)
Wait time	This fifth move "is not actually speech at all, but silence!" (p. 17). It involves giving learners time to think before a question is directed at them. It involves also giving them time to organise their thoughts after the question has been asked.	It teaches learners that they are not in a race against time, but in a place where careful reflection before speaking is valued. "If we do not use wait time consistently and patiently, [learners may] give up and fail to participate, knowing that they cannot "beat the clock"" (p. 18), nor indeed many of their more confident, outspoken, and articulate classmates.

Adapted from Chapin, O'Connor and Anderson (2009, pp. 12-18)

40 Direct quotes included in this table all come from Chapin, O'Connor and Anderson (2009).

In the following extract from my second interview with Ms P it is clear that some of her teaching decisions are (at least implicitly) motivated by a similar sense of the desirability of getting learners to verbally share their mathematical thinking. I have used ellipsis dots [...] to indicate where I have removed text not directly relevant to the present point.

> **S-AR:** ... What I noticed with the way you teach is, when they come up to the board to work out something, you always tell they must theta [*IsiXhosa: 'talk'*] about what they're doing.
>
> **Ms P:** Ja. Ja.
>
> **S-AR:** Why do you want them to do that?
>
> **Ms P:** 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 [*isiXhosa: 'somebody'*] is doing it like this!" You know? [...] That's why I say, "Say something. Don't just do it for yourself. Do it for – with them." You know?
>
> **S-AR:** And is that your idea, or did you find it from somewhere?
>
> **Ms P:** No. [*Laughs*]. I just – 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." [*Laughs*]
>
> **S-AR:** I like it.
>
> **Ms P:** And ... it also - what can I say? It is also reinforced in him or her. Maybe sometimes this he had copied from someone. And then he starts writing. I just want to know if he knows what he's doing.
>
> (Interview 2P, Lines 260-279)

Anderson, Chapin and O'Connor (2011) subsequently produced a facilitator's 'Talk Moves' guide in which they provided guidance on implementing the five main talk moves. The rationale behind 'Talk Moves' in mathematics distils down to the following four points:

- To help learners clarify and share their own mathematical thoughts with classmates.
- To help learners orient to and listen carefully to classmates' mathematical ideas.
- To help learners deepen their own understanding of mathematics as well as their capacity to reason about it.
- To help learners take up and engage with classmates' mathematical thinking.

(Paraphrased from Anderson, Chapin & O'Connor, 2011, p. 13;
O'Connor, Michaels, Chapin & Harbaugh, 2017, p. 9)

Based on their own involvement in the 'Talk Science Project' (where science teachers were introduced to 'talk moves'), Michaels and O'Connor (2015) have cautioned, however, that despite the enormous potential of 'talk moves' in terms of opening up classroom discussion (while IRE practices' tend to close it down), much remains to be done to clarify exactly *how* talk contributes to learning. They note also that "the simple deployment of talk moves does not ensure coherence in classroom discussions or robust student learning" (p. 344), arguing that more needs to be done to help teachers know *how* and when to use particular talk moves. There needs also, they say, to be a much clearer understanding of "the relationship between teachers' domain-specific knowledge and their use of productive talk moves" (Michaels & O'Connor, 2015, p. 344). I see - as is implied in Michaels and O'Connor's statement - a dialectical relationship here. Generic knowledge of managing talk moves can only ever achieve so much in the absence of appropriate domain-specific knowledge. I am aware of the considerable attention that has been given in the past few decades to enhancing South African teachers' domain-specific knowledge, particularly as regards mathematics, language, and science.

2.5.3 LEARNING TO USE L2 TO TALK IN COGNITIVELY 'RICH' WAYS

For this penultimate section of the Literature Review chapter I focus briefly on work that has been done on ways of reconciling L2 learners' existing levels of linguistic proficiency with their being able to meet the cognitive demands expected of them in terms of curriculum requirements. Johnson (1995) warned that "understanding communication in second language classrooms is not a simple task" (p. 3). So, for example, Gibbons (2006), writing of the challenges facing L2 students (such as is the case for Ms M's and Ms P's L2 learners), noted that they may:

> … have fewer opportunities for learning … fewer opportunities for extended language use with teachers; … receive less feedback … participate less often in class discussion; … [be] asked less cognitively demanding questions and generally have fewer opportunities to talk; … [and] use discourse structures which are evaluated less positively. [They often attend] schools which have low expectations of ESL students' performance, and which … present a curriculum heavily weighted towards concrete learning and tasks that are reduced in cognitive demand. (pp. 67-68)

Gibbons was here drawing on research findings relating to L2 learners in mainstream classes from, amongst other places, UK, USA, Canada, New Zealand and Australia. Given the kinds of circumstances she describes these learners as facing, the question arises as to the extent to which they actually get sufficient experience in talking about, in the case of Ms M's and Ms P's learners, for example, Grade 4 mathematics knowledge in and through an L2 LoLT.

Not being able to communicate fully in the LoLT is clearly a major impediment, one that conduces to the kinds of teacher-centredness, and *dependence* on the teacher that more dialogic approaches seek to displace. Writing of the desirability of developing in learners greater autonomy, Mariani (1997) linked notions of 'dependence' and 'autonomy' to what he termed two "parallel concepts": 'challenge' and 'support' (unpaged). "To answer our students' need for autonomy," he wrote, "we challenge them. To answer their need for dependence, we support them" (Mariani, 1997, unpaged). It was through the writing of Gibbons (2015) that I first encountered Mariani's ideas, in particular his 'four zones of teaching and learning', represented diagrammatically in Figure 2.5, below. Gibbons indicated that she had found Mariani's framework "particularly useful [insofar as] it relates scaffolding to the degree of intellectual challenge of the task" (2015, p. 17). There is (as I noted earlier) a marked similarity between these ideas and those contained in Cummins's quadrant (Figure 2.3, Section 2.4.4).

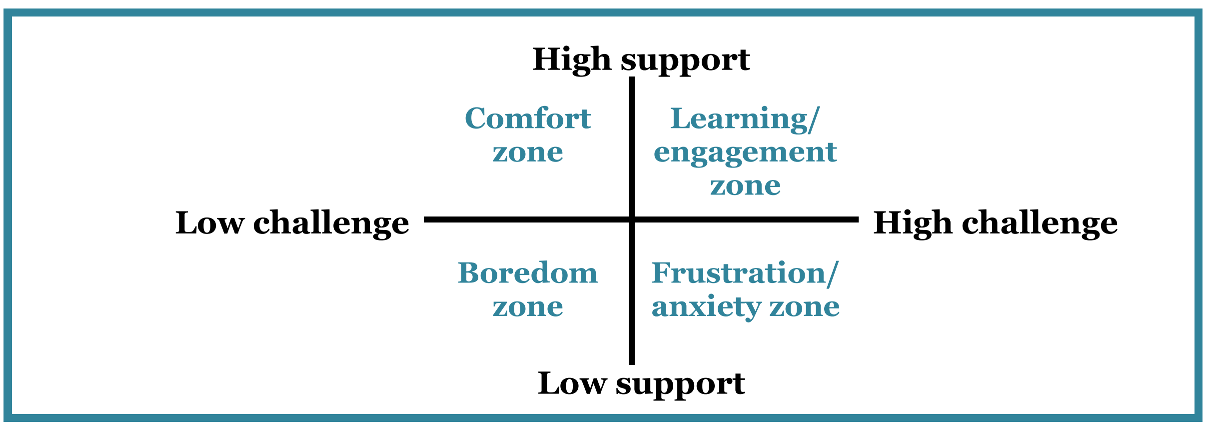


***Figure 2.5:* Mariani's framework of four basic types of challenge/support patterns** (synthesised from Mariani (1997, unpaged) and Gibbons (2015, p. 17))

Based on some observations of lessons where children are learning through an L2, my impression is that the occasions when they are occupying Mariani's 'learning/ engagement' zone are relatively rare compared to when they are in either a 'boredom' ('tuned-out') or a frustrated and anxious zone, yet it is the high support/ high challenge zone where, as Gibbons argues, that, on the basis of "considerable research over a number of years", the greatest learning benefit is to be derived (2015, p. 18). In this respect - she argues - "[L2] learners need the same access to intellectually challenging work as all other students" (Gibbons, 2015, p. 21).

The challenge, however, is how to, in the words of Hill and Miller (2013), "foster higher-order thinking and learning for students with limited English proficiency" (p. xii).

Hill and Miller (2013) make the important point that "a lack of English language proficiency does not necessarily indicate a corresponding lack of higher-order thinking skills" (p. xiv). I have qualms about their insertion of the word 'necessarily' here. Without challenging the power and usefulness of English, I believe that, were learners to be given greater opportunities for using (and receiving support in developing) their L1 proficiencies, there would be a concomitant flourishing of their capacity to practise higher-order thinking skills (irrespective of whether these were done through L1 or L2). I wholly endorse, however, the points Hill and Miller make around the need to address barriers to L2 learners' higher-order thinking. Evaluating the extent to which Ms M's learners, for example, were exercising higher- or lower-order thinking in L2 is outside my scope. If though, I were to infer from the L2 verbal evidence learners in the observed lessons provided, it would be difficult to consider their responses as evidence of higher-order engagement. Quite independently of issues relating to socio-economic status factors, the obstacles placed in these learners' paths by an L2 LoLT are profound. It was in reflecting on this circumstance that I found particularly compelling the work Hill and her colleagues have done on seeking ways for simultaneously supporting L2 learners' language development while at the same time expecting higher levels of cognitive engagement. Using what they call the 'Thinking Language Matrix', Hill and Miller (2013) provided the following framework (Table 2.9, below) whereby the stages of second language acquisition outlined by Krashen and Terrell (1995/1983) (see Table 2.3 of Section 2.4.1) are aligned with Bloom's taxonomy of levels of cognition (Bloom, Englehart, Furst, Hill & Krathwohl, 1956).

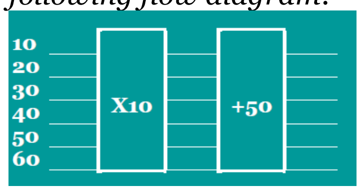
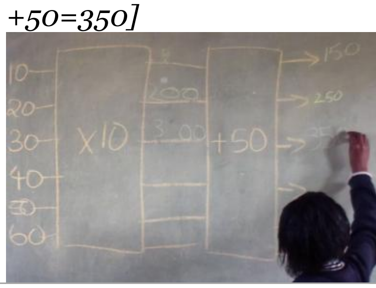
Table 2.9: 'Thinking Language' matrix

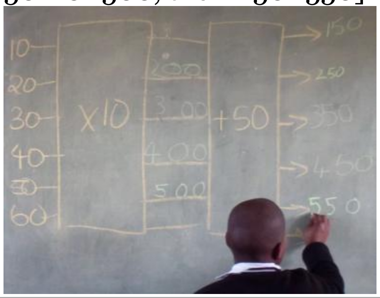
BLOOM'S LEVELS OF COGNITION		KRASHEN & TERRELL'S STAGES OF SLA — Silent novice →→→ Expert user: **Silent/ pre-production** *Non-verbal communication (e.g. body language, facial expression, pointing)*	**Early L2 production** *One- to two- word responses, often using formulaic chunks*	**L2 Speech emergence** *Short sentences and phrases in response to teachers' prompting*	**Intermediate L2 fluency** *Longer, more lexically & grammatically complex sentences*	**Advanced L2 fluency** *Approaching native-like communicative competence*
Simple/ Concrete ↓↑ Complex/ Abstract	**EVALUATION** *(comparing and contrasting, assessing, arguing, defending etc.)*					
	SYNTHESIS *(generating, combining, formulating etc.)*					
	ANALYSIS *(probing, differentiating, inferring, comparing etc.)*					
	APPLICATION *(using (perhaps in a new context), demonstrating, operating, solving etc.)*					
	COMPREHENSION *(selecting, restating, discussing, organizing, summarising, reporting etc.)*					
	KNOWLEDGE *(recognizing, recalling, naming, describing etc.)*					

(Synthesised from Krashen and Terrell (1995/1983); Sadker (2002); Hill and Björk (2008); Hill and Hoak (2012); Hill and Miller (2013).)

Hill and Hoak (2012) challenge what they labelled "a common misperception" that in the earlier stages of SLA L2 learners are largely limited to cognitive tasks pitched at the Knowledge and Comprehension levels of Bloom's taxonomy. "If," they wrote, "we direct and maintain [L2 learners'] engagement at the lowest levels of thinking, we confine them to the lowest level of learning." (p. 10). This, Hill and Miller (2013) argue, can be avoided if teachers become more aware of what sorts of verbal responses they might expect of their learners at any particular stage of L2 development and of suitable strategies for simultaneously evoking more cognitively rich responses from their learners.

The value of the 'Thinking Language' matrix lies in helping teachers see how, irrespective of their learners' actual levels of L2 proficiency, L2 learners can - given appropriate mediation - be exposed to more cognitively challenging types of task. So, for example, as the 'Thinking Language matrix grid suggests, in the silent/ pre-production phase, while L2 learners might not yet be able to verbally answer a teacher's questions in the L2, they could be expected to provide non-verbal responses to questions (through nodding, shaking their heads, pointing, arranging shapes from biggest to smallest, indicating whether or not they agree with a statement, and so on). Below is an example of Ms P's learners demonstrating (mainly non-verbally) their comprehension of the requirements of a task. (Ms P's use of isiXhosa is shown in red.)

Turn	**Learner**	**Ms P**
26		*[The Grade 4s are halfway towards completing the following flow diagram:*  *Ms P calls on a learner to complete the next line of the sequence.]* Okay, Sisi [*'Girl' in isiXhosa*]. *[Ms P hands child the chalk.]*
27	*[Child fills in 30x10=300, then +50=350]* 	
28		Where did you get that 350? Utheni? [*'What did you do?' in isiXhosa*].
29	*[Learner shows Ms P by pointing at each of the numbers in the sequence that she tackled them.]*	
30		Okay. *[Ms P calls on another learner.]* Tyeelboi.
31	*[Child comes up; fills in the next sequence correctly:* 40x10=400, then +50=450]	

Turn	**Learner**	**Ms P**
32	*[Next child comes up; fills in the next sequence correctly:* 50x10=500, then +50=550] 	
33		Wenze njani ndifuna uqonda apha? kwenzeke ntoni. [*'How did you get the answer? I want to know' in isiXhosa*].
34	*[Learner shows by pointing the sequence he followed to get the correct answer.]*	
35		Akuthathi ngobeka uthi 500+50. Susiqhatha fondini susi robber susi rober fondini [*'You don't just write an answer. You say, "500 +50 …". Don't rob us. Don't rob us, Man' in isiXhosa*]. *[Ms P calls on another child to complete the final line of the number pattern.]*
36	*[Child cannot manage it.]*	
37		… *[Ms P calls on another child.]* Khawuze, Ntombi. Khawuze [*'Come here, Girl. Come here' in isiXhosa*].
38	*[Another child comes up; fills in the sequence correctly:* 60x10=600, then +50=650.]	
39		Ngubani? ['*What's the answer?' in isiXhosa*].
40	It's 600. And 600+50 = ~	
41		Ngubani? ['*What's the answer?' in isiXhosa*].
42	It's 650.	
43	*[Child returns to her seat.]*	Okay. Okay. (Lesson 20P, Turns 26-35)

This lesson extract shows Ms P asking for, and accepting the first learner's non-verbal explanation. The second learner's answer is filled in without any further pressing from Ms P. The third learner is asked to explain, with the gentle implication that, by not verbally articulating ('talking through') his procedure, he is 'robbing' the class of the opportunity to hear his thought process (Turn 35). That said, Ms P did not press him further. She instead simply called on a next child to come up and complete the final number pattern sequence. The child appeared hesitant so Ms P called on another. The child came up and correctly completed the pattern. In this instance, Ms P did not, however, ask her to *explain* how she had got the answer, simply asking instead that she articulate the answers verbally for her classmates. This the child did, suggesting she had entered the early L2 production phase.

Once again, the ‘Thinking Language’ matrix is useful here in highlighting that although an L2 learner may only be able to use one or two words from their L2 repertoire in response to a question, this does not mean that they are not exercising higher-order thinking. In this context, a variation on Cummins’s dual iceberg model (see Figure 2.2), involving learners common underlying ‘conceptual’ (as opposed to ‘linguistic’) proficiency could be envisaged, whereby teachers make strategic use of their learners’ L1 (a language which, as in Ms M’s and Ms P’s case, teachers share with their learners). As is shown in the Ms P’s lesson extract above, and as I discuss further in Chapter 9, L1/L2 code-switching was a marked feature of her observed lessons. Writing in 2000, Setati and Adler noted that not only do many South African learners have to code-switch across languages, but *also* across mathematical discourses:

> Learners … have to cope with the new language of mathematics [both informal BICs/and formal CALP] as well as the new language in which mathematics is taught. (2000, p. 247)

As with the work cited in Sections 2.5.1 and 2.5.2, Hill and Miller (2013) emphasise the importance of supporting learners in using classroom talk as a simultaneous means of developing both their academic language skills and their conceptual understandings. Learners “learn to do things with language when they participate in meaningful activities that engage and challenge them” (Hill & Miller, 2013, p. 1-2). As such, classroom talk can never be treated as “an end of itself”; it is essential that is be “structured to elicit rich oral academic language” (Hill & Miller, 2013, p. 95). In this context, Johnson (1995) noted that:

> … if teachers understand how the dynamics of classroom communication influence second language learners’ perception of and participation in classroom activities, they may be better able to monitor and adjust the patterns of classroom communication in order to create an environment that is conducive to both classroom learning and second language acquisition. (p. 3)

In their mathematics lessons, Ms M’s and Ms P’s responsibilities clearly lie less with SLA than with learning of mathematics. Code-switching can be an invaluable tool in helping L2 learners in the latter respect, but, as I note in the discussion in the next section, it is not something that is always acknowledged as educationally ‘good’ practice, and I am aware of many South African teachers who express guilt about doing it. In the next section I explore ‘translanguaging’. I see this as something which has the potential to cast code-switching practices in a more positive light. As Lewis, Jones and Baker (2012b) explain, whereas code-switching “has associations with language separation”, translanguaging “*celebrates* and *approves* flexibility in language use and the permeability of learning through two or more languages” [italics added] (p. 659).

2.5.4 FACILITATING SENSE-MAKING THROUGH TRANSLANGUAGING

I highlighted in earlier discussion the paradoxical situation whereby, despite the South African DoE’s commitment to a language policy “most supportive of general conceptual growth” (1997, p. 2), a majority of South African schools have opted into what effectively amounts to a subtractive approach to bilingualism that works to obstruct children’s chances of conceptual growth. As McKinney, Carim, Marshall and Layton (2015) note, this monoglossic (and overwhelmingly Anglonormative[41]) orientation has had “profoundly inhibiting effects on [South African] children’s participation in classrooms and ultimately their access to quality education” (p. 103). What this, in turn, constitutes is a serious equity issue. In this section I share some views which *challenge* the hegemony of ‘purist’ or ‘monoglossic’ views of bi- or multi-lingualism. Notwithstanding McKinney, Carim, Marshall and Layton’s claims about a ‘monoglossic orientation’ (2015), in actual fact the situation throughout South Africa is essentially a diglossic one. ‘Diglossia’ is a term that relates to situations where two or more languages (or varieties of the same language) exist in a community, but decisions as to which is appropriate in different contexts are governed by (often unwritten) power and prestige differentials. For most bi- or multi-lingual South Africans, therefore, there are distinct contexts within which they choose (or are *allowed* to choose) to use one or other of their languages. So, while African languages may be used mainly in oral and personal spheres, English is the dominant language in more formal, official, and literate spheres.

In the third of my research questions for this study I used the term ‘emergent bilingualism’: ‘In what ways do the teachers use their learners’ *emergent bilingualism* as a resource for teaching and learning?’ I have subsequently learned that the label ‘emergent bilingual’ is one mooted by García (2009), a leading exponent of what she has termed ‘translanguaging’ (after

41 ‘Anglonormativity’ is a term McKinney introduced to refer to “the expectation that people will be and should be proficient in English, and are deficient, even deviant, if they are not” (Footnote, McKinney, Carrim, Marshall & Layton, 2015, p. 103).

Williams, 1994[42]). García has long been concerned for the plight of L2 learners in (particularly) the USA, and has published prolifically around this issue. She argues that labels such as ‘limited English proficiency’ and ‘English Language Learner’ view L2 learners through “a monolingual and monoglossic lens”, and, in so doing, project a deficit image (2009, p. 325). Such labels, she wrote, work to “perpetuate educational inequities and squander valuable linguistic resources” (García, 2009, p. 325). By contrast, she sees the label ‘emergent bilingual’ as reflecting a more positive image of L2 learners (validating their L1 while simultaneously challenging implied linguistic deficits) (García, 2009, p. 325). “We continue to speak,” García writes, “about ‘additive’ and ‘subtractive’ bilingualism, as if languages were whole units that can be added or subtracted … without recognizing the more dynamic language practices characteristic of the world today” (2017, p. 15).

Embracing the Conteh and Meier’s idea (2014) that the twenty first century is witnessing a ‘multilingual turn’, Wei and García (2017) reject “static monoglossic” views of language in terms of which languages are conceived of as separate, autonomous and self-contained wholes (2017, p. 2). When interviewed by Grosjean (2016) about translanguaging, García commented that “if we are truly interested in knowing what bilingual students know and what they can do with language, we must separate their ability to use certain forms of one language or another from their ability to use language” (unpaged). She went on to highlight a point Grosjean had himself articulated in one of his earlier online posts, namely that “bilinguals are NOT the sum of two complete or incomplete monolinguals; rather, they have a unique and specific linguistic configuration. The coexistence and constant interaction of the two or more languages in bilinguals has produced a different but complete language system [capitalisation the original]” (Grosjean, 2012, unpaged). This point García identified as “essential to the concept of translanguaging” (Grosjean, 2016, unpaged). As García and Seltzer (2016) explain, “translanguaging involves more than “shuttling or switching between one language and another”, it involves “going *beyond* [italics in the original] the concept of named languages to recognise the single language system of bilinguals” (p. 19).

42 The first use of the term ‘translanguaging’ is attributed to Welsh educator, Cen Williams. Using the term *‘trawsieithu’*, Williams described a pedagogy whereby learners were explicitly encouraged to draw on their L1 and L2 in integrated ways in order to conceptually process the ideas and concepts they encountered in their classrooms (perhaps, for example, *speaking* in L1, but *writing* in L2). Baker (2001) then translated the word *‘trawsieithu’* to ‘translanguaging’.

Included under the umbrella of 'translanguaging' is code-switching. In answer to the question, "Isn't translanguaging what others call "code-switching"?" García's response, however, was an emphatic, "Absolutely not!" (2011, page 1 of 7, online article). Translanguaging is not just about switching across two or more different language codes, for, as she then explained:

> ... the notion of code-switching assumes that the two languages of bilinguals are two separate monolingual codes that could be used without reference to each other. Instead, translanguaging posits that bilinguals have *one linguistic repertoire* from which they select features *strategically* to communicate effectively. (García, 2011, page 1 of 7, online article)

Code-switching is a practice which – as I noted in the previous section, and, as García & Wei (2014) note also - is "often stigmatized" (unpaged, e-book version). Writing of attitudes towards code-switching, Dewaele and Wei (2014), for example, noted its frequently being referred to in derogatory ways. Examples they cited include 'verbal salad' (Nigeria); 'still colonized' (Morocco); 'very irritating' (Hong Kong); and dismissed as 'gibberish' (Dewaele & Wei, 2014, pp. 236-237).

South African classrooms are no exception as regards ambivalence towards code-switching. So, for example, in her study of code-switching in the context of some rural and township South African schools, Probyn (2009), noted that code-switching "has not been sanctioned in teacher training in the past and many teachers regard [it] ... as illicit, a sign of linguistic and pedagogic incompetence, rather than a valid communicative strategy" (p. 129). One of the teachers participating in Probyn's study even talked of the need to 'smuggle' "the vernacular into the classroom" (2009, p. 124). Perhaps *because* code-switching is so often viewed in deficit terms, little has been done to lend it legitimacy. Teachers thus, as Benson noted, tend to use it "unsystematically" (2004b, p. 208). Little is done at official levels to guide teachers towards using code-switching in more constructive and productive ways. Writing about code-switching in the specific context of primary mathematics classrooms, Setati and Adler insisted that:

> Attention to code-switching and its use in multilingual mathematics classrooms is an important part of a process of legitimising what teachers actually do (i.e. harness learners' main language as a resource for learning) in a context where pressure to access and acquire English is enormous. (2000, pp. 265-266)

As Dewaele and Wei (2014) noted, negative attitudes towards code-switching are reflective of the "ideologies of monolingualism and linguistic purism" (p. 237). It is precisely this that

García and others - through their advocacy of translanguaging - challenge. Unlike subtractive approaches to bilingualism, translanguaging is a pedagogy whereby “the entire linguistic repertoire of bilingual children [may be] used flexibly and strategically in instruction in order to engage the children cognitively, academically, emotionally and creatively” (García & Wei, 2014, unpaged, e-book version). Separated autonomous language systems, García and Wei argue, are merely a *societal construction*. Translanguaging “enables us to transgress [these] categorical distinctions” (García & Wei, 2014, unpaged, e-book version), so creating opportunities for emergent bilinguals to exercise greater agency over their sense-making endeavours. I suspect most linguists would take issue with García and Wei’s dismissal of the different languages’ systems as mere ‘societal constructions’. I like, though, the idea of having learners draw on their ‘entire linguistic repertoires’ in the name of making meaning in, for example, the mathematics classroom. As I show in Chapter 9, much of Ms P’s mathematics teaching practices incorporate what I believe would be termed translanguaging (as opposed to mere code-switching).

2.6 MOVING FORWARD

In this chapter I have engaged with literature, and, in particular, I have combined and synthesised various literature sources across contexts and decades in new ways so as to provide a rich basis to inform my data analysis. Having explored my selection from the academic literature that which I saw as key to highlighting some of the challenges and possibilities teachers (and their learners) encounter in using talk to mediate mathematics learning, I now move to the next part of the thesis (Part 3). In Part 3 I provide an overview of the methodological considerations relating to this study. I discuss this framework in relation principally to the collection of the empirical data during the classroom observations phase when I sat in on Ms M’s and Ms P’s Grade 4 mathematics lessons, and when I interviewed them both so as to learn more about what *they* saw as the enabling and constraining factors impacting on their effective mediation of their Grade 4s’ learning of mathematics. I examine the issue of reliability and validity insofar as this applies in a piece of qualitative work, while noting that in research of this nature, constructs such as trustworthiness and resonance might be seen to more methodologically appropriate and, indeed, attainable.

As I have done in the preceding chapters, and as I continue to do throughout the thesis, I use the empirical data collected from these two teachers in two ways mainly. Firstly - where I see an appropriate opportunity - I use the data to help illuminate, ground, and animate more theoretical aspects of discussion. Secondly, the data provide me with an authentic framework from within which I am able to then narrate the respective stories of Ms M's and Ms P's use of classroom talk relative to their teaching of Grade 4 mathematics.

Part 3: Methodological reflections

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

> *Rather than to speak of research carrying emancipatory intent, it may be useful to speak of research as carrying possibilities and hope.*
>
> (Vithal, 2000, p. 19)

3.1 INTRODUCTION

This case study exploration of the ways two Grade 4 teachers used classroom talk to support their children's mathematics learning is located within a primarily qualitative, and primarily interpretive frame of reference. While there are some small quantitative elements in the data-gathering methods used, my main aim here was to develop deeper *qualitative* insight into how - "within [their] real-life context[s]" (Yin, 1984, p. 23) - the research site teachers' orchestrated talk in their mathematics lessons. I also wanted to gain insight into some of the factors that seem to have influenced the nature of such talk. I have sought throughout to embed these 'real-life' insights within a broader framework. Firstly, I have embedded it within the professional literature relating to issues of teaching and learning through a second language (as per the discussion in Chapter 2). Secondly, I have embedded it within the (largely) theoretical literature that derives from the work of Vygotsky, Bernstein, and Halliday (as per the discussion in Chapters 5, 6 and 7). The work of all three of these theorists helps not only to clarify the centrally important role language plays *in* meaning-making processes, but also how centrally influential sociocultural considerations are *to* meaning-making processes.

Stake (2010) observes that "perhaps the most distinctive feature of qualitative research is that it is interpretive, a struggle with meanings" (p. 38). My own struggle in this respect has two layers: firstly to try to capture and portray the teachers' use of language as a tool for helping their learners make meaning in the observed Grade 4 mathematics lessons; secondly to attempt to carefully interpret the impact this appears to have on the kinds of learning taking place in these lessons. Given that any interpretative effort is bound up in methodological choices, in this chapter I outline, and also justify the choices made.

I start with some discussion of the research orientation for this piece of case study research. I then explain the thinking behind the selection of the settings and participants for the study, and provide some further detail on these sites and teachers. Next, I outline the data gathering process, including the ethical considerations which informed it. This is followed by a discussion around questions of validity. I then reflect on my position relative to the two teachers whose classroom talk practices constituted my unit of analysis, as well as on the extent to which the particular case explored here may have 'generalisability potential', or, as Yin (cited by Maxwell, 2012, p. 94) called it, "analytic generalisation". I then describe how I set about making sense of the mathematics classroom talk data drawing on the analytical and explanatory potential of my theoretical frame and on insights derived from the literature on the role of talk in literacy and numeracy development. I end the chapter by briefly identifying some limiting factors impacting on the study.

3.2 (CRITICAL) REALIST RESEARCH ORIENTATION

I have chosen to use the term '(critical) realist' (after Maxwell, 2012) to describe my research orientation. An interpretive view holds that in any social context, participants act according to the "meanings and motives" (Haralambos, Holborn & Heald, 2000, p. 971) they assign to that context. Such meanings as participants hold, however, can never truly be independent of influences operating from outside themselves. In analysing the classroom data, therefore, I have included discussion of some of the 'meanings and motives' informing aspects of the teachers' patterns of discourse, but I have tried also to discern some of the enabling and constraining factors that appear to influence this discourse.

I remain mindful throughout of the problematic nature of views claiming that a situation's 'reality' is primarily socially constructed, and dependent on participants' perceptions. Externally imposed realities must be taken into account, and so, in exploring the teachers' 'realities', I recognise also the dialectical nature of some of the external factors impinging on circumstances within both teachers' classrooms. These include changing views about the nature of teaching and learning, and how these have been construed both in general terms and in specific relation to mathematics education; plus South Africa's socio-political history; its socio-economic patterning; and its post-apartheid educational reform and redress initiatives. In my interpretative endeavour, therefore, I take an overarching realist perspective while trying simultaneously to take account of the effect personal perceptions may have on an individual teacher's actions. In essence, then, my research orientation embraces Maxwell's characterisation of (critical) realism, in which is combined

> ... a realist ontology (the belief that there is a real world that exists independently of our beliefs and constructions) with a constructivist epistemology (the belief that our *knowledge* of this world is inevitably our own construction, created from a specific vantage point, and that there is no possibility of our achieving a purely "objective" account that is independent of all particular perspectives). (2012, p. vii)

I have adopted Maxwell's bracketing of the word 'critical' throughout this section because I need to distinguish my research endeavours from the traditions and methodologies of, for example, Bhaskarian, or Archerian forms of critical realism (Archer, Bhaskar, Collier, Lawson & Norrie, 1998). My own notion of 'criticality' aligns with Vithal's (2000) conception of mathematics education as having vital links to the social, the cultural and the political realms, and to concerns for issues of social justice and equity. In addition to my involvement in literacy teaching and learning, I bring to this case study many years of teaching the Sociology of Education and Multicultural Education courses in my Faculty. Both these areas are closely bound up in attempting to uncover ways for addressing these very issues.

Media reports on South Africa's education outcomes are replete with negative reports about schools' and teachers' apparent failure to meet post-1994 reform goals. A report produced in 2013 by South Africa's Centre for Development and Enterprise provides a classic example of this kind of deficit discourse. This report baldly states that, "One of the most important factors limiting the quality of mathematics education is the poor quality of our teachers, and numeracy and mathematics teaching in particular, especially at lower grade levels" (2013, p. 4). In setting up this research study, I shared with my supervisor my antipathy towards potentially contributing to the ongoing 'deficit discourse' around South African schools and teachers. She herself has written of the disempowering effects of deficit discourses where teachers "are implicitly and sometimes explicitly blamed for the failure of new policies" (Graven, 2012c, p. 128). Such deficiency 'storying' of teachers, she wrote, "shuts down the space for meaningful ongoing learning in the classroom" (Graven, 2012c, p. 129). What is needed instead, she wrote, is a 're-authoring' of teachers' stories in which their "wealth of teaching experience" (Graven, 2012c, p. 130), rather than their presumed 'failure' to successfully execute reform initiatives, is foregrounded. This is, in and of itself, a social justice issue, and, as Graven was subsequently cited as having remarked, "We need to tell the story differently" (Gush, 2015, p. 25).

While there is no denying the dysfunctionality of circumstances in many South African schools, and the dubious conduct of some South African teachers, the many teachers with whom I have regular contact give every evidence of being genuinely concerned about circumstances in their work environments, and concerned also to work towards making a positive difference. I recognise that the often trying circumstances in which they work are generally outside individual teachers' control, but that said, I recognise too, that teachers can and do make a difference. I want therefore to as far as possible avoid a 'deficit discourse'. For, as Gibbons (2006) noted, are "not only … unhelpful in addressing the educational failure of students, [but] … also profoundly disempowering for teachers, since the problem of 'failing to learn' is located outside of the power of an individual teacher to address" (p. 67).

A key part of my objectives for this study has been to illuminate the classroom talk practices of two well-intentioned, motivated teachers working under relatively demanding conditions, who, on their own initiative, as well as through their membership of NICLE, are working towards making a positive difference. I have highlighted instances where they have provided evidence of their readiness to embrace more dialogic modes of classroom interaction in their mathematics lessons. Where this did not happen, I have sought to provide insight into some of the challenges these teachers face in trying to steer their young learners toward more active and engaged discourse patterns for mathematics learning.

3.3 A CASE STUDY APPROACH

Writing of case studies in the area of applied linguistics, Duff (2014) notes that in the face of large-scale research undertakings, rendered highly efficient by access to new and rapid data collection and processing technologies, small-scale case study may appear "rather quaint—a throwback to simpler, less complicated times" (p. 233). Such case studies have, nonetheless, "helped practitioners and stakeholders better understand the experiences and issues affecting people in various socio-educational and linguistic settings … and raised awareness of the complexities associated with multilingualism" (Duff, 2014, p. 234). She subsequently rues the relative dearth of case studies in which "both *linguistic* dimensions of learning/use … and *sociocultural* aspects" [italics in the original] are included (Duff, 2014, p. 235). Observations of this sort provide further impetus for the present study.

As Denscombe explains, the distinctive feature of a case study approach is its focus "on just one instance of the thing that is being investigated" (2008, p. 35). The instance (or unit of analysis) in the present case study is – as previously noted - Grade 4 teachers' use of classroom talk in their mathematics lessons, in particular Ms M's and Ms P's use of classroom talk. It is this mathematics classroom talk across the two sites that, in Stake's words (after Flood), constitutes the "bounded system" (2005, p. 444) for the empirical, as opposed to theoretical, aspects of the study. I do, however, also use data from my observations of the talk in Ms M's and Ms P's mathematics classroom to illustrate some of my interpretations of aspects of Vygotsky's, Bernstein's, and Halliday's ideas.

Bassey (1999) notes that collecting case study data involves firstly, asking questions and paying close attention to the answers; and secondly, observing events and carefully documenting their significant features. In my own questioning around mathematics classroom talk, and in my observations of such talk in the research sites, my goal was to develop more fine-grained, or, as Sfard puts it, "higher resolution" (2012, p. 2), insights into the ways in which the teachers managed the discourse during the observed mathematics lessons. Street (2013/1995), writing of the "significance of the socialization process in the construction of the meaning of literacy for participants", argues that investigation of such significance "necessarily entails an ethnographic approach" involving "closely detailed accounts of the whole cultural context in which [particular literacy practices] have meaning" (p. 29). The current investigation may best be labelled a 'micro-ethnographic' case-study. I say this in recognition of the relatively short periods of data-gathering, and of the specific, and thus relatively sharply-defined, focus on classroom talk. I am here drawing on Le Baron's description of microethnographic research as that which "addresses "big" social and organisational issues through careful analysis of "small" moments of human activity" (2008, unpaged). The 'small moments' under the metaphorical microscope for this study come from two Grade 4 mathematics classrooms which, as noted in the introductory chapter, Graven identified as constituting 'opportunity samples'. I now expand on this notion of 'opportunity'.

3.4 SETTING AND PARTICIPANT SELECTION

In Section 1.10 I explained that the two township schools in which this research was carried out are part of Rhodes University's SANCP community. SANCP's 2012 *Final Report: School Functionality* explains that schools participating in the University's SANCP project were selected on the basis of their perceived 'functionality'. While the report noted that "notions of school functionality are controversial and require sensitive interpretation" (SANCP, 2012, p. i), on the basis of seven key characteristics, the SANC identified twelve schools as amongst those having potential to derive benefit by input from the project. The Report notes that in the case of significantly *dysfunctional schools*, "only radical management interventions are likely to have any effect at all", while in the case of *highly functional schools* Numeracy Chair interventions would probably be superfluous (SANCP, 2012, p. iii). In decisions around appropriate schools in which to make interventions, the Report notes that schools lying between these extremes represent the "ideal targets for the Numeracy Chair's Programme" (SANCP, 2012, p. iii).

In some of the research methodology literature on sampling there seem to be instances of conflation of 'opportunity samples' with 'convenience samples' and a somewhat dismissive assessment of their merits (see, for example, Denscombe, 2007; Cohen, Manion, & Morrison, 2011; Newby, 2014). I would challenge such blanket assessments. In the context of my own research, far from Newby's suggestion that "convenience sampling is the use of data sources that just happen to be around" (2014, p. 257), the sampling decisions for the present study in fact pre-dated the study. I therefore had the good fortune to benefit from the rigorous selection processes which led to the SANCP Chair identifying appropriate school sites for its intervention initiatives. The two township schools used for my study thus constitute a sample within a larger sample. Both are in this sense purposive samples (Cohen et al., 2011, p. 153), chosen on the basis of their being part of SANCP, and of their Grade 4 mathematics teachers being participants in the NICLE PD project. They are also, I acknowledge, convenience samples (Cohen et al., 2011, p. 155) in that they are readily reachable from my place of work. More importantly than this, however, my doctoral supervisor, who is the present incumbent of the SANCP Chair, specifically identified Ms M and Ms P as likely to be able to contribute interesting and varied insights around their Grade 4 mathematics teaching practices in relation to the language policies and practices of their respective schools. The sites at which Ms M and Ms P work are at once sufficiently similar and sufficiently different from each other in respect of the following:

- They both work in schools serving isiXhosa-speaking township learners and, by Grade 4, both schools have English as their official LoLT. As noted in the introductory chapter (Section 1.10), at neither school are the Grade 4 learners (officially) learning through their home language. In terms of LoLT, Ms M's school follows a modified 'straight for English' language policy, whereby, while there is certainly some emphasis on using mother tongue as a resource for some early literacy learning in Grades 1-3, the school prides itself on having English as the main LoLT from Grade 1. Given this, and as noted, officially, Ms M's school is expected to follow the English *home language* curriculum, despite its learners not being native speakers of English. The language policy at Ms P's school parallels that recommended in South Africa's CAPS, namely mother tongue (i.e. isiXhosa in this instance) as the main LoLT through the FP years.

The language statistics in Tables 1.2 and 1.3 of Chapter 1 provided insight into the sheer scale of the shift that takes place for so many South African Grade 4 learners *away* from their mother tongue as LoLT in favour of English as the main LoLT. The learners at both research site schools are thus amongst the many who face the dual challenge of *mastering* English, while learning mathematics *through* English.

- Although both are competent bilinguals (isiXhosa and English), neither Ms M nor Ms P are themselves native speakers of English. This almost inevitably impacts on the way they steer their learners towards engaging with English as the language both of the classroom generally and – specifically – for the purposes of learning about mathematics.
- Their two schools serve different socio-economic sectors of the local township community. Ms M's school is fee-paying, while Ms P's is not. That said, most if not all the children attending these two schools come from homes lower down the socio-economic status scale than would be the case in, for example, an ex-Model C school[43]. As such, Ms M's and Ms P's learners are more vulnerable to the negative impact that lower-SES can, and often does have on children's literacy and numeracy development profiles.

The expectation was that these two sites could generate rich perspectives around the nature of mathematics classroom talk within a predominantly second language and 'previously disadvantaged' teaching/ learning environment.

On the basis of the foregoing considerations, Ms M and Ms P were each approached and asked whether they would be willing to allow me to attend their Grade 4 mathematics lessons for a two week observation period (second half of 2014). Both agreed, whereupon I approached their principals for permission to conduct research in their schools. See Appendices 1 and 2 for copies of the letters given to Ms M and Ms P, and to their respective principals. Copies of the principals' signed permissions forms are available in my Research Archive.

Having obtained the principals' go-ahead, I was then able to approach the relevant provincial Department of Education officials for formal permission to work in these schools. I was

43 The term 'Model C' dates from the early days of racial desegregation of South Africa's schools. In 1990, in recognition of the imminent demise of its apartheid policy, South Africa's Nationalist Government ruled that historically whites-only state schools could - under closely circumscribed conditions - admit Black learners (Vally, Dolombisa & Porteus, 2002). This marked the start of what were referred to as 'Model C' schools (or - post-1994 - 'ex-Model C' schools) (Hofmeyr, 2000). Given their historical legacy, and other continuing differences, most ex-Model C schools tend to be significantly better resourced in terms of infrastructure and personnel than township schools, and charge significantly higher fees.

granted permission, subject to certain conditions (including the requirement that I did not disrupt the normal working of the school day). See Appendix 3 for a copy of the official letter subsequently received from the Provincial Education Department.

Before the start of my classroom observations I had also outlined for the learners' parents (or caregivers) my research intentions. I did this through a letter (written in both isiXhosa and English) in which I also sought their signed permission to video their children's mathematics lessons during the data-gathering period. I explained that they were welcome to meet me or telephone me should they have concerns, and assured them also that had they any reservations about their child appearing in my video recordings, I would take the necessary steps to exclude the child's image from the recordings. No parents objected to my plans. A copy of this letter is included in Appendix 4, while the set of signed consent forms is lodged in my Research Archive.

Ms M and Ms P are both experienced primary school teachers. The fact of their both being members of NICLE afforded me the opportunity of engaging with them in a co-learning capacity. With the rest of the NICLE teachers, we participate in NICLE's explorations of optimal and innovative ways of enhancing young learners' numeracy development. We share a commitment to finding ways of helping improve achievement outcomes in school mathematics.

At the time the observation data were collected, Ms M was in her seventeenth year of teaching. Throughout this time, she had taught mainly IP mathematics, having taken up her present post twelve years previously. Ms M has a four-year initial teaching qualification (a three-year Certificate in Education, followed by a one-year Higher Diploma in Education). She then completed a one-year Advanced Certificate: Education specializing in Technology Education (2011), followed by a Bachelor of Education (Honours) qualification in which she included an elective course in Mathematics Education (2013). Her later qualifications (2011-2013) were obtained through part-time study. At the time of the present study, Ms M was responsible for teaching all Grades 4 to 6 Mathematics classes at her school.

Ms P's initial professional qualification is a three-year Certificate in Education completed in 1995, to which in 2005 she added a one-year Advanced Certificate: Education specializing in Information and Communications Technology completed over two years of part-time study. She has worked at the same school for the entire 21 year period after obtaining her initial qualification, the first six years as an FP teacher, and then at the IP level. At the time of the present study she was responsible for teaching the school's Grade 4 Mathematics and English First Additional Language classes.

Unlike Ms P and Ms M, I have been away from mathematics teaching for some considerable time. Although I worked as a Grade 5 primary school teacher in the late 1970s at a time when primary teachers were mainly generalists, for several decades my work has been outside the world of school mathematics. Teaching my Grade 5 learners mathematics was something I enjoyed and felt I was reasonably good at, but, mindful of the considerable developments that have taken place in mathematics education since I left primary school teaching, I could not but feel somewhat apprehensive re-entering mathematics education when, in 2013, I joined NICLE. I was re-assured by my supervisor's insistence that my main focus remain with the language/ literacy aspects of mathematics teaching and learning.

In this capacity I worked alongside Ms P and Ms M to explore some of the issues relating to the talk that took place in their Grade 4 mathematics lessons. An important aspect of my presence in their classrooms was that they should see me not as someone coming in to evaluate them, but rather as someone who shared with them, and with the NICLE community, a commitment to enriching the quality of mathematics teaching and learning in the SANCP schools. I was interested in learning from them – in the natural setting of their own classrooms - about the kinds of challenges mathematics teachers face in trying to respond constructively to the reform imperatives placed before them. That said, my being there - even in an ostensibly co-learning capacity - inevitably altered their 'normal' classroom climates, and posed a potential threat to the "ecological validity" of the study (Cohen et al., 2011, p. 195), notwithstanding Ms P's assurance to the contrary:

> **S-A R:** How did you feel having me in the class?
>
> **Ms P:** I didn't feel anything, ma'am. That's what I was saying to ~ talking to the Principal about. ... I was doing my work as usual.
>
> (Interview 2P, Lines 354-358)

In Section 3.7 where I discuss validity (or, as I prefer in the present context to call it, 'trustworthiness'), I touch on the issue of 'reactivity'. Ms P's choice of using 'ma'am' in addressing me in interviews, for example, was a little disconcerting. In Section 3.8 I reflect in some detail on aspects of 'positionality' which, as Merriam et al. note, "is determined by where one stands in relation to 'the other'" (2001, p. 411). (This 'where' is, of course, not something over which a researcher necessarily has a great deal of control. 'The other's' viewpoints constitute another inevitable influence over this.) As the next extract indicates, Ms M did experience some initial uneasiness about my presence, though, like Ms P, she said it made little difference overall to her teaching.

> **S-A R:** Do you think my presence in your maths lessons interfered or changed slightly the atmosphere of your lessons?
>
> **Ms M:** I think in a way it did because I know first of all, for myself, I'm not being sometimes very comfortable, thinking, "Hey! Am I doing something right you are going to reflect on, or whatever?" Also the children, I know they sometimes misbehave when they see someone else in class, as if maybe they want to be seen that they're also present in class. But to them I think it's only one day – or two – then after that they know there's this person in the class, and for myself, I told myself, Ms M, be yourself, do what you do in the lesson, pretend that there's nobody in the lesson, and do your lesson the usual way.
>
> **S-A R:** So I don't need to be too concerned that what I was seeing is different from normal?
>
> **Ms M:** No. Not at all.
>
> (Interview 2M, Lines 15-27)

I now turn briefly to justifying my choice of Grade 4 as the grade setting for my exploration of classroom talk. SANCP's 2011-2015 focus was on the Grade 3 to 4 transition from FP to IP. NICLE teachers were thus predominantly Grade 3 and 4 teachers. In light of the ANA results and other assessments indicating that Grade 4 learners did not have strong foundations in mathematics, content covered in NICLE sessions focused mainly on issues relating to ways of supporting teachers in their efforts to redress gaps in foundational numeracy. From my own (more language-oriented) perspective, as the first year of the IP schooling, Grade 4 marks the start of the important period when most South African learners move away from mother tongue and confront a predominantly English LoLT. This transition makes Grade 4 a particularly vulnerable year, probably contributing to what Chall and Jacobs (2003) described as the 'fourth-grade slump'. This slump is precipitated by, or exacerbated by, *inter alia*, children's encounters at this stage with more complex and less carefully-scaffolded text[44] and with an increase in the spread of school subjects to be studied.

The performance results discussed in Section 1.9 of the introductory chapter highlighted a significant fall in South African learners' average Mathematics ANA scores (2011 to 2014).

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44 I am here using the word 'text' in the way Halliday and Hasan (2013/1968) envisaged it: "any passage, spoken or written, of whatever length, that … form[s] a unified whole. … [It] is a unit a language in use" (pp. 1-2). I revisit this (linguistic) conceptualisation of 'text' in Chapter 7 (Section 7.2).

(The FP average for this period was 55.8%; the IP average for the same period was 33.8%.) These combined factors make Grade 4 an especially important, interesting, even critical, 'moment' in a child's learning trajectory.

3.5 EMPIRICAL DATA GATHERING

Classroom observation was my main means of collecting the data for this study. Interviews were conducted also with both teachers. Field notes and a research journal were kept throughout. I also kept copies of the worksheets used in the lessons, and, where textbook materials were used, kept a record of them.

Observation data were collected over a four week period (2 consecutive weeks in each school) beginning in the second week of the third term of the 2014 school year. I observed 14 of Ms M's Grade 4 mathematics lessons (seven for each of her two Grade 4 classes), which amounted to just under 12 hours of lesson observation. I observed 17 of Ms P's Grade 4 mathematics lessons, taught to her two Grade 4 classes. Together with time spent on morning prayers and greetings, plus two test periods, this totalled 17 hours of audio- / video-recorded material. The fewer hours spent observing Ms M's Grade 4 mathematics classes were simply a consequence of the school's timetabling arrangements and the fact that on the penultimate day of the two-week period Ms M indicated that no teaching would take place as the children were scheduled to write tests.

I made audio- and video-recordings for all lessons. Some few minor incidents of equipment malfunction prevented me from capturing a complete dual record of proceedings. The checklists of the lesson observations in Ms M's and Ms P's Grade 4 mathematics lessons (Chapters 8 and 9 respectively) indicate where these occurred. Throughout the observation period, however, I also kept field notes in which I recorded potentially significant occurrences, my on-the-spot reflections, and questions to myself that I thought needed further consideration. The field notes also constituted a useful backup for those few times when recording devices let me down.

I did not conduct the observations with any observation schedule as such. I was not interested at that stage in quantifying data. I also had a sense that the recordings would allow me to re-visit the lessons any number of times during the analytical phase of the project. In retrospect, I have wondered whether it may have been wiser to have developed some sort of semi-structured observation schedule and used this in addition, but I realised that the downside of this is that it may have distracted my own observation activity. It might also have distracted the teachers, perhaps making them self-conscious or worried, wondering what exactly it was that I was noting down (as is the case when pre-service teacher education lecturers conduct a ‘crit’ of teaching).

Simpson and Tuson describe observation as being “the most intrusive of all techniques for gathering data” (2003, p. 55). For each lesson, to minimise my intrusion, I sat where the teachers indicated they wanted me to be. In both cases, though their classroom layouts differed, this was at the teacher’s desk. Some of the children’s behaviours indicated that they were initially intrigued by my presence, and there was on occasion some ‘playing to the camera’ from them, but throughout I tried, in the words of Cohen et al., to “stand aloof”, occupying the role of a “non-participant observer” (2011, p. 297). During lesson times I avoided having any overt interaction with the learners. I neither made eye-contact with any of them, nor displayed any reaction to what was going on in the classroom. My impression was that they quickly came to see me as part of the proverbial classroom furniture.

I used a stereo digital voice recorder, and a full HD camcorder for the recordings. The camcorder was mounted on a pan-tilt head tripod which to some extent compensated for the fact that I was not able to move around the classrooms. While the sound quality of the recordings may not have been entirely optimal, I am satisfied that, though some of the one-on-one interactions between the teacher and individual children were not fully audible, I was able to capture a good percentage of the talk that went on in the lessons.

Each lesson was then transcribed in full. I initially attempted to manage the transcriptions myself, but this proved to be an extremely time-consuming process. While my supervisor advised me to focus my energies on transcribing critical moments, I was anxious about my ability to pre-judge what constituted such critical moments. I thus brought in assistance from outside. I found this particularly necessary in the case of Ms P’s lessons as she used a lot of isiXhosa. My limited repertoire of isiXhosa vocabulary was entirely unequal to the task. I needed therefore to have Ms P’s lessons transcribed, and the isiXhosa sections translated. This was done in the first instance by a part-time student assistant working for SANCP. When this assistant’s contract period with SANCP ended, I arranged to have the rest of the lessons transcribed by a research assistant working on another project in our Faculty. Both assistants are native isiXhosa speakers. Finally, to assess the soundness of their isiXhosa-English translations, I had all of the transcriptions of Ms P’s lessons checked by a third native isiXhosa speaker, also a part-time student assistant to SANCP. Ms M spoke very little isiXhosa in her lessons. The lessons were mostly in English, barring a few brief occasions – mostly when she was helping some of her struggling learners. This made the transcription process much simpler. I transcribed some of Ms M's lessons myself, and hired an experienced local transcriber to do the rest. In my subsequent analysis of the classroom talk in these lessons I was then able to work back and forth between the transcription documents and the video recordings. In each instance, where I had sought outside assistance in the transcription/ translation process, I emphasised to my assistants the importance of respecting the commitment I had made to maintain and respect the right to confidentiality of the participants at my research sites. Full transcriptions of all lessons, together with the interview transcripts, are stored in my Research Archive (see Appendix 5: Contents List: Data Archive). Extracts from a range of the observed lessons are built in to the body of the thesis.

As noted earlier, an interpretive view holds that participants in any social context act according to the meanings they ascribe to that context, hence Haralambos, Holborn and Heald's assertion that "social action can only be understood by interpreting the meanings and motives on which it is based" (2000, p. 971). To gain insight into some of Ms M's and Ms P's meanings and motives, and notwithstanding Kvale's point (2002) about the inevitability of asymmetries in power relations and of such asymmetry having potentially 'distorting' influences on interview data, I formally interviewed each of them on two occasions. Each of these interviews was in-depth, and semi-structured, in the sense that I had developed a set of questions around the sorts of things I wanted to explore further with both teachers, and at the same time wanted to ensure a degree of similarity in the overall structuring of the interviews across the two teachers.

In addition to giving me the opportunity to probe for meaning, these interviews allowed me to seek other sorts of information from the teachers relating to their teaching history and their views around other aspects of their work. The interviews thus facilitated triangulation with other data. I touch on the issue of triangulation in Section 3.7.

The first of the formal interviews with each teacher was conducted before I had entered either of their classrooms, the second shortly after I had finished the periods of observation in their respective classrooms. Each interview was audio-taped and subsequently transcribed. As with the lesson transcriptions, the full interview transcriptions are included in the Data Archive (see Appendix 5 for contents list).

When giving to Ms M and Ms P their respective sets of lesson and interview transcripts, I indicated that there was the opportunity for further discussion. When I met with Ms P to hand over the completed transcripts, she made a number of additional comments. I asked her if she would mind my recording our conversation, to which she agreed. I therefore have transcribed data from this third, less formal, interview with Ms P. On leaving the lesson observation and interview transcripts with her, I told her that she was welcome to get back to me if there was anything in them that she would rather I did not include in the thesis write-up. Hearing nothing further from her, I assume she was happy with the transcriptions.

When I met Ms M to hand over the completed transcripts, she took them away with her, indicating that she did not have anything she wanted to raise at that stage. She visited me three days later to let me know that she was completely satisfied that the transcripts represented an accurate record of the observed lessons. She in fact said that she had thoroughly enjoyed reading through them, remarking that some of the transcribed material had made her laugh. She said she had asked herself a couple of times as she read: “Did I really say that?” She gave me the go ahead to include as much of the material contained in the transcripts as I felt was appropriate to the study.

3.6 RESEARCH ETHICS

Ethical considerations and procedures for this case study conform to my University’s requirements, at the heart of which lie two key principles: informed consent and respect for persons. I have attempted to ensure that no breach of confidentiality pertaining to the identities or performances of individual learners or teachers occurred. I have used pseudonyms throughout and endeavoured to avoid providing the sorts of information that might indirectly identify the research sites and/or the individuals linked to them. Both Ms M and Ms P knew they had the right to withdraw from the research at any time. Similarly, as indicated earlier (Section 3.4), I sought the informed consent of the learners’ parents/ caregivers.

Also as indicated in the previous section, both teachers understood that their lesson observation and interview transcripts would be part of the ‘public documents’ going into the thesis. I explained though that they would have the opportunity of going through the transcripts to ensure that they felt I had captured things accurately, and in ways that did not make them feel uncomfortable. As, for example, I explained to Ms M, “I don’t want anything in there that you would prefer didn't go, or if you feel I've done it wrongly. … [Reading the transcripts] will give you an opportunity to say, "Hey, Sally-Ann! This. I'd prefer that this wasn't ~" (Interview 2M, Lines 518-522).

This member checking, or "respondent validation" (Nisbet & Watt, as cited in Cohen et al., 2011, p. 299) is an important element in ensuring the trustworthiness of my data. Maxwell identified it as "the single most important way of ruling out the possibility of misinterpreting the meaning of what participants say and do" (2009, p. 244). This links directly with what in a later text he termed 'interpretive validity' (Maxwell, 2012). I refer to this in the following section. Relating also to my commitment to 'interpretive validity' are my efforts at checking on the translation of the isiXhosa used in the observed lessons (particularly Ms P's). To do this I sought guidance from SANCP's part-time research assistant, a final year student, and a native isiXhosa speaker. She read through the full set of lesson transcripts, and apart from a few inconsistencies to which she drew my attention, expressed herself satisfied with the overall quality of translation. I am aware that, because the written form of isiXhosa is not yet fully standardised, there may still be some inconsistencies. A classic illustration of this sort of thing arose during one of our NICLE sessions. It was in fact the Principal of Ms P's school who alerted our NICLE group to certain isiXhosa/ English translation issues. I discuss this incident and my follow-up on it in a postscript to Chapter 9.

3.7 'TRUSTWORTHINESS'

I have chosen to head this subsection 'trustworthiness' rather than use a more conventional term such as 'validity', even though, in his discussions of validity in qualitative research, Maxwell (2012) implies that these terms embody a similar meaning. Validity revolves around the extent to which the inferences (or interpretations) a researcher makes can be judged as "logically derived and credible" (Robertson, 2012, p. 53), and for Maxwell, in the context of qualitative research, this is not a matter of ""mirroring" … between account and reality" (2012, p. 133).

Maxwell cites Hammersley and Atkinson's point that "data in themselves cannot be valid or invalid; what is at issue are the inferences drawn from them" (2012, pp. 133-134). He then identifies three types of validity that he considers important in qualitative research. These are *descriptive* validity (striving for accuracy in descriptions from the research site); *interpretive* validity (sensitivity to the emic perspective, which in this case refers to Ms M's and Ms P's perspectives and the meanings that they ascribe to circumstances); and *theoretical* validity (relating to the legitimacy of the concepts and constructs used to explain one's findings) (Maxwell 2012).

In presenting my data, and during the analysis and synthesis phases of this study, I have attempted to attend to all three of the validity categories identified by Maxwell.

- In my efforts to achieve descriptive validity, I approach this primarily, though not exclusively, through gathering my data in sufficient depth and detail to facilitate 'thick description' (after Geertz, 1973)[45]. Thick description, Cresswell and Miller argue, helps to produce "verisimilitude", thus strengthening credibility "through the lens of readers who read a narrative account and are transported into a setting or situation" (2000, p. 129).
- Regarding interpretive validity, I argue that data from my discussions with Ms M and Ms P, both informally, and through the interviews, enabled me to provide sufficient evidence of these teachers' thoughts, feelings, beliefs and attitudes toward what transpired in the observed lessons and in relation to factors outside their teaching which they see as impacting upon their learners' verbal participation in their lessons.
- And finally, as regards the issue of theoretical validity, I believe that through my weaving in of actual examples from Ms M's and Ms P's contexts to highlight and illuminate aspects of the theoretical discussion in Chapters 4 to 7, I was able to reinforce the links between the study's theoretical frame and the actual research context data, and thereby strengthen its potential to make a theoretical contribution. In terms of my selection from the literature on literacy and numeracy development and the insights it provides on the crucial contributions of classroom talk to such development, I have further sought to address this aspect of validity.

Two potential threats to the trustworthiness of qualitative research that Maxwell (2009) identifies are, firstly, researcher bias via the intrusion of a researcher's own "theory, values or preconceptions" (p.243), and secondly, reactivity to the potentially unsettling influence of the researcher's presence on the research site. In relation to questions of researcher bias, however, Denscombe provides the following counter-argument:

45 Although, in almost all of references I found to it in the research literature, credit for the concept of 'thick description' is given to the late American anthropologist, Clifford Geertz (1926-2006), Geertz himself (1973) attributed it to British philosopher, Gilbert Ryle (1900-1976).

> As researchers, the meanings we attach to things that happen and the language we use to describe them are the product of our own culture, social background and personal experiences. Making sense of what is observed during fieldwork observation is a process that relies on what the researcher already knows and already believes, and it is not a voyage of discovery which starts with a clean sheet. (2007, p. 68)

In similar vein, England (1994, p. 84) wrote, "We do not parachute into the field with empty heads and a few pencils or a tape-recorder in our pockets ready to record the "facts"." I pick up on Denscombe's and England's points from in my next section where I reflect on my own position (relative to the focus of my study and in relation to Ms M and Ms P).

Turning now to the issue of reactivity, the extracts from Ms M's and Ms P's interview transcripts cited in Section 3.4 suggest that while some small degree of reactivity was certainly at play initially, neither teacher seemed significantly influenced by my presence. Quite independently of the soundness of my surmise here, it is perhaps worth noting Becker's point (cited in Maxwell, 2009, p. 243) that "in natural settings, an observer is generally much less of an influence on participants' behaviour than is the setting itself."

The strategies I used to limit threats to the trustworthiness of my account of the nature and apparent consequences of the kinds of classroom talk taking place in the Grade 4 classrooms included – as already mentioned - member checking, plus triangulation across the various data sources. I align with Denscombe's view of triangulation as more of a means of providing "a fuller picture" (Denscombe, 2007, p. 139) than as a validity control mechanism as such. The sources used to provide this 'fuller picture' are my field notes, the audio- and video-recordings of the lessons, the lesson observation transcripts, the interview recordings and transcripts, and other post-observation discussions with both teachers.

3.8 POSITIONALITY AND REFLEXIVITY

Notwithstanding my description of my relationship with Ms M and Ms P as being one of co-learnership, there are issues relating to my position in the wider educational community relative to theirs. I would like again to quote from England (1994, p. 87). She concludes her eloquent discussion of reflexivity and positionality by noting that "the positionality and biography of the researcher plays a central role in the research process, in the field as well as in the final text". I have alluded in a number of places throughout this write-up to my own background. I will now focus specifically on this background relative to my work with Ms M and Ms P.

England argues that “the research relationship is inherently hierarchical” (1994, p. 86). This hierarchical element is certainly a factor in the present study. Although I gained access to Ms M’s and Ms P’s classrooms mainly through our joint membership of NICLE, we joined NICLE with different purposes. Ms M and Ms P joined because they teach primary school mathematics, and because their schools are part of SANCP. I joined NICLE because of the language in mathematics research I was interested in pursuing. Ms M and Ms P are school teachers. I am a university lecturer. In fact, Ms M was a student in some of the courses I taught during her Advanced Certificate: Education and Bachelor of Education (Honours) studies (in 2010 and again in 2012, respectively). This is how we first met. Although I have not taught Ms P, her Principal was a member of one of my Faculty’s Bachelor of Education (Honours) programmes, and registered for some of the courses I was responsible for. She and I have subsequently enjoyed a very positive relationship. I, in fact, have *also* taught Ms M’s Principal, the perhaps inevitable ‘price’ of being part of a relatively small, local, ‘university town’ community.

To cite England again: “relationships with the researched may be reciprocal, asymmetrical, or potentially exploitative” (1994, p. 82). Whatever asymmetries there may currently be in my relationship with Ms M and Ms P, it is my intention that the end result of this research be made into something with reciprocal value. Setati, in exploring the differences between working ‘on’ and working ‘with’ teachers, noted that “working “with” and “on” teachers is about reciprocity” (p. 100). In terms of the present work in Ms M’s and Ms P’s mathematics classrooms, this aspect of reciprocity will take place mainly through our continued joint membership of NICLE, and our commitment to exploring ways for improving learners’ numeracy learning outcomes. There will be opportunities here to acknowledge Ms M’s and Ms P’s centrally important contribution to the project. The NICLE team leaders have also indicated that they would like to schedule some SANCP workshops based on the work done in Ms M’s and Ms P’s classrooms. Assuming they are willing, I propose to involve Ms M and Ms P in the planning and implementation of such workshops so that we can feed back into the field in helping raise professional awareness around the importance of classroom talk for mathematical meaning making. We may have opportunity also to extend this further, perhaps through a joint presentation at one of our regional AMESA (Association for Mathematics Education of South Africa) conferences, and perhaps even through a co-authored publication in AMESA's *Learning and Teaching Mathematics Journal*, a professional teacher-focused publication.

In the immediate context however, I wish now to engage with the question of exploitation by returning to my earlier allusion to the ethical principle of respect for persons. I hope readers of this thesis will find that I have represented Ms M and Ms P, and their professional strengths in ways that do them justice: acknowledging their commitment, and genuine efforts to teach in constructive ways; and contextualizing their struggles in an empathetic, sound, and theoretically coherent manner.

Being a white, English-speaking academic, whose only primary classroom teaching experience comes from during the apartheid era, where all of my learners were white and English-speaking; girls of 10-11 years of age from moderately affluent and literate home circumstances, I recognise that my own school teaching context was markedly different from the contexts in which Ms M and Ms P currently work. Both Ms M and Ms P are black, isiXhosa-speakers, whose black, isiXhosa-speaking learners come from much less affluent and less literate home circumstances than the children I taught. In broad terms, the differences between the primary school context I taught in all those years ago and the contexts Ms M and Ms P now teach in mirror the marked 'bimodal distribution' of achievement in literacy and numeracy across the different socio-economic and racial sectors of South African society of which Fleisch wrote (2008).

I am reliant, therefore, on Ms M and Ms P, through careful listening and watching, and without making comparative judgments, to help me deepen and enrich my own understandings of the challenging professional circumstances in which they work, and – to quote England one final time – work at "[incorporating] the voices of "others" without colonizing them in a manner that reinforces patterns of domination" (1994, p. 81). It is for this reason that, in Section 3.4, I expressed as I did my concern regarding Ms P's addressing me as 'ma'am'. While 'ma'am' may be a perfectly normal show of respect in circles uncomplicated by an apartheid history, in the South African context, using 'ma'am' in addressing a fellow professional who happens also to be a white woman risks invoking impressions of subordination (at variance with my expressed co-learner position in relation to Ms P). Black/White relationships in South Africa remain a complex affair, but perhaps Ms P's use of 'ma'am' reflected - in an uncomplicated way - the style of one teacher addressing another teacher.

Citing Nisbet and Watt (1984), Cohen et al. (2011, p. 293) warn that a researcher's own subjectivity may compromise a study's internal validity, "despite attempts made to address reflexivity" (p. 293). Peshkin too voiced caution about researcher subjectivity, observing that, although "subjectivity is like a garment that cannot be removed ... [and] ... is insistently present in both the research and non-research aspects of our life" (1988, p. 17), "untamed subjectivity mutes the emic voice" (1988, p. 21) (in my case, the voices and meanings Ms M ad Ms P ascribe to their mathematics teaching circumstances). I have tried to remain vigilant in relation to this threat. Engaging in what phenomenologists call *epoché* (the bracketing off of one's own preconceptions about a situation)[46] is, however, no mean feat, and perhaps approaches the impossible. As Maxwell (1992) writes, "as observers and interpreters of the world, we are inextricably part of it; we cannot step outside our own experience to obtain some observer-independent account of what we experience" (p. 283). I have attempted nonetheless to be scrupulous in the exercise of *epoché*; to remain alert to how my own beliefs and experiences may influence, at worse, distort, my interpretations of the data from Ms M's and Ms P's observed mathematics lessons. I have attempted also to be always reflexive, which as Berger describes, constitutes "the self-appraisal in research", involving, as it does, "turning the researcher lens back onto oneself to recognise and take responsibility for one's own situatedness within the research" (2015, p. 220). Also, in weaving in the empirical with the theoretical, I have as far as possible used Ms M's and Ms P's words, so that they can, so to speak, 'speak' for themselves, and readers can add their own interpretations to mine.

I close this section with a quote from Mercer (1994). I include it here because, apart from its resonance with aspects of my own study (a sociocultural approach, *and* a focus on classroom talk), I believe Mercer's comments echo but also temper some of the concerns expressed above around questions of reflexivity.

> One of the special attractions of the sociocultural perspective is that it is reflexive – it accounts for the research process itself. It recognises that a researcher who observes and analyses talk is essentially just another language-user, a listener, a passive participant in the process of teaching and learning. The researcher's aim is to understand what the active participants understand, and to use the same means that they use – language – to do so. (1994, p. 122)

46 Wikipedia explains that 'epoché is a term popularised by Husserl. It derives from "an ancient Greek term which, in its philosophical usage, describes the theoretical moment where all judgments about the existence of the external world, and consequently all action in the world, are suspended" (retrieved December 20, 2014, from https://en.wikipedia.org/wiki/Epoch%C3%A9).

3.9 GENERALISABILITY

In relation to the issue of generalisation in case study research, Stake suggests that "the real business of case study is particularization, not generalization" (1995, p. 10). That said, citing a study by Griffith (2000), Bertram and Christiansen note that a case study needs three things to demonstrate its generalisability: "typicality, detailed description and multisite research" (2014, p. 124). To the extent that my study has these three elements, it may be seen to be in some degree generalisable. Cohen et al. are less unequivocal about the generalisability potential of case studies, pointing out that "a case is not a sample" (2011, p. 294). Drawing on Yin's arguments, they do however support the idea of a case study having 'analytic' generalisability; the potential, in other words, to contribute to relevant theory bases (Cohen et al., 2011). This point echoes Flyvbjerg's argument that though "knowledge [from a case study] cannot be formally generalized [this] does not mean that it cannot enter into the collective process of knowledge accumulation in a given field or in a society" (2006, p. 227). Certainly, in terms of the theoretical work contained in Chapters 2 and 4 through 7, I have sought to make some contribution here in terms of analytic generalisability.

I have already - in the introductory chapter - alluded to the idea of 'resonation' as an alternative to generalisation, and, as noted by Cresswell and Miller (2000, p. 129), "thick description" provides one means whereby readers may assess the extent to which a particular interpretative case study resonates with other settings. Bassey similarly argued this point, writing that "an important criterion for judging the merit of a case-study is the extent to which the details are sufficient and appropriate for a teacher working in a similar situation to relate his [/her] decision-making to that described in the case-study" (1981, p. 85). For Bassey, "the relatability of a case-study is more important than its generalisability" (1981, p. 85). Maxwell (2013) noted the potential that qualitative research offers for "generating results and theories that are understandable and experientially credible" (p. 31) to an intended audience (whether one is here defining one's audience in terms in the first instance of the participants immediately involved (Ms M, Ms P and the NICLE community) or in terms, ultimately, of the wider educational research community).

3.10 ANALYSIS OF THE OBSERVED CLASSROOM TALK

Drawing on Lofland, Cohen et al. (2011, p. 221) list the following three questions that a piece of naturalistic enquiry should address:

- What are the characteristics of a particular social phenomenon?
- What are the causes of this social phenomenon?
- What are the consequences of this social phenomenon?

These questions speak directly to the research questions developed for the present study (as enumerated in Section 1.3 of the introductory chapter). Given that the social phenomenon, or 'unit of analysis', for this study is classroom talk, it is the transcriptions of the audio- and video-recordings that constitute my main sources of empirical data. As Graddol (1994) remarks, "… recording [and a subsequent written transcription] has the effect of turning an ephemeral spoken event into a relatively stable object for analysis" (p. 45).

As outlined in the introductory chapter, a core theoretical goal for this study is the bringing together of three different sources of theoretical insight from the work of three educational luminaries (Vygotsky, Bernstein, and Halliday) in my analysis. As I explain in Chapter 4, I have opted for a convergent, synthesizing approach. Included among those whose advice I sought in arriving at this decision was Professor Neil Mercer. As was evident from my discussion in Section 2.5.1 of the previous chapter, he has contributed to an enormous amount of research and development work on classroom interaction and on the importance of spoken dialogue for the development of children's thinking. He advised that I "design my analytic methods to be as simple as possible" (e-mail communication, August 28, 2014). This comment helped me move towards the following triple-layered *linguistic* analysis of the observed mathematics lessons.

- I begin with a basic analysis of talk during the observed mathematics lessons, drawing on aspects of Sinclair and Coulthard's hierarchical discourse units (acts, moves, exchanges and transactions) (Sinclair & Coulthard, 1975; Coulthard, 1985). I include a description of their exchange structure analysis strategies in Chapter 8 (Section 8.3.1).

- For the second layer of analysis, and given the high incidence of teachers' questions in Ms M's and Ms P's lessons, questions which – not unexpectedly - mirror the three-part IRE (initiation-response-evaluation) exchange pattern, I then focus specifically on the two teachers' questioning styles. Here I draw on categories of question developed by *inter alia* Long and Sato (1983) and by Bellon, Bellon and Blank (1992). I describe aspects of their approaches to classroom question analysis in Chapter 8 (Section 8.3.2).

- The third layer of analysis represents my attempt at synthesizing insights from theories of second language acquisition and literacy/ numeracy development in and through a second language to illuminate some features of Ms M's and Ms P's classroom talk practices and how these appeared to build up their learners' linguistic capital, particularly in relation to the development of their mathematics register along a BICS/ CALP continuum.

I reiterate the point made in Section 1.10 of the introductory chapter, namely that I have no intention of *comparing* the two teachers' classroom talk practices. Analysis of each set of practices is – in its separate way – intended to add to the potential 'richness' of the present exploration of classroom talk in relation to Grade 4 mathematics teaching and learning.

I return to Lofland's three questions cited at the start of this section.

What are the characteristics
What are the causes of the particular phenomenon under examination?
What are the consequences

In responding to these questions, the narratives shared in Chapters 8 and 9 seek firstly to capture the general characteristics or patterns of Ms M's and Ms P's classroom discourse; secondly to try to situate this within the broader socio-economic and socio-political contexts of their schools; thirdly to link this to the apparent evidence of children's mathematical learning, as represented to me by Ms M and Ms P, and as was demonstrated in the children's 2014 Mathematics ANA scores reflected in Table 1.1 (Section 1.10 of Chapter 1), and in terms of some of SANCP's data for their respective schools.

3.11 SOME DELIMITATIONS AND LIMITATIONS

I discuss in this section some limitations and *de*-limitations of the present study.

The first delimitation is that this study is primarily *conceptually* driven. The purpose of its empirical element is largely to animate the theory contained in the study. That said, of course one needs to reflect carefully on limitations to the quality of one's data collection, selection, analysis and presentation, and the claims one makes relative to it.

A second delimitation (as opposed to limitation) relating to the empirical data I have used to tell Ms M's and Ms P's respective stories lies in the fact that case studies, by their nature, tend to have a shorter and narrower focus than some other types of research. One consequence of this in my own case study design was that the short periods of observation in both teachers' classrooms did not allow for a temporal element. Mercer (2008) notes that there is a "cumulative quality to the educational process … involving the gradual induction of students … into new ways of using language for representing knowledge and making sense of experience" (p. 34). In terms, however, both of the time available and of what was covered in the lessons observed, I am not able make claims relating to such accumulation in patterns of mathematics classroom discourse with Ms M's and Ms P's Grade 4s.

Language factors constituted a second set of limitations. Firstly, I struggled to tease out the extent to which the nature of the classroom discourse in the two sets of Grade 4 classrooms was a result of the fact that the teaching was taking place – at least officially – in a language with which many of the children were not yet fully conversant. I was also unable to evaluate the extent to which this situation in any way tempered Ms M's and Ms P's language use – either consciously or unconsciously, or both - as they attempted to 'negotiate [mathematical] meaning' (after Pica, 1994, as cited by Skehan, 2001, p. 80) with their learners, although, as was revealed in the interviews, both teachers certainly identified language as a barrier to their learners' mathematical learning. Secondly, as noted in Section 3.5, while Ms M used very little isiXhosa in the mathematics lessons I observed, Ms P used isiXhosa extensively. My presence may have been an inhibiting factor to Ms M in this respect though there was no indication of this. Transcribing her lessons was relatively straightforward. For transcribing Ms P's lessons, on the other hand, I was, as noted in Section 3.5, reliant on others because it involved a great deal of IsiXhosa/English translation. While I took steps to validate the translations, I am aware of the non-ideality of doing discourse analysis on 'non-original' recorded text. In the introductory section to Part 5 I elaborate further on the ways in which I approached my analysis of the discourse in Ms M's and Ms P's observed mathematics lessons.

A third aspect of limitation relates to the decision to use an interdisciplinary approach, drawing on psychology, sociology, linguistics, and other aspects of educational theory as these relate to literacy and numeracy development. There are advantages in this spread, but it may also mean that no one of these sources of insight is maximally exploited. I am confident though, now that the research is complete, that the richness derived from using these multiple sources does to a degree counteract the inevitable attenuation of any one of them. In this I draw strength from Martin's view that "productive interdisciplinarity … enriches disciplinarity; it doesn't water knowledge down" (2011, p. 37). In his concluding discussions around the issue of interdisciplinarity, the Martin's further remark resonates with my own experience in this research:

> Those of us who have participated in interdisciplinarity dialogue know that life wasn't meant to be easy, but at its best we have all experienced moments in which the effort involved proved more than worthwhile. (2011, p. 57)

One final limitation that I wish to note derives from the nature of research *per se*, and perhaps especially qualitative research where the goal is to 'make meaning(s)' of one's data. Researchers' access to 'reality' can only ever be partial, refracted and filtered through the lenses of their own subjectivity, occluded to some extent by what participants in the research site – both consciously and unconsciously – make visible. In the case of the present study, Ms M and Ms P gave me access to their Grade 4 mathematics classrooms, and - in interviews - they gave me access to some of their thoughts. My skills as a data gatherer dictated what I was able to see and hear. I could not, without significantly more sophisticated (and hence potentially more invasive) recording technology, capture all of the verbal interactions in their classrooms. I did not – as noted previously - attempt to interact directly with the children. I was reliant primarily therefore upon my own visual reading of the classroom situations and upon the teachers' perspectives on the aspects I thought it wise to 'interrogate' further with them.

3.12 MOVING FORWARD

In Part 4 I engage explicitly with the second of my research goals, namely to scrutinise those aspects in the work of Vygotsky, Bernstein and Halliday that I see as contributing to a fuller understanding of some of the ways language works to afford differential opportunities for literacy and numeracy development, and to make links between this and aspects of the empirical data collected from Ms M and Ms P in the context of their Grade 4 mathematics teaching. I begin Part 4 with a relatively short chapter in which I explain my theoretical framing, and justify my inter-/ trans-disciplinary approach. This is followed by three chapters in which I deal – respectively – with the selections I have made from Vygotsky's, Bernstein's and Halliday's enormous bodies of work.

Part 4: The study's theoretical frame

CHAPTER 7: DRAWING ON HALLIDAY

CHAPTER 4: THEORETICAL FRAMING AND EMPIRICAL ILLUMINATION

> *Lenses can be thought of as a series of tiny refracting prisms, each of which refracts light to produce their own image. When these prisms act together, they produce a bright image focused at a point.*
>
> (In the physics classroom: The anatomy of a lens[47])

4.1 INTRODUCTION

Included in this case study exploration of the contribution classroom talk makes in the teaching and learning of mathematics, is - as noted in the introductory chapter – my more theoretically-oriented goal of seeking to distil from the work of Vygotsky, Bernstein and Halliday ideas relating to the centrality of language for literacy and numeracy development. This fourth part of the thesis contains my distillation. I start with this comparatively short overview chapter in which I provide some explanation and justification of my choice of framing metaphor as the means of holding together the different streams of insight constituting the study's theoretical frame: the metaphor being that of a multifocal lens. I then devote a chapter to each of the three theorists in which I highlight (with empirical data) the ways in which the work of each has helped inform and frame the study.

'Framework' according to *Longman Dictionary of Contemporary English* (LDOCE) is 'a set of ideas … or beliefs from which something is developed'. This definition implies a degree of unity that I do not feel quite captures what I am trying to achieve here. I have chosen therefore to use the word 'frame', defined in the LDOCE as 'a structure that surrounds something … *and holds it in place*' [italics added]. I might even use the phrase 'frame of reference' here to refer to the particular set, or combination, of theoretical ideas and related assumptions from which I analyse and interpret the implications of the verbal interactions I observed in Ms M's and Ms P's Grade 4 mathematics lessons.

In Chapter 2 I drew on academic literature relevant to the role of talk in the development of children's literacy and numeracy and explored some synergies across the fields of literacy and numeracy. Given the context in which this study is located, I gave particular emphasis there to views around optimal ways of supporting children's talk in contexts where they are both

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47 Epigraph retrieved October 8, 2015, from http://www.physicsclassroom.com/class/refrn/Lesson-5/The-Anatomy-of-a-Lens

learning their additional language and having to develop their literacy and numeracy in and through this language. I believe that, taken together with the ideas explored in this fourth part of the thesis, I will have provided a sufficiently strong platform from which to engage with the more empirically-oriented goal of the study, namely my analyses of the patterns of talk observed in Ms M's and Ms P's Grade 4 mathematics lessons.

4.2 PROSPECTS FOR SYNERGY

While there has already been extensive intellectual investment on the part of a great many academic and professional minds in examining all of these ideas, a major part of my own academic project here is to gather up from these intellectual resources a *particular* and novel combination of ideas; a combination that I hope may be of special relevance in furthering the work of SANCP and other educators in assisting teachers to navigate some of the challenges that language issues pose for our young learners of mathematics.

As the 2014 Mathematics ANA Scores contained in the introductory chapter showed (Table 1.1), the national average for Grade 4 learners was 37%; the provincial average (in which was contained all of the NICLE teachers' learners) was just under 35%; and the achievement gap between learners of Quintile 1 and Quintile 5 schools was 20%. These are worrying statistics, and ones in which, certainly in the eyes of Ms M and Ms P and many others working in similar circumstances, language is clearly implicated.

It is in relation to the issue of language that Vygotsky's, Bernstein's and Halliday's ideas cohere so well, but, extending beyond this recognition of the centrality of language, there is also their common emphasis upon socio-cultural and socio-political aspects of learning. In this sense, their ideas illuminate both the centrally important role of language in learning and the ways in which contextual and linguistic differentials can - indeed almost invariably do - impact on educational outcomes.

Drawing on Lerman and Tsatsaroni (2004), Simon (2009) notes that, "currently there are more theories of learning in use in mathematics education research than ever before" (p.477). This is in part a consequence of the fact that mathematics education has what Bernstein termed a "horizontal knowledge structure"; one in which a "range of languages [of description] have to be managed, each having its own procedures" (1999, p. 164). I noted in Section 1.2 of the introductory chapter that the languages of description of Vygotsky, Bernstein and Halliday represent respectively the disciplines of psychology, sociology and linguistics[48]. Simon (2009) writes of “an unproductive divide that sometimes is a part of discourse in our [mathematics education] field” (p. 479). Here he was talking about adherence, most often ideologically motivated, to particular theoretical standpoints. Simon argues instead for “the possibility of coordinating the results of work from different theories” (2009, p. 481), which is precisely what I have sought to achieve in the present study.

Using arguments similar to those articulated by Simon, Martin (2011) advocates interdisciplinarity as a helpful mechanism for dealing with “real world problems” (p. 35). In explaining the synergy between SFL and Bernstein’s sociological work, Martin writes:

> Conversation is fostered by having a problem with which both disciplines are concerned, the ability to trespass on each other’s domain by providing complementary perspectives on comparable phenomena, and possession of a discursive technology which can make visible things the other discipline wants to know. (2011, p. 37)

I have added to this interdisciplinary mix two further ingredients: Numeracy teaching and learning, and language and literary teaching and learning. I am aware - as indeed I indicated in Section 3.11 of the methodology chapter - that this eclectic mix could “entail a loss of disciplinarity” (Martin, 2011, p. 35). At the same time, however, I believe such use of multiple sources has the potential to add richness to my overall analysis of the talk that I saw taking place in Ms M’s and Ms P’s lessons, and through this provide a theoretical contribution in this respect.

In seeking some sort of framing metaphor for the present study, I exploratively engage with the ideas of ‘co-ordination’, ‘interdisciplinarity’[49] and ‘synthesis’. As I explain in the following section, it is, in fact, less about synthesis (which I feel would be an altogether over-ambitious goal in the present circumstances) and more about complementarity and synergy.

48 A claim that Bernstein and Halliday represent sociology and linguistics respectively is unlikely to attract challenge. I am aware, however, that assigning Vygotsky simply to the psychology slot may be contentious. Wertsch (1985), for example, points out that Vygotsky never trained professionally as a psychologist. This very absence of professional pigeonholing, Wertsch argues, contributed to Vygotsky’s ingenuity of thought: “It is precisely because he was not *only* a psychologist that he was able to approach this discipline with a fresh eye and make it part of a more unified social science” (1985, p. 2). Along similar lines, Kozulin, in his introduction to Vygotsky’s ‘Thought and Language’ text, noted that, though Vygotsky was “never to receive formal psychological training, [he nonetheless] emerged as an original thinker, with his own ideas on what constitutes the subject and the method of psychological study” (1986, p. xvi).

49 Note, however, the semantic shift I make in the concluding paragraph of this chapter. This happened under the influence of Halliday’s cogent advocacy of ‘trans-’ rather than ‘inter-’ disciplinarity (2008).

4.3 A FRAMING METAPHOR

While a literature search can never be exhaustive, I have read widely in tracking down literature sources for this study across a range of contexts and decades. I have found numerous articles where writers have drawn on Vygotsky and Halliday[50], or Halliday and Bernstein, or Bernstein and Vygotsky or, indeed on all three (as Lerman (2009) did). However, while I realise there are almost certainly others, in my own search I encountered just two papers where a writer has explicitly sought some synthesis of the three. The first article is by Joseph Foley (1991). He was at that time working in the Department of English Language and Literature at the National University of Singapore, and in this 1991 article drew on these theorists' ideas in conceptualizing what he termed 'a unified theory' of L1 andL2 learning. The second, more recent article is by the late professor emeritus in linguistics at Macquarie University in Sydney, Australia, Ruqaya Hasan (2002). In it she explored links between semiotic mediation, language and society, and the respective contributions of Vygotsky, Halliday and Bernstein with the aim of producing what she described as "a reasonably coherent account … of the sociogenetic development of human consciousness" (Hasan, 2002, unpaged).

In reflecting on how best to articulate my own plan to bring Vygotsky's, Halliday's and Bernstein's ideas together to help frame and focus this investigation into mathematics classroom talk within the South African context, I finally settled, as noted in this chapter's introductory section, on using a multifocal lens as my framing metaphor. This, I know, is not an uncommon metaphor. I am, for example, aware of Lerman's much-cited use of a lens metaphor (1998) where he makes an analogy between a video- or still camera's zoom lens function and a researcher's zooming in and zooming out on the various micro-/ macro-aspects of a research setting. My own lens metaphor is more elementary: that of a simple convex lens functioning to converge rays of light onto a particular focal point. It is the work of Vygotsky, Halliday and Bernstein that constitute the metaphorical rays, and these in turn are refracted through the lens of research on aspects of second language acquisition and literacy/numeracy development in and through a second language. Drawing on these multiple

50 Wells, for example, in his extended article examining the complementarity of Vygotsky's and Halliday's ideas about language and learning (1994), paid their work homage as follows: I have been influenced by the work of two scholars above all others. The first of these is Halliday… . … My other mentor was Vygotsky. … In all this time … I have thought of the work of Halliday and Vygotsky as highly compatible and - in many important ways - complementary" (p. 42). "Both," he wrote, "recognise that schooling is very much concerned *with the development and reconstruction of meaning*" [italics added] (Wells, 1994, p. 70).

insights, I then attempt to bring more sharply into analytical focus some of the patterns of talk observed in Ms M's and Ms P's Grade 4 mathematics lessons, including some of the potential consequences of such patterns.

Writing in 2001, Lerman noted the increasing range of "intellectual resources" from which mathematics education is drawing (2001, p. 87) in relation to concerns around issues of power, and the ways in which [in 'Bourdieuian' terms] power frequently translates into social and cultural reproduction. Lerman observes that while the main theoretical resources for such insights come from the fields of sociology, anthropology and cultural studies, psychology too has been embracing an increasingly sociocultural orientation with an interest in the ways that, in Lerman's words, "consciousness is constituted through discourse" (2001, p. 88). Again making use of his zoom lens analogy, he goes on to expand on views which argue that "social practices are discursively constituted, and … people become part of practices as practices become part of them" (2001, p. 88). In Chapters 8 and 9 I explore the extent to which this might be seen to be the case not only in relation to Ms M's and Ms P's Grade 4 mathematics learners, but also in relation to Ms M and Ms P themselves.

Notwithstanding Lerman's warning that "incompatibilities lurk in incautious complementarities" (2001, p. 88), my goal in the present study is – as previously noted - to work towards convergence (rather than synthesis) of those 'intellectual resources' I regard as offering complementarity. Below (Figure 4.1) I capture this intent in diagrammatic form.

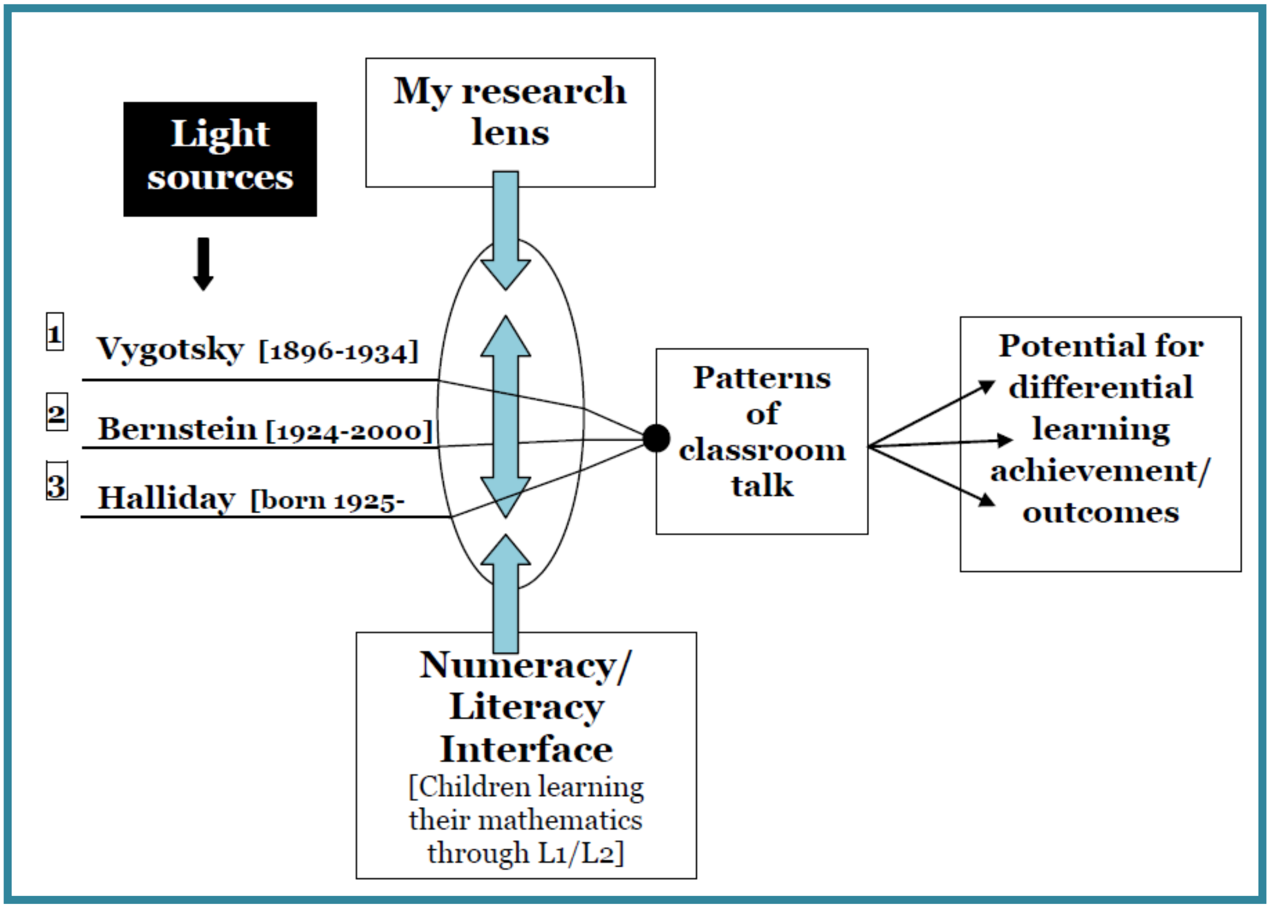

Figure 4.1: **Converging light sources on some potential consequences arising out of different patterns of classroom talk**

In the following three chapters, I distil from the vast 'intellectual resources' of Vygotsky, Bernstein and Halliday those complementary insights I see as relevant to my study. I illustrate this graphically in Figure 4.2, below.

In Figure 4.2 (below) I took the liberty of appropriating Martin's visual ideas in portraying my own use of a range of disciplines in this exploration of two teachers' use of classroom talk. It was in presenting the possibilities for dialogue between linguistics and sociology that Martin, a close colleague of Halliday's, depicted graphically the move away from disciplinary isolation towards dialogue between disciplines ('interdisciplinarity') (2008, PPT slides 8-12).

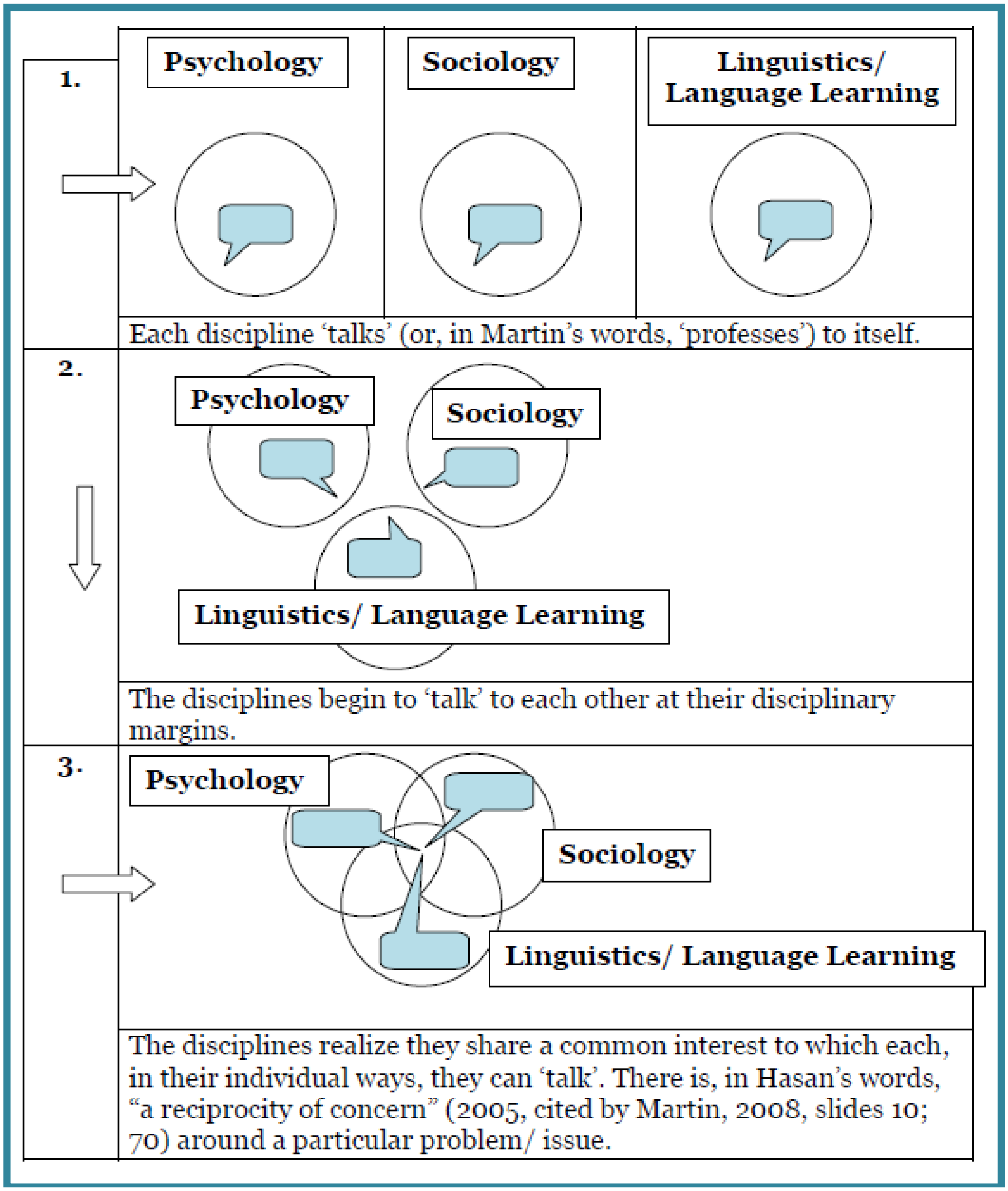

Figure 4.2: **Addressing problems/ issues through dialogue across disciplines**

Asked his views on '*inter*disciplinarity' relative to the field of applied linguistics, Halliday expressed a preference rather for a '*trans*disciplinary' approach to drawing on different 'intellectual resources'. Transdisciplinarity, he felt, avoided the sort of "a little bit of this, a little bit of that, a little bit of the other" situation which could then lead to the individual strengths of contributing disciplines becoming diluted and/ or fragmented (Halliday & Burns, 2006, p. 114-115). To again exploit the (multiple) light sources analogy of my lens metaphor

(Figure 4.1), I conclude this opening chapter to Part 4 of my thesis with what I see as a particularly apposite observation subsequently made by Halliday whereby he acknowledged the advantages inherent in complementarity. Complementarity, he wrote, is what "turns 'either/or' into 'both/and'. Light is either particle or wave; it can't be both – but it is" (2008, p. 36). In the next chapter I begin my transdisciplinary journey by highlighting some aspects of Vygotsky's psychology that I consider relevant to the present study.

CHAPTER 5: DRAWING ON VYGOTSKY

> *Vygotsky and his followers provide a rich and vivid palette of theoretical and methodological ideas which can be utilised as we struggle to understand the processes through which the human mind is formed.*
>
> (Daniels, 2008, p. 1)

5.1 INTRODUCTION

Although Vygotsky's work is "inherently cross disciplinary [in] nature" (Wertsch, 1985, p. 230), he is probably best known for his work in developmental psychology. In drawing on aspects of Vygotsky's sociocultural theory, I wish particularly to focus on his important ideas around links between social (collective) and individual development; links between language and thought; his ideas concerning the ways in which learning is mediated; and the distinction he made between 'spontaneous' and 'scientific' concepts. I note here that since there are innumerable translated versions of Vygotsky's work, while I have tracked many of my citations of his writing back to a single source, this has sometimes proved to be difficult. There thus remains some overlap in some of the cited sources listed in the Reference list.

Vygotsky's core premise in relation to teaching and learning is that all learning is socially mediated and historically and culturally situated (Vygotsky, 1930; 1979; 1986). Because culture, as noted by Claxton (2002), has multiple layers, any interactional instance between a teacher and his/ her learners is thus:

> … imbued with influences from the classroom culture, from the culture of the subject discipline, from the school, from the community, from the nation and ultimately from the changing nature of international politics and economics – as well as from the home cultures and histories of the individual concerned. (Claxton, 2002, p. 26)

In the past several decades there has been growing realisation that views of learning which focus primarily on aspects of individual cognitive development without taking account also of these important external - what might be loosely termed 'cultural' - dimensions, can never adequately account for differences in educational outcomes across time and space and across different social groups *within* particular times and spaces. In relation to the *particular*, though, its time and space too has a history. So, for example, circumstances in Ms M's and Ms P's classrooms are a consequence of the unfolding of a particular history, and thus call for what Mercer and Littleton (2007) term the kind of "temporally sensitive understanding" (p. 138) that a Vygotskian sociocultural perspective allows.

Differential attainment levels across different spaces within a society, based on, for example, class (determined largely, but not entirely, by socio-economic factors), race and gender, serve too to highlight how socio-cultural factors shape (constitute) the ways in which learners experience, and respond to, education. Much contemporary work on trying to understand, and thence remediate, such differentials has, in no small measure, been informed by Vygotskian ideas.

Vygotskian thinking is perhaps especially compelling to educators working in a country such as South Africa, emerging as it is from the shadows of apartheid ideology and its concomitantly profound patterns of subordination, inequality, and inequity on grounds of people's racial classification. Despite the transition to democracy in 1994, South Africa's divided past continues to have profound effects on the country's patterns of advantage and disadvantage on several fronts, not least of which being ongoing economic and educational disparities in relation - mainly - to Black South Africans. South Africa remains a racially unequal society, notwithstanding arguments that 'class' rather than 'race' is increasingly emerging as the basis for the country's ongoing stratification (see, for example, Chisholm, in Chisholm, 2004, p. 11). In a subsequent article, Chisholm noted that "racial redress has not translated into economic redress" and that schools serving low-SES (mainly Black) learners "on the whole do what they did before: prepare their students for the working class and unemployment" (2008, unpaged). Balfour (2015) observed that, in terms of much that has happened as regards educational reform in South Africa, "the outstanding beneficiaries are our already enabled middle-class black and white children" (unpaged). He then continued:

> If apartheid was defined by limitations of mobility (areas to live in, education to access, professions to pursue, labour to undertake) and exclusion in terms of race, then neo-apartheid may be defined as those same limitations arising from class. (Balfour, 2015, unpaged)

Giddens and Sutton note that 'exploitation' is central to Marxian analyses of class (2012, unpaged). I introduce a Marxian focus at this point because, throughout, and as I note in my next section, Vygotsky strove to situate his theoretical thinking within a Marxist frame of reference (Lerman, 2014). Giddens and Sutton explain exploitation as follows:

> In feudal societies this often involved the expropriation of produce from peasant

> to landlord. In modern societies, Marx argued, the expropriation is less visible but still exists in the form of surplus value or, as capitalists call it, profit. One side's surplus value is the other's necessary profit margin. (2012, unpaged)

From a Vygotskian perspective, any socio-cultural analysis of classroom situations has to be situated against a wider socio-political and historical backdrop. South Africa's apartheid form of capitalism was massively exploitative of Black people's labour, and it is well known that Marxist ideology informed a great deal of the African National Congress's liberationist strategizing. Both of these factors have impacted in their different ways on circumstances within our classrooms and on policy decisions on how best to make things more equal and equitable for our learners.

5.2 BRINGING VYGOTSKY'S IDEAS OUT FROM BEHIND THE 'IRON CURTAIN'

My own exposure to the thought-provoking ideas of Vygotsky is relatively recent. It was only in the mid-1990s that Vygotsky's ideas began to rise to significant prominence in discussions around theories of learning in my University's Faculty of Education. This was, in part, a function of the fact that his work came late to western attention.

In his introduction to the 1986 publication of Vygotsky's text *Thought and Language*, Kozulin explains that from the late 1920s Vygotsky's work fell increasingly into disfavour in his native Russia. His cross-disciplinary approach it seems was at odds with Stalin's totalitarianist drives. Vygotsky's work was criticised as being anti-Marxist and "pronounced 'eclectic' and 'erroneous'" (Kozulin, in Vygotsky, 1986, p. xliii); denounced as "reactionary bourgeois pseudoscience" (Fu, 1997, p. 10). It was only in the late 1950s in Russia that it "was "rehabilitated" in the course of de-Stalinization" (Kozulin, in Vygotsky, 1986, p. li).

Although still attracting controversy within Russian theoretical circles, by 1985, Kozulin was able to write that Vygotsky's work had "broken the linguistic, cultural, and ideological barriers and [was] about to become a topic of international interest and study" (in Vygotsky, 1986, p. liv). There then followed, in the words of Wertsch and Tulviste (1992), "a major upsurge of interest" in his ideas (p. 548), such that, in 2010, Verenikina reported a survey of most-cited education articles which showed that between 2004 and 2008 articles drawing on Vygotsky's theoretical contributions "came top of the list by a large margin" (p. 16). One of Vygotsky's great strengths was that, as Wegerif (2004) notes, he was "an engaged educator as well as a psychological theorist" (p. 149). As such, his interest extended beyond mere theorizing. He was, as Wegerif explains, interested in "changing children by teaching them more effectively" (2004, p.149). Vygotsky was *actively participating* in "historical transformation in the new socialist experiment that surrounded him and to which he was committed" (Wegerif, 2004, p. 149).

Because of his emphasis on the collective (social and cultural) aspects of psychological development, Vygotsky's work in important senses straddles the psychological and the sociological. He was amongst the first scholars to highlight the significance of cultural experience and the central role played by cultural artifacts (*inter alia* language, books, pictures and other man-made objects) in children's cognitive development. And whereas, as Kramsch notes, most applied linguists would nowadays see language and culture as "inseparable" (2013, p. 305), Vygotsky was ahead of many of his contemporaries[51] in characterizing language as an integral aspect of culture. In so doing he was amongst the first also to draw attention to the links between the *micro- aspects* of individual development and the *macro- context* of wider socio-historical and socio-cultural settings. Researchers using a Vygotskian sociocultural frame of reference need, in their analyses of a particular issue, to take account, therefore, of how that issue (in my case, patterns of mathematics classroom talk) appears to be "constituted in its relations to the wider macro-situation and the micro-situations" (Lerman, 2001, p. 90). They need to make clear "the links between structure and agency and between culture, history and power and students' learning of mathematics" (Lerman, 2001, p. 90). They need, in other words, to pay attention to the potential effects of the *collective* on the ways individual consciousness develops, and to the situated nature of this relationship.

5.3 MOVING FROM THE COLLECTIVE TO THE INDIVIDUAL

Vygotsky was interested in the ways human behaviour and consciousness develop. In their introduction to Vygotsky's *Mind and Society* text, Cole and Scribner note in particular his interest in the "transformation of elementary psychological processes into complex ones" (Cole & Scribner, in Vygotsky, 1978, p. 7). As previously noted, for Vygotsky such transformation takes place within a socio-cultural context. It is a collective activity: "Individual consciousness is built from outside through relations with others" (Kozulin, in Vygotsky, 1986, p. xxiv). Vygotsky explained it thus:

51 The ethno-linguistic work of American anthropologists Boas, Sapir and Whorf, during roughly this same period, made similar connections (Sapir, 1921; Whorf, 1941). They too argued that a dialectical relationship exists between language and culture: culture controls, and is controlled by language and both are, in turn, a function of the particular environment in which the peoples of a particular culture live and operate.

> *The child's higher psychological functions manifest themselves ... as a form of co-operation with other people ... it is only afterwards that they become the internal individual functions of the child himself* [italics in the original]. (1994a, p. 354)

As Lerman (2001) puts it, it is through social relationships that "sociocultural roots of thought become internalised in the individual" (p. 89). So, in the context of the present study, for example, a key element in the development of Ms M's and Ms P's learners' perceptions about mathematics and about themselves as *learners* of mathematics comes through what they internalise from their interactions with Ms M and Ms P in their respective classrooms. Similarly, in the context of the present study also, Ms M's and Ms P's participation in NICLE provides them with opportunities to engage with new or different conceptions of mathematical *teaching* practice.

Bruner, who was amongst those who helped alert western educators to the value of Vygotsky's theories, remarked that Vygotsky's genius lay in recognizing "that individual human intellectual power depended upon our capacity to appropriate human culture and history as tools of mind" (1996, p. 123). This emphasis on the importance of cultural experience derives from the "fundamental" role Marx's theory of historical materialism played in Vygotsky's thinking, principally Marx's idea that "historical changes in society and material life produce change in "human nature" (consciousness and behaviours)" (Cole & Scribner, in Vygotsky, 1978, p. 7). Thus, whereas many of Vygotsky's fellow psychologists moved from the individual to the collective, trying, he said, "To derive *social* behaviour from *individual* behaviour [italics added];" in his view, the individual's psychological development emanated from and through the collective. "The first problem" Vygotsky argued, "is to show how the individual response emerges from the forms of collective life" (cited in Wertsch, 1985, p. 59). For Vygotsky, 'interpsychological', collective processes underpin the development of "all the higher functions".

> Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, *between* people (*interpsychological*), and then *inside* the child (*intrapsychologi*cal) [italics in the original]. (Vygotsky, 1930, p. 48)

It is the human capacity to produce meaning through the use of signs and symbols that enables functioning on both levels: the social (interpsychological) plane and the individual (intrapsychological) plane. Hasan (2002) writing on Vygotsky's ideas around semiotic mediation in relation to the development of human consciousness, notes that although "meaning can be construed by various semiotic modalities … only language at once defies time, is capable of being reflexive, classifies reality, construes communicable human experience, and articulates the many voices of a culture with equal facility" (page 3 of 15, online article). It is social interaction and dialogue in a cultural context that makes sense-making possible (Renshaw & Brown, 2007); and it is through *participation* in cultural activity, that children gradually gain access to the "sense-making resources of society" (Mercer & Littleton, 2007, p. 13). The latter authors describe children's "cognitive development [as] a kind of apprenticeship" into the use of that particular society's "cultural tools" (p. 13). Principal among these tools is language; hence, Renshaw's description of Vygotsky's work as lying at the "*intersection* of psychology and linguistics" [italics added] (2004, p. 1)

5.4 MAKING LINKS BETWEEN THOUGHT AND LANGUAGE

In terms of Vygotsky's sociocultural theory - and as briefly touched upon in Section 2.3 of the Literature Review chapter - language is not simply a 'cultural' tool; it is also a 'psychological' one (Mercer & Howe, 2012; Mercer & Littleton, 2007). Mercer (1995) explains the distinction. Language is a psychological tool in that "each of us uses [it] to make sense of experience"; it is a cultural tool in that each of us uses it "to share experience and so to collectively, jointly, make sense of it" (Mercer, 1995, p. 4). In this respect there is thus an inextricable link between thought, language, and sociocultural context. Vygotsky expressed this inextricability as follows:

> Thought development is determined by language, i.e., by the linguistic tools of thought and by the sociocultural experience of the child. …. The development of logic in the child … is a direct function of his socialized speech. … The child's intellectual growth is contingent on his mastering the social means of thought, that is, language. (1986, p. 94)

There was, Vygotsky argued, an essential and close "reciprocal" / "interfunctional" relation between thought and language (Kozulin, in Vygotsky, 1986, p. xxxii). Vygotsky believed that, in young children, thought and speech initially have "different roots", but that, as children develop, these two functions begin to merge and "develop together under reciprocal influence" (Kozulin, in Vygotsky, 1986, p. xxxi). I attempt to depict this relationship in Figure 5.1, below.

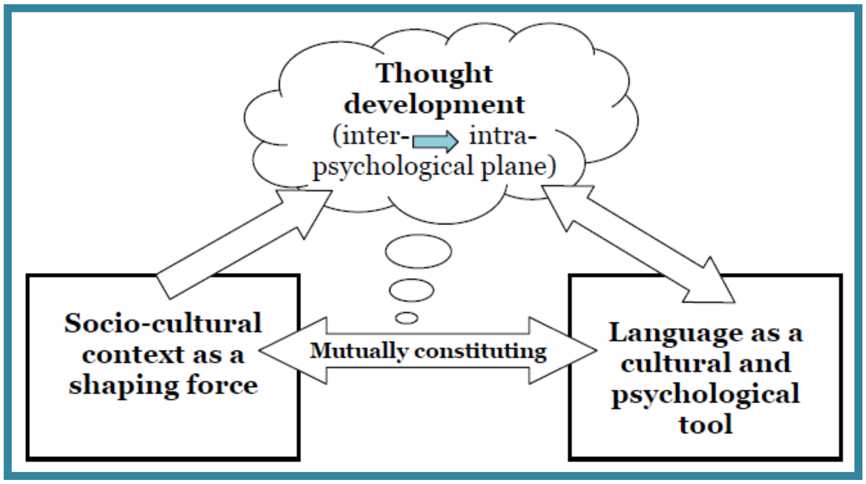

Figure 5.1: **Links between language, sociocultural context and cognition**

The main unit of analysis for Vygotsky as regards concept development was the word, and its associated meanings. Word meaning, he said, "represents such a close amalgam of thought and language that it is hard to tell whether it is a phenomenon of speech or a phenomenon of thought" (1986, p. 212). He later in this same text noted, "Thought is not merely expressed in words; it comes into existence through them" (1986, p. 218). In learning the language of their culture, therefore - and it is important here not to imply a static, essentialised view of 'culture' - children do not "simply discover labels to describe and remember significant objects or features of ... [their] social and physical environment but ways of *construing* and *constructing* the world" (Wood, 1998, p. 17).

In the course of construal and construction, word meanings are seldom static. They have, instead, the capacity to grow in complexity as a child's (or even an adult's) understanding of particular phenomena evolves (grows and deepens): "As word meanings change in their inner nature, then the relation of thought to word also changes" (Vygotsky, 1986, p. 217), and, as always, context is central. Vygotsky captures this as follows:

> A word in a context means both more and less than the same word in isolation: more, because it acquires new context; less, because its meaning is limited and narrowed by the context. (1986, p. 245)

It is out of an evolving contextual complexity that we see the notion of a 'Brunerian spiral' being exemplified: "Any subject can be taught effectively in some intellectually honest form to any child at any stage of development" (Bruner, 1960, p. 33). On a more contemporary note, Maton (2011) virtually echoes Vygotsky's point regarding the capacity of word meanings to change and develop in terms of their degree of precision[52]. Maton uses the term 'semantic density' to capture the ways in which more and more meaning can become condensed within a word. I can illustrate this with an example that Lerman (2014) provided in discussing spontaneous and scientific concepts. It demonstrates some contextual shifts in the meaning potential of the word 'half'. Lerman's example was in relation to the simple act of sharing a chocolate.

> If I am in the playground as a little child and somebody says, "I am going to share my chocolate with you," and breaks the chocolate into two pieces, it is fair enough for me to say, "Your half is bigger than my half." Not fair to say that in the classroom – in the mathematics classroom. It is only a half if it is exactly the same size as the other piece. (Lerman, 2014, p. 13)

A change in the level of abstraction might then also be brought into play in this same imaginary mathematics classroom of Lerman's. Here I can again draw on Maton (2011). He uses the term 'semantic gravity' to describe the degree to which meaning relates to its context. As word meanings deepen in complexity in the classroom situation, learners are expected to grapple with increasingly abstract mathematical ideas and concepts, and semantic gravity is thereby weakened (and, by the same token, semantic density is increased). The word 'half' to which Lerman's example refers, can be represented thus: ½. As a further abstraction, learners may then be introduced to the specifically mathematical terms 'numerator' and 'denominator', terms I witnessed Ms M reminding her learners of in one of the observed lessons. I provide further illustration of this movement toward greater meaning complexity (greater semantic density/ weakened semantic gravity) in Section 5.7, where I discuss Vygotsky's ideas on the transition towards more powerful ways of thinking using scientific, rather than everyday, concepts.

As children move on up through their school grades, the goal is that they gradually improve their linguistic capacity to grapple with complex and abstract ideas. Vygotsky outlined in detail the process whereby the sophistication of children's communicative competence grows, from an infant's capacity to vocalise simple emotional release or a desire for social contact (Wertsch, 1985, p. 93) to older children's capacity to engage with ideas in increasingly complex ways, on both the inter- and intra-personal planes, using the signs and words appropriate to their socio-cultural context.

52 It is interesting to note that Maton's work perfectly illustrates the way knowledge is built. While Maton generally credits the development of his Legitimation Code Theory to the influence of Bernstein's ideas, as I observe in the introductory paragraph of the next chapter, Bernstein, in turn, paid homage to the influence on his own thinking of Vygotsky's ideas.

As Vygotsky explains, though signs and words are used “first and foremost as a means of social contact with other people” (1930, p. 14), they gradually evolve also into the more sophisticated semiotic tools needed for more complex kinds of communication (for example, for learning school mathematics). “Learning,” he explained, “is more than the acquisition of the ability to think; it is the acquisition of many specialized abilities for thinking about a variety of things” (Vygotsky, 1930, p. 75). And - consistent with the sociocultural tenet - he emphasised that learning never begins simply at the school door: “Any learning a child encounters in school always has a previous history” (1930, p. 76). Based on her (more contemporary) research, Hasan (2001) did however note that not all children’s previous history necessarily conduces to the development of the sorts of “*epistemic mentality*” [italics in the original] (p. 26, after Claxton) that fits well with school expectations. This said, and using the example of school arithmetic, Vygotsky made the point that “long beforehand [children] have had some experience with quantity - they have had to deal with operations of division, addition, subtraction, and determination of size. .... Children have their own preschool arithmetic” (1930, pp. 76-77). This is a point Graven and Lerman (2014) echo in their article around a five year old child’s ‘ah-ha’ encounter with the buttons on a TV remote control: “Children, when they enter school, may know a lot more about mathematics than the teachers might think” (p. 31).

As discussed in the Literature Review chapter, the knowledge children bring to school can be compromised in cases of learners, such as many of those in Ms M’s and Ms P’s classrooms, who not only come from relatively low socio-economic status home backgrounds, but who then also encounter ‘school arithmetic’ via the semiotic tools of a second language rather than their pre-school (home) language. I again touch briefly here on these aspects in the context of Vygotsky’s ideas around language as a semiotic tool. Firstly, as noted, a great deal of local and overseas evidence testifies to the intractability of links between literacy/ numeracy achievement and socio-economic status (see, for example, Secada, 1992; Bradley & Corwyn, 2002; Hart & Risley, 2003; Chall & Jacobs, 2003; Pretorius & Machet, 2004; Hoadley, 2005; Graven, 2014a). Secondly, quite independently of SES, in the case of a great many South African learners, there is no escaping the (invariably negative) consequences of children having inadequate access in their classrooms to their primary source of linguistic capital, namely their L1 (home tongue). Subtractive-, as opposed to additive-bilingualism (concepts I clarified in Section 2. 4.3 of the literature review) is the norm in a great many South African classrooms, including in Ms M's and Ms P's Grade 4 mathematics classrooms, and in a great many instances, socio-economic status and linguistic factors intersect.

What, in this respect, I ask, might this mean in relation to Vygotsky's belief (1968) that speech and thought initially have different "roots" and that "only with the establishment of interfunctional systemic unity does thought become verbal, and speech become intellectual" (Kozulin, in Vygotsky, 1986, p. xxxii)? Relating these arguments to the situation facing Ms M's and Ms P's Grade 4s, it would seem to me that Vygotsky may here have adumbrated the distinction between BICS and CALP, articulated some four decades later by Cummins. As noted in Section 2.4.4 of the literature review, this distinction becomes especially crucial where learners' acquisition of their L2 provides their springboard to content area learning in and through this language, and there is thus a need to build up their CALP. Important here to recall is Cummins's research-based claim that though – in ideal circumstances – it is possible for children to acquire their L2 BICS in two years, it takes considerably longer to develop L2 CALP.

I tentatively suggest that such a time lag may have significant implications for "the establishment of interfunctional systemic unity" (in Vygotsky, 1986, p. xxxii) between children's CALP-type speech and their capacity to think in and through an L2. In the case of Ms M's and Ms P's Grade 4 learners, neither group has yet even entered the foothills of the 5-7 year turning point as regards L2 CALP. As previously noted, Ms P's Grade 4s are in their first year of L2 as the main LoLT; Ms M's Grade 4s are in their fourth year, and neither group is representative of learners in the kinds of optimal bilingual teaching/ learning circumstances envisaged in Cummins's findings. The BICS/ CALP time differential Cummins and others have identified would seem in some senses to parallel Vygotsky's argument that (a) "developmental processes do not coincide with learning processes ... the developmental process lags behind the learning process"; and (b) that it is in this gap ('lag') that the potential for "zones of proximal development" (ZPDs) begins, thereby (*potentially*) providing "the basis for the subsequent development of a variety of highly complex internal processes in children's thinking" (Vygotsky, 1930, p. 84).

I close this section on links between language and thought by highlighting a grammatical subtlety in Vygotsky's use here of 'ZPDs' (as opposed to, for example, 'the ZPD'). Vygotsky's usage implies a generality that would be absent were the determiner 'the' used. Could it be that he perhaps chose to use the plural form here to signify a broader applicability (as, indeed, would be the case had he here simply referred to ‘<u>a</u> ZPD’)? The grammatical function of a determiner is to limit the meaning of a noun. In English use of ‘a’ (or ‘an’) and ‘the’ before a noun shows whether something in particular is being referred to [for example, “… <u>the</u> Vygotskian concept of <u>the</u> zone of proximal development …” (Meira & Lerman, 2009, p. 199)], or something in general [“We see in these moves … the emergence of <u>a</u> ZPD” (Meira & Lerman, 2009, p. 210)]. In English, the determiners ‘the’ and ‘a/ an’ are – respectively- labelled ‘definite’ and ‘indefinite’ articles. Russian, by contrast does not use definite and indefinite articles (Blunden, n.d.; K. Kolesina (Professor, English Philology Department, Rostov State University, Rostov, Russia), e-mail communication, December 13, 2015). In almost all of the Vygotskian literature I have encountered (either translated into English from its original Russian, or directly written in English), however, it is the definite article that seems to be most regularly applied to the concept of ZPD. While I may be making a semiotic mountain out of a semantic molehill, it has set me to wondering whether such predominance might be seen as implying a misleading degree of specificity, at odds with the fact of there being no *one* ZPD, but rather any number of different ZPDs materializing in any number of different contexts. Meira and Lerman (2009) explain this point as follows (albeit that they too follow the definite article route): “The ZPD is … not something that pre-exists; it is not carried around, like a box, by the child, nor is it some kind of force field which the teacher has to find. … the ZPD emerges, or not, in the moment, as part of the microculture of the classroom” (pp. 204-205).

5.5 MEDIATING MATHEMATICAL UNDERSTANDING

As alluded to in the introductory chapter, and as I discuss in Chapters 8 and 9, both Ms M and Ms P expressed concerns about their learners’ current levels of numeracy proficiency as they enter Grade 4 mathematics which inevitably impacts on the ‘microculture’ of their respective classrooms. They also questioned the readiness of many of their learners to engage with their mathematics learning in and through English as LoLT. Here, for example, is what Ms P remarked when asked her opinion on the switch from mother tongue to English in Grade 4:

> Those kids – if you are talking – speaking - English – yoh! – it’s like you are not talking. You know? Only one or two, they will understand what you are saying, but lots of them, they don’t understand. So that’s why I code-switch a lot. (Interview 3P, Lines 13-16)

From an equity perspective, the challenge, perhaps most especially for teachers working in circumstances such as Ms M's and Ms P's classrooms, revolves around finding suitable mechanisms for, in the terms used by Hammond and Gibbons (2005, p. 6), "*supporting-up*" their learners, as opposed to "*dumbing down*" the curriculum demands put before them. Such mechanisms are essentially a function of how access to the symbolic knowledge of schooling is mediated.

Contrary to Piaget's view that particular aspects of learning required a child to have reached the relevant developmental stages (Wood, 1998; Fernyhough, 2008), Vygotsky believed that learning (through instruction) led (or preceded) development. He explained this point by making the following important distinction between 'development' and 'learning':

> Learning is not development; however, properly organized learning results in mental development and sets in motion a variety of developmental processes that would be impossible apart from learning. (1930, p. 83-84)

Mediation was central to Vygotsky's thinking (Wertsch, 1994; Wertsch, 2007). As noted, for him, all higher mental functions are "products of mediated activity", this mediation occurring in interaction with others and through access to the various cultural and psychological tools (notably language) available in particular contexts (Kozulin, in Vygotsky, 1986, pp. xxiv-xxv) [53]. Mediation is geared towards moving the child from reliance on the assistance of others towards ever-increasing self-reliance, and relies on the emergence of an appropriate ZPD. Vygotsky described his concept of ZPD as follows:

> It is the difference between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (1978, p. 86)

Meira and Lerman (2009) suggest - given that Vygotsky's conceptualisation of a ZPD took shape in the last 15 months of his shortened life, and he therefore did not have a great deal of time to refine it - it is "inevitable and proper that researchers working with the concept of ZPD appropriate and transform it" in light of their own theoretical leanings (p. 200). They themselves conceive of a ZPD as an "ever-emergent semiotic field for interaction and communication where learning leads development" (Meira & Lerman, 2009, p. 199), that

53 A construct closely associated with Vygotsky's concept of mediation, and sometimes used synonymously, is 'scaffolding' (a term coined in 1976 by Wood, Bruner and Ross). Given that 'scaffolding' constitutes such an especially apposite metaphor for a constructivist view of learning (after Piaget), it carries the risk within it of some conceptual conflation of social constructivism with Vygotskian sociocultural theory. This needs to be resisted (a point Lerman emphasised in his 2014 presentation under the auspices of SANCP).

"emerges (or not) in [the particular learning] activity" (p. 203). This is a conception that sits well with the work of the present study with its focus on the kinds of semiotic support Ms M and Ms P provided in trying to open up and navigate ZPDs for their learners' mathematical meaning-making processes, though the extent to which either of them was able to achieve this was inevitably constrained by the linguistic and other circumstances in their respective classrooms.

Bruner, in expanding upon Vygotsky's ideas around mediation, refers to this as a "loan of consciousness" (1986, p. 76). Through the skilled making of such 'loans'[54] mathematics teachers mediate – grade-by-grade - between their learners' existing levels of mathematical ability (including common-sense understandings of, and ways of dealing with and thinking and talking about such things as 'number operations and relationships', 'space and shape', 'measurement') and those specialist ways of practising, thinking and talking about mathematics found in, for example, a mathematics department of an institution of higher learning.

There are, as Moschkovich (2015) notes, three core areas on which mathematics teachers need to focus their mediational energies; namely, firstly providing learners with "opportunities to practice procedural skills, [secondly to] develop conceptual understanding, … [and thirdly to] participate in mathematical practices" (p. 1068), and each of these requires a somewhat different form of mediation. In ideal terms, then, Ms M's and Ms P's work as teachers of Grade 4 mathematics is, through providing suitable semiotic and other forms of mediation, to assist their young learners to move from whatever levels of mathematical proficiency they enter Grade 4 with, ever closer towards whatever levels have been identified as grade appropriate in the curriculum. A key way of doing so is to strengthen their learners' capacity to engage with (participate in) grade appropriate mathematics practices, principally through helping them become more confident and proficient users of language "as a tool for [mathematical] reasoning" (Mercer & Sams, 2006, p. 507). The 2014 ANA results for Ms M's and Ms P's Grade 4s reported in Table 1.1 of the introductory chapter indicate that many of their learners are not yet meeting what are officially perceived as grade appropriate levels of mathematical proficiency (though, as noted, some few have in fact achieved these levels).

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54 'Loan' is a useful term in the sense that it implies something that is not permanent. A point emphasised in the literature regarding scaffolding is that - whether literal or metaphorical - it too is temporary in nature. Once a building has been completed the scaffolding is taken down. Similarly, once a learner has achieved mastery over an aspect of learning, scaffolding becomes superfluous. The learner is now able to act independently in relation to that particular aspect of learning.

Further, as I show in Chapters 8 and 9, the capacity of a great many of the children to engage in anything close to approximating 'exploratory talk' of the sort envisaged by Barnes (1976) appeared - in the course of the observed lessons - to be profoundly compromised. Historical and socio-cultural influences on the contexts in which Ms P and Ms M are operating affect both the *extent* to which they are able to achieve their ideal objective in this respect, and also the *form* their semiotic mediation takes. This bears on Vygotsky's point, cited earlier, that a key determinant of "thought development is .... the sociocultural experience of the child" (1986, p. 94). To this – given the probability of at least *some* elements of shared experience – I would add the sociocultural experience(s) of the child's teachers. Figure 5.2 summarises diagrammatically the substance of the discussion so far in this section.

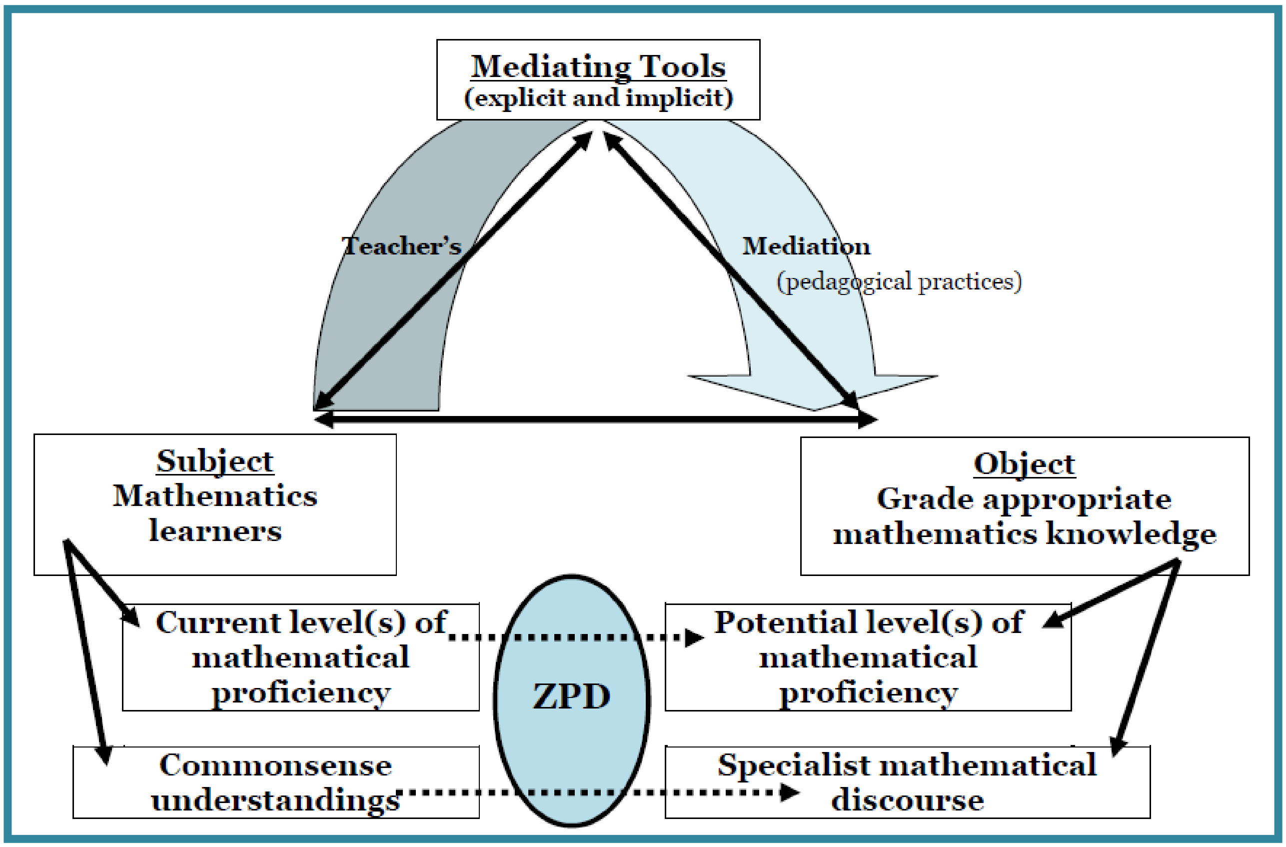

Figure 5.2: **Aspects of mediation in relation to mathematics teaching and learning**

As regards 'mediating tools', I have included in Figure 5.2 Wertsch's distinction between 'explicit' and 'implicit' mediation (2007). Wertsch explains that Vygotsky's conceptualisation of mediation was never fully stabilised. Despite its being core to Vygotsky's thinking, he never, in Wertsch's view, reached a point of giving it a "single unifying definition" (2007, p. 179).

Instead, it "emerged in his texts in a variety of ways, and in the process, somewhat different meanings arose" (Wertsch, 2007, p. 179). Wertsch identified what he saw as two different types or categories of mediation emerging in Vygotsky's writing. Explicit mediation was intentional, often material, and thus more outwardly permanent (or, in Wertsch's words, "nontransitory") (Wertsch, 2007, p. 191). Implicit mediation, Wertsch explains, was more semiotically-based, most often presented verbally, and thus more "transitory and seemingly ephemeral" (2007, p. 191). Wertsch attributes the differences between them to the particular audience Vygotsky was addressing in his writing at any one time. When addressing mainly a psychology-oriented audience, "his analysis [was situated] in a social language of the psychology of his day". When addressing a mainly linguistic-oriented audience, his aim was "harnessing a social language that belonged to a tradition of semiotics" (Wertsch, 2007, p. 191). Given that the focus of the present study is on the nature of talk in mathematics classrooms, it is the latter 'implicit', linguistically oriented type of mediation that is of primary interest. This ties in also with Meira and Lerman's notion of ZPDs as semiotic spaces in which teachers can support their learners towards appropriating "ways of communicating" mathematically (2009, p. 200).

5.6 ENGAGING WITH LEARNERS WITHIN THEIR ZPDs

Successful classroom interaction is dependent on the extent to which teachers and their learners are able to enter a ZPD and share knowledge and understanding. It is not within the scope of the present study to assess the extent to which English as LoLT contributes to 'breakdowns' in these processes. I do, however, try (in Chapters 8 and 9) to show some of the ways in which Ms M and Ms P attempt to resolve learners' mathematical 'mis'-understandings. I explored the notion of 'negotiation of (or for) meaning' in the Literature Review chapter (Section 2.4.1). In Chapters 8 and 9 I share episodes focusing on how negotiation of meaning unfolded in the observed lessons, and how, through such things as repetition and/ or rephrasing, Ms M and Ms P would try to ensure that their learners were making sense of the mathematics taking place in a lesson. As I use the term 'negotiation' here, I remain aware that negotiation is essentially a two-way process. In the context, however, of Ms P's and Ms M's observed mathematics lessons, the negotiation tended to be a somewhat one-sided affair, at least verbally. Both teachers were pushed to read mainly non-verbal cues regarding the extent to which their learners were (or were not) making meaning of the various interactions.

Much of the challenge teachers face lies in successfully instantiating a learner's ZPD, and in their knowing how most appropriately to mediate this space once it begins to open up, or - in the words of Graven and Lerman (2014) – how best within this space for teacher and learner to "catch each other's attention" (p.30). The idea of reciprocity is important here. Meira and Lerman (2009) note that a ZPD "is often fragile", and much depends on a teacher's "ability to listen and revise her interpretations of [a particular dialogic] situation" (p. 217). It is this kind of reciprocity and flexibility that often appears to be absent where there is markedly teacher-centred teaching. This then reduces the prospects for teachers and learners engaging in the kinds of fruitful interactions described above.

In expanding on his conception of ZPDs as gaps (or semiotic spaces) between what children can learn on their own (without help from more knowledgeable others) and what they may be capable of learning through interacting with knowledgeable others, Vygotsky used the analogy of "buds" or "flowers", rather than the fully developed "fruit" to describe those capacities that are "in the process of maturation" (1978, p. 86). He further explained that whereas a child's actual developmental level "characterizes mental development *retrospectively* [italics added]", the child's potential within a ZPD "characterizes mental development *prospectively* [italics added]" (Vygotsky, 1978, pp. 86-87). My motive in adding the emphasis in this citing is because much of my classroom observation data would seem to indicate that Ms M and Ms P focused a great deal of their teaching on the 'retrospective' rather than the 'prospective'. I make this claim with all due caution for, while some inferences may be drawn from the ANA results shared in the introductory chapter, it is not within the scope of the study to attempt to determine the actual developmental levels of Ms M's and Ms P's Grade 4 learners.

As I note in Chapters 8 and 9, both teachers expressed some frustration in that they felt many of their Grade 4 learners had come through to them from FP underprepared for the demands of IP level mathematics. This – inevitably – will have informed some of their teaching decisions and practices. That said, there is also the risk of children performing according to the expectations teachers have of them, as was so powerfully demonstrated by Rosenthal and Jacobson (1968) in their ethically-questionable experiment with American elementary school children (*Pygmalion in the Classroom*)[55].

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55 In 1965 Rosenthal (a professor of social psychology) and Jacobson (an elementary school principal), set out to examine the effect teacher expectation could have on learner performance. The researchers assigned the label "growth spurters" to a percentage of learners at an elementary school on the false premise that these were the learners who an intelligence test had identified as having promise (Rosenthal & Jacobson, 1968, p. 16). (In fact

In the previous section I alluded to Ms M and Ms P 'navigating the ZPD with their learners'. Mercer (1994) expressed some reservations about the appropriateness of the ZPD for analyses beyond the level of the individual. "Teachers," he wrote, "normally have to plan and operate at the level of the class or group, and the idea of a group of learners with a shared ZPD seems to me to stretch the concept too far!" (Mercer, 1994, p. 104). He suggested that "a different, though related, concept that deals with the *synergy* of a learning group" would be better (1994, p. 104). In a later text he introduces the concept of an IDZ (intermental development zone) (Mercer, 2000). This may well be a more apt concept for the many South African classrooms where the focus is more on the collective than the individual (see, for example, Hoadley's analysis (2012) of aspects of teaching and learning in South African primary schools).

Although in his discussion of the concept of an IDZ, Mercer seems equally to be focusing on interactions between a teacher and an individual learner, to me, the 'inter-' part of this alternative concept signals something more synergistic and 'group-like' (as opposed to solely individual). Mercer explained that in his view "the ZPD is (despite Vygotsky's social focus) still essentially an individualistic concept" (e-mail communication, January 7, 2016). His other motive in introducing the concept of an IDZ was to enable him to "conceptualize the dynamic nature of teaching-and-learning, in which levels of mutual understanding shift over time:" something he felt the ZPD does not really accommodate (e-mail communication, January 7, 2016).

Whether talking about a ZPD, or an IDZ, teaching styles are also at issue. As I elaborate in Chapter 8, I noticed in most of the observed lessons, for example, that Ms M – especially - tended towards whole class, rather than differentiated teaching. This resulted in the pace in her lessons being set to the slowest of the learners in her class. Vygotsky's view that well-planned and mediated learning has the potential to 'accelerate' development (Alexander, 2005, p. 6) is somewhat undermined by this practice. Allowing children to set the pace, as Ms M frequently appeared to do, effectively negated the proposition that "the only "good learning" is that which is in advance of development" (Vygotsky, 1997, p. 34). Relevant here is Mariani's four quadrant framework (1997) as discussed in Chapter 2 (Section 2.5.3). As noted,

no test had been administered.) The researchers then withdrew from the school and allowed the 'magic' of this information to work on the teachers' interactions with the selected learners. When the researchers returned to the school they found that, on the whole, the 'chosen' learners had indeed 'spurted', this, despite their having been randomly selected.

Mariani used this framework to represent his thoughts on optimising the balance between levels of challenge and support. The best learning, he argued, is that which combines high challenge with high support. Where, for whatever reason, teachers are insufficiently alert to opportunities for the emergence of either ZPDs or IDZs, to 'catch their learners' attention' in these zones, the likelihood of their learners being able to progress towards more powerful forms of mathematical thinking must - almost inevitably - be compromised. Aspects of this challenge are further illuminated by the empirical data in Chapters 8 and 9.

5.7 TRANSITIONING TO MORE POWERFUL FORMS OF THINKING

In an article written in February 1934, just four months before his death, Vygotsky expanded on his ideas on the processes involved in conceptual development, and – in particular - the acquisition of academic, as opposed to everyday (or spontaneous) concepts. The ZPD, according to Vygotsky, is where "a child's empirically rich but disorganised spontaneous concepts "meet" the systematicity and logic of adult reasoning [and] as a result of such a "meeting," the weaknesses of spontaneous reasoning are compensated by the strengths of scientific logic" (Kozulin, in Vygotsky, 1986, p. xxxv).

Vygotsky was critical of some other contemporary views of conceptual development, in particular those coming from behaviourist traditions which suggested that concepts could simply be "assimilated" ready-made, as it were. Instead, he argued, concepts are formed through

> … a complicated and real act of thinking which cannot be mastered by simple memorization, and which inevitably requires that the child's thinking itself rise to a higher level in its internal development, to make the appearance of a concept possible within the consciousness. (1934b, p. 356)

He was also critical of Piaget's line of reasoning in this regard. Describing Piaget's initial thinking as "basically correct", he then proceeded to identify what he saw as three "erroneous ideas" embedded within this thinking (Vygotsky, 1934b, p. 361). Principally, Vygotsky objected to Piaget's perception that children's cognitive development involved "a gradual withering away [and] displacement … of childish thinking by the more powerful and vigorous adult thinking process" (1934b, p. 362).

For Vygotsky, so-called 'childish thinking' constituted the bedrock from which subsequent higher-order thinking evolved. Children's spontaneous concepts, Vygotsky argued, provide "the necessary, *but not sufficient* [italics added], conditions for progress toward more powerful forms of thinking" (Renshaw & Brown, 2007, p. 533) in which ideas become ever more decontextualised and abstract, but throughout which the "dividing line" between spontaneous and academic concepts remains "highly fluid, passing from one side to the other an infinite number of times in the actual course of development" (Vygotsky, 1994b, p. 365).

Wertsch (1985) provides a useful synopsis of Vygotsky's explanation of the way children's thinking evolves (its "ontogenetic progression") (p. 100). Wertsch (1985) begins by reference to the experimental work of Vygotsky and some of his colleagues with children in which they engaged the children in block sorting and classification tasks. Vygotsky identified various patterns in children's thinking, starting from essentially random, trial and error efforts at sifting and sorting blocks into what Vygotsky labelled "unorganized heaps" (Wertsch, 1985, p. 101) through to increasingly stable and systematic forms of organisation using ever more objective classification criteria, ever closer to those a mature thinker would employ. On the path towards what Vygotsky termed true (or scientific) concepts (and, ultimately, *systems* of concepts), children's thinking moved from these undifferentiated 'heaps', through thinking in complexes (making connections, though not in ways that might be obvious to an adult observer), and then on through a transitional phase of what Vygotsky termed "pseudoconcepts" (Wertsch, 1985, p. 105)[56].

The movement away from random, subjective thought and towards a capacity for scientific thinking requires decontextualisation, generalisation *plus* "conscious realization and hence voluntary control" (Wertsch, 1985, p. 103). This requires also an increased capacity for metalinguistic (use of language to talk about language) and metacognitive (use of language to think about thinking) reflection.

For Vygotsky, then, children's development of academic (or scientific) concepts rested upon deliberate and systematic "cooperation between the teacher and child" (1962, unpaged) and upon children's growing linguistic consciousness and proficiency. For him, it was language that provided children with the symbolic means to "direct … control … and channel" their thinking (Vygotsky, 1994c, p. 47) in increasingly logical and culturally appropriate ways.

56 Vygotsky regarded the pseudoconcept phase as an especially important one in a child's conceptual development: "It casts light both backward and forward. On the one hand, it illuminates the phases of complexive thinking that the child has already passed through. On the other, it serves as a bridge to a new and higher stage, as a bridge to the formation of [genuine] concepts" (1962, unpaged).

“Thinking in concepts,” he said, “is not possible in the absence of verbal thinking” (Vygotsky, 1962, unpaged). Clearly the *nature* and *quality* of verbal thinking is an issue here.

Next, in this transdisciplinary journey across my theoretical light courses, I move to a discussion of Bernstein’s *sociologically*-oriented ideas on how external, socio-political factors appear to impact on the nature and quality of verbal thinking and on other aspects of children’s academic development. As Bernstein himself cautioned, “Symbolic ‘tools’ [read language, primarily] are never neutral; intrinsic to their construction are social classifications, stratifications, distributions and modes of recontextualising” (1993, p. xvii).

CHAPTER 6: DRAWING ON BERNSTEIN

> *Bernstein was a passionate supporter of the rights of disadvantaged students. … His research project for over 40 years was concerned with understanding the (re)production of social inequality through schooling.*
>
> (Singh, 2001, p. 572)

6.1 INTRODUCTION

Writing in 1995, Bernstein remarked that while he had never attempted to integrate his work with that of Vygotsky, from early on he had been "deeply influenced" by Vygotsky's ideas around the links between thought and language. "It set up a buzzing in my head," he said, "which I can still hear" (p. 400). Bernstein also, in this same article, paid homage to the influence of Halliday on his work. This I cite later.

In drawing on the ideas of Bernstein, I wish particularly to focus on his sociolinguistic work on speech codes, on his ideas around the classification and framing of knowledge, and on his explication of how pedagogic discourse impacts on recognition and realisation rules. I use these ideas for explanatory, rather than analytical, purposes.

My own encounter with the ideas of Basil Bernstein was in my undergraduate studies in the early 1970s. This was in relation to his identification of language style as an important element contributing to differential educational attainment across Britain's social class divides. My understandings around this link between language and educational outcomes were subsequently extended when, in the early 1980s, I completed my honours degree in education. The programme included a course in sociology of education, which - in turn - included a section dealing with language issues in the classroom.

As a sociologist, Bernstein's interest lay in understanding how societies *reproduce* themselves: how existing power structures within a society tend to remain in place, thereby enabling the maintenance of powerful groups' positions of dominance. His theories, as Hoadley and Muller (2010) observe, provide us with "a theoretically informed approach to the awkward question of the intractability of unequal schooling outcomes" (p. 69).

It was Bernstein's experiences as a school teacher that contributed to his concern for "understanding and eliminating the barriers to upward social mobility" (Sadovnik, 2001, p. 607). Paradoxically, despite the subsequent charge made that Bernstein's linguistic code theory promoted a discourse of linguistic deficit, it was his desire to challenge the deficit discourse dominating explanations of working class underperformance in schools that fuelled his theoretical endeavours.

As noted in the introductory chapter, ongoing attempts are underway on many levels to redress issues of underperformance in South Africa's schooling system, a great many of which are a consequence of the country's apartheid legacy. Despite these efforts, 21 years into its new democracy, South Africa's progress remains extremely slow, and – in many instances – circumstances have deteriorated and gaps between middle and lower socio-economic status groups have widened (see, for example, data in Tables 1.6 and 1.7 of the introductory chapter). Writing of the take-up of resources (both human and material) by mathematics teachers participating in one of her research projects, Adler (2012) noted - particularly in relation to poorer schools - some "unintentional deepening of inequality" (p. 5).

Bernstein's ideas provide tools that enable rigorous exploration of how inequalities are reproduced through curriculum and assessment policies and practices. His work has been widely used by South African scholars, most particularly in their analyses of post-1994 attempts at curriculum revision. Taylor (2000), for example, writing of a trend towards hybridisation of everyday and "codified curricular knowledge" (p. 58), noted that in the South African context views that mathematics and science curricula in particular appeared to work as "exclusionary mechanism[s]", had prompted a "radical redress" (p. 66). This involved the greater inclusion of learners' everyday knowledge into these curricula. Alluding to the work of Dowling (who drew extensively on Bernstein's ideas (S. Lerman, personal communication, 4 July, 2014)), however, Muller explained how the unintended consequence of such "recontextualisation of everyday material into the curriculum for disadvantaged learners involve[d] a twofold deformation" (p. 67), the outcome of which in relation to mathematics, had left those of South Africa's already disadvantaged learners "free to be ... local individual[s] but ... failed mathematics learner[s]" (p. 68).

The power of Bernstein's thinking lies not just in its capacity to sharpen our understanding of how power *reproduces* itself, but also to provide "an explanatory framework ... and tools to understand and analyse contemporary *changes* [italics added] occurring in ... education" (Bernstein & Solomon, 1999, p. 266). In this same article, Bernstein indicated that his prime interest lay in "the long process of understanding and describing the agencies, contexts and practices through which we are both constructed and constructing ourselves and others" (p. 275). The value of such understanding lay, he said, in making us "better able to choose the forms we create rather than [have] the forms … created for us" (p. 276). He closes off this point by noting that "effective choice … requires this understanding, and failure is often the result of rhetorical solution or ideologically driven aspiration" (Bernstein & Solomon, 1999, p. 276). The presence of both rhetoric and ideology is manifest in much of what currently happens in South African schooling. See, for example, Spaull's condemnation of what he sees as the DBE's blindness to many of the dysfunctionalities plaguing South Africa's schooling system: "It is not possible," he observes, "to solve a crisis that does not officially exist. … The DBE genuinely believes there is no on-going crisis in the quality of education in South Africa. This is simply not true" (2013a, p. 59). While Spaull's suggestion of 'denial' on the part of the DBE may be a bit strong, there is evidence of the DBE trying to downplay the scale of problems. The headline attached to the Minister of Basic Education's media statement in the wake of the November 2016 release of the TIMSS 2015 results: *SA most improved education system in the world* (DBE, 2016) is perhaps a case in point. Such masking of the severity of a situation might conduce to complacency.

In the next section I turn to the work Bernstein did around the dialectical role language plays in the reproduction of social and educational inequalities.

6.2 LANGUAGE, ATTAINMENT, AND SPEECH CODES

Bernstein's initial focus was on why so many British working-class children appeared to find it more difficult communicating in the formal environment of a classroom than their middle-class counterparts. While circumstances in South African schools are different from those in Britain – both at present, and at the time Bernstein was developing his theoretical constructs – I nonetheless see great explanatory power in his ideas around language and academic achievement in the South African context.

Bernstein described language as "one of the most important means of initiating, synthesising, and *reinforcing* ways of thinking, feeling and behaviour which are functionally related to the social group" (1959, p. 312). In looking at samples of learners' scores on IQ tests, Bernstein (1960) noticed that the discrepancy between verbal and non-verbal scores appeared to be greater for working-class children than for middle-class children. This, and other insights relating to his findings around the different ways in which working and middle class parents engaged verbally with their children, led him and his research team to the view that a key contributor to differentials in educational achievement was children's access to, and use of, what he initially termed ‘formal’ (as opposed to ‘public’) language (Bernstein, 1959). He subsequently re-labelled these ‘elaborated’ and ‘restricted’ codes respectively (Bernstein, 1964). Bernstein saw these different speech codes (or systems for making meaning) as arising from different forms of social relationship, and from differences deriving from whether a child’s parents worked in ‘mental’ or ‘manual’ occupational categories (Bernstein, 1971).

Bernstein identified context as being central to understanding how these different codes, or patterns, of speech emerge and play out. A restricted code is essentially an oral language, one embedded in context (“particularistic”), and one in which much of the sub-text is implicit, whereas an elaborated code is generally more contextually disembedded and explicit (“universalistic”) (Bernstein, 1973, p. 70). These codes, linked as they are both to social experience and to context, conduce to what Hasan termed “variant forms of consciousness” (in Sadovnik, 1995, p. 188), or, as Diaz termed them, “meaning matrices” (cited in Hoadley and Muller, 2010, p. 70) which then influence the ways in which individuals make sense of experiences. As Bernstein (1971) explained:

> Particular forms of social relation act selectively upon what is said, when it is said, and how it is said. [These can then] generate very different speech systems or codes . . . [and thereby] create for their speakers different orders of relevance and relation. The experience of the speaker may then be transformed by what is made significant or relevant by different speech systems (p. 144).

What children come to school with from their primary sites of socialisation inevitably influences the extent to which they are able to resonate with the ‘consciousness’ or ‘meaning matrix’ required of them at school. Because it is more closely aligned to a literate discourse, an elaborated code is better suited to the ‘orders of relevance and relation’ of schooling. Whereas middle-class speakers are generally familiar with an elaborated code of speech, working-class children tend to be less so. This, Bernstein (1973) explained, leads to working class children not always being fully able to make meaning of classroom discourse and thus access the kinds of abstract thinking embedded in and through a more literate discourse. Many such children struggle to recognise that classroom discourse is – perforce – different from the particularistic, context-embeddedness of their everyday discourse. Contributors to discussions around research which set out to explicate this struggle include Hawkins (1969), Holland (1981); Cooper (1998), Cooper and Dunne (1998), Hasan (2001), and locally, Hoadley (2006; 2007). As noted previously, the majority of the children attending Ms M’s and Ms P’s schools come from homes which, in Bernsteinian terms, would attract the label ‘working class’ (even though, in many cases parents are unemployed or employed on an intermittent, usually lowly-paid, basis). I return to this aspect shortly.

Although Bernstein's early efforts to link language styles and learning outcomes have been criticised as promoting a discourse of deficit (see, for example, Labov, 1970)[57] and he himself made significant modifications to these ideas, his work in exploring the link(s) between language and learning has been enormously influential. He remained steadfast, however, in rejecting accusations that his characterisation of the restricted code represented a theory of deficit, arguing that, on the contrary, everything revolved around questions of appropriacy to context. Bernstein's argument was that a restricted code is not inherently inferior:

> … one code is not better than another; each possesses its own aesthetic, its own possibilities. Society, however, may place different values on the orders of experience elicited, maintained and progressively strengthened through the different coding systems. (1971, p. 135)

Hence, in a classroom setting (as compared to, for example, a manual workplace setting), a restricted code becomes less generally appropriate, and - consequently - less valued. Sadovnik explains this point as follows:

> Bernstein argued that restricted codes are not deficient, but rather are functionally related to the social division of labour, where context-dependent language is necessary in the context of production. Likewise, the elaborated code of the middle classes represents functional changes necessitated by changes in the division of labour and the middle classes' position in reproduction rather than production. (2001, p. 688)

In relation to mathematics education, Lerman (2001) too challenged accusations that linguistic code theories contributed to a deficit model. Rather, he argued, they helped explain aspects of "differential opportunity" (2001, p. 94). While I recognise the ingenuousness of drawing direct parallels between the British circumstances Bernstein described and South African circumstances, I believe that his ideas help illuminate in interesting and plausible ways (however incompletely) the struggles learners such as those in Ms M's and Ms P's classrooms face when language gets in the way of their being able to fully engage with, and participate in, the discourse of mathematics required to become mathematically proficient. Firstly, the divisions in this country, although not simply along class lines, have profoundly

57 Christie (2008) reports that "Halliday once said [of Bernstein] that 'one of the problems … was that he never fitted people's stereotypes, their ready-made categories into which all thinkers are supposed to fit. So the left branded him as right-wing and the right-wing branded him as left-wing'" (p. 3).

affected the socio-economic structuring of South African society. High numbers of (mainly Black) people in the lower socio-economic strata do not even have the opportunity of becoming members of a 'working class'. Instead, as noted, many are in fact members of a '*workless* class'. Secondly, although many South African children in the process of learning their mathematics mainly through a second or third language, are clearly not using *restricted codes* in a strictly Bernsteinian sense, they are almost inevitably restricted (or compromised) in terms of not being able to fully *formulate* and then *articulate* their ideas in ways that align with classroom 'speak'. Essentially then, for such children, there is, as Hoadley and Muller (2010) note, "a double hurdle to clear, namely acquiring both the specialized [mathematical] knowledge of school, as well as the coding orientation with which to realise this acquisition" (p. 71); and standing between them and these two hurdles, there is an equally challenging *third* hurdle: that of becoming adequately proficient in the official classroom LoLT (English). Such hurdles combine to help perpetuate existing inequalities in children's mathematical sense-making. Figure 6.1 provides a diagrammatic representation summarizing my discussion thus far around language style and learning outcomes.

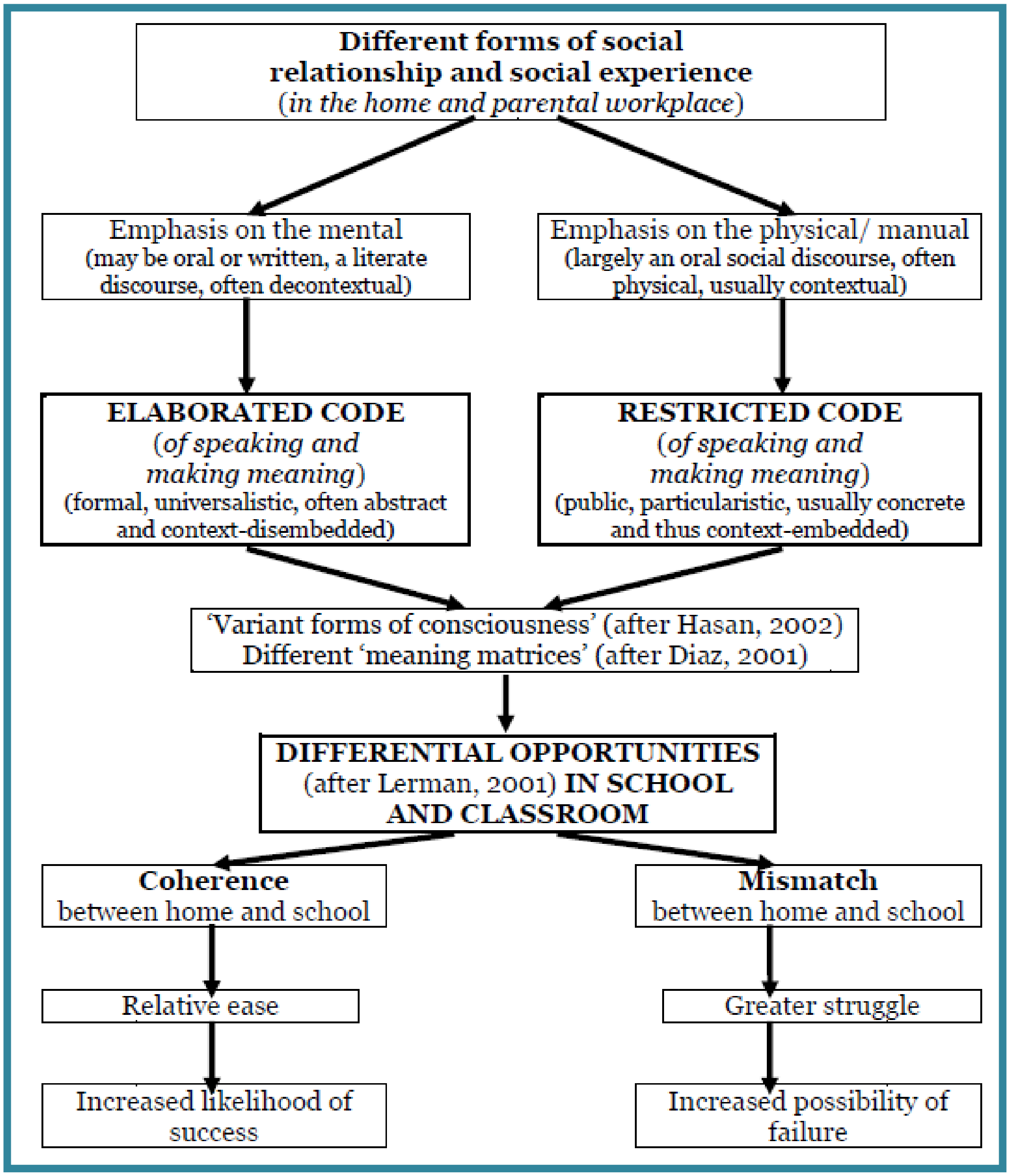

Figure 6.1: **Bernstein's language codes and the success/ failure trajectory**

The circumstances captured in Figure 6.1 may have less to do with "mathematics or cognition" than with the broader socio-political context (Zevenbergen & Lerman, 2001, p. 571). "Social biases," Bernstein argued, "lie deep within the very structure of the educational system's processes of transmission[58] and acquisition and their social assumptions" (2000, p. xix).

58 Bernstein's use of the word 'transmission' (and my own adoption of it when discussing his ideas) has a different connotation from its use when, for example, we talk about the kinds of 'transmission modes of teaching' commonly associated with teacher-centered practices.

"Such biases," he notes, "can become, and often are, an economic and cultural threat to democracy" (Bernstein, 2000, p. xix).

6.3 THE STRUCTURING OF KNOWLEDGE

Bernstein's later work provides a powerful language of description for examining aspects of the processes of transmission and acquisition taking place in Ms M's and Ms P's Grade 4 mathematics lessons. The post-1994 institution of common learning area curricula for all schools across South Africa[59] has sought to streamline as well as embrace different styles of transmission. The acquisition element remains however, very context dependent. In her discussion around conceptions of curriculum, Cornbleth (1985) distinguished between what she termed 'technical project' and 'social process' views of curriculum. She noted that with 'social process' views "the focus shifts from intentions and planning to realization" (p. 36). In line with this latter view, she subsequently used the phrase 'curriculum as contextualized social process' (1990, p. 13), later arguing that context "powerfully shapes teaching and thus students' opportunities to learn" (Cornbleth, 2001, p. 74).

Bernstein's later work similarly focuses on the differing learning opportunities afforded learners from different social groups via the way educational knowledge is structured in a curriculum. The way educational knowledge is structured (its organisation, distribution (transmission and acquisition), and evaluation) acts, he argued, as "an agency of social control" (Bernstein, 1973, p. 65), whereby "the power relationships created outside the school penetrate the organisation, distribution and evaluation of knowledge through the social context" (1972, p. 217). Bernstein's theorising helps illuminate the dialectic that exists between macro- (for example, broad curriculum aims) and micro- (for example, localised opportunities to learn) educational aspects. In this respect, he achieved what many other sociological theorists strived towards, but failed to accomplish: to create a theoretical pathway between sociology's structuralist and interactionist (or interpretive) perspectives[60].

Bernstein (in Sadovnik, 1995) explains that the development of his "higher order concepts" of classification and framing enabled him to distinguish between aspects of 'power' and aspects

59 The DBE's most recent curriculum innovation has been its Curriculum and Assessment Policy Statement (CAPS) which the Department began phasing in from 2012. This represents the third curriculum reform effort since 1994.

60 Bernstein's fellow countryman, Anthony Giddens, through his development of structuration theory achieved a similar synthesis (that between structure and agency) (see, for example, Giddens, 1984).

of ‘control’ (p. 399) as these play out in education. Classification here pertains to “the degree of boundary maintenance between contents” (i.e. to do with the organisation within and across knowledge areas), while framing pertains to “the degree of control teacher and pupil possess over the selection, organization, pacing and timing of the knowledge transmitted and received” (i.e. relating to aspects of transmission and acquisition of knowledge and skills) (2003/1973, p. 88).

Strong classification reflects a ‘collection code’ where school subjects are well, and explicitly, insulated and differentiated one from the other, and where there may be the expectation of greater, subject-specific specialisation. Weaker classification blurs some of the boundaries between subjects (an ‘integrated code’) (Sadovnik, 2001). Bernstein, in relatively simple terms in this instance, typifies strong and weak classification as “things must be kept apart”, and “things must be brought together”, respectively (2000, p. 11).

I noted in the introductory chapter the ‘structural and curricular turbulence’ that has been a feature of South Africa’s post-1994 educational landscape. Even in the decades preceding the milestone event of the 1994 democratic elections, there were noticeable pendulum-like swings in degrees of classification and framing affecting South African primary schooling. When I taught Grade 5 learners in the 1970s, for example, I would say that both classification and framing were quite strong. Subjects were taught as separate entities (albeit in most instances by the same, essentially generalist, teacher) and the teaching programme for any one year was closely monitored. For example, amongst other things, my colleagues and I were required to closely adhere to the various Cape Education Department syllabi documents; we needed to produce year-plans of exactly what would be taught when; we needed also to keep a record book showing that the plan was in fact being actualised; and we were subjected to frequent visits from various members of the inspectorate. For a short period after I had left school teaching there was some weakening in classification and framing, with a move towards a much more integrated curriculum. The boundaries between Geography and History, for example, were collapsed; cross-curricular project work was in vogue; team teaching was advocated. There was subsequently some disenchantment with this integrated teaching/ learning approach, and – in line with some strengthening in classification - the demand for specialist teachers in certain subject areas (perhaps particularly for Mathematics, Science and Language) increased. Post-1994 saw further, much more marked, change. The macro agenda of reform and redress, and the building in of democratic principles, impacted on the micro processes of schooling. I believe mixed messages were sent out about both classification and framing in the various attempts at curriculum reform post-1994. The mix of global competitiveness / reform ideals has served to both weaken and strengthen classification. Writing specifically of the changes outlined in the first post-1994 curriculum (Curriculum 2005), for instance, and on the basis of extensive analysis of the relevant curriculum documents, Graven (2001) explains "previously tightly bound subjects" were "reorganised into eight learning areas ... broader and more integrated than previous subjects, for example Language, Literacy and Communication; Mathematical Literacy, Mathematics and Mathematical Sciences" (p. 327). This was accompanied by a move toward more learner-centred principles which conduced to weaker framing.

Graven (2001) notes that while "the weakening of classification and framing values in Curriculum 2005" could "be seen as empowering" in relation to the aims of political redress, they equally were potentially "disempowering" in terms of the support given to teachers to help them cope with the new sets of challenges placed before them (p. 334). Graven (2002a) noted the enormity of the task of preparing teachers for the envisaged changes: "teacher development in this context of change is far more complex than simply retraining teachers"; it requires helping teachers develop "new professional identities" (p. 26). The extent to which this was in fact realised across the board is dubious (Graven, 2002a; 2002b; Bantwini, 2010). So, for example, when, in 2009 the Minister of Basic Education commissioned an investigation into the challenges experienced in implementing the NCS (the second post-1994 curriculum), amongst the challenges highlighted in the report was the quality of in-service training provided to teachers to help them cope with the new demands of the curriculum. The panel of experts who produced the report described such training as "too superficial ... too generic ... decontextualised ... unsupported" (DBE, 2009, p. 55). Consistent with this view, Ms B, a teacher in whose classroom I earlier did some research, likened the assistance she had received at training workshops run by Eastern Cape district officials to being "microwaved" (Robertson, 2012, p. 234).

Following official acknowledgement of the non-viability of Curriculum 2005 (Chisholm et al., 2000), the NCS/RNCS sought to strengthen classification, though leave framing relatively weak. CAPS (which - as already noted in a previous footnote - is the *third*, and current, post-1994 curriculum) represents an effort to again strengthen both classification and framing, particularly the latter, with very explicit attention being given to selection, sequencing, pacing and evaluation aspects. Pausigere and Graven (2013) and Pausigere (2014) used Bernstein to analyse some of the ongoing shifts in classification and framing that have occurred in South African schools post-1994 and the implications of this for teachers' professional identities. Their research points to strengthened classification and framing in school mathematics in the current CAPS curriculum.

Compared to many other school subjects, and notwithstanding the reclassification detour into the learning area 'Mathematical Literacy, Mathematics and Mathematical Sciences' (with only phase and not grade-specific guidelines), in the first post-apartheid curriculum, school mathematics has generally tended towards stronger classification, even in the face of newer approaches to the teaching of mathematics which have weakened some framing aspects. At Ms M's and Ms P's schools, in line with the DBE's curriculum requirements, mathematics is separately timetabled, and, in Ms M's case, all of the IP mathematics lessons are taught by the same specialist mathematics teacher (namely by Ms M herself)[61].

6.4 RECOGNITION AND REALISATION RULES

Classification and framing play out in pedagogic discourse and practice, to create the recognition and realisation rules (Bernstein, 2000). It is classification that determines the orientation required within a particular learning context. In other words, it determines what is, or will be, *recognised* as legitimate. Framing is what determines how this particular orientation is to be *realised*; in other words, the means whereby something is deemed to have been achieved.

Both Ms M and Ms P, as I expand upon in Chapters 8 and 9, mention that their coverage (and thus their learners' realisation) of the Grade 4 mathematics curriculum is – for a variety of reasons - compromised. Ms P, in particular, has remarked that she does not have sufficient time to give as much attention to struggling learners as she believes is necessary. Aspects of her comments in this regard resonate with Bernstein's point that where there is strong framing of pacing "time is at a premium" (2004, p. 206). Especially pertinent in the context of the present study is Bernstein's observation that time pressures then affect "the deep structure of pedagogic communication" and "will tend to reduce pupils' speech and privilege teachers' talk" (2004, p. 206). Morais (2002) claims that Bernstein "repeatedly argued that successful

61 Perhaps in other contexts Ms M may not be seen as a 'specialist mathematics teacher' because she does not have a specialised qualification in mathematics *per se*. Her mathematical specialisation came via her successful completion of the *mathematics education* courses that were part of her various teacher qualification programmes (that is, via the field of recontextualisation, rather than the field of production (Bernstein, 1999)).

learning depends to a great extent on the weak framing of pacing [whereby] children have some control over the time of their acquisition" (p. 560). She noted too, however, that making provision for such practice is likely to be more costly. My own question in relation to the issue of cost would be "What long-term costs does the potential for a high 'drop-out' rate incur – at both the societal and the individual level?" The national averages for Grade 9 Mathematics in the 2012, 2013, and 2014 ANAs were 13%, 14%, and 11% respectively (DBE, 2014, p. 8). Across this same period the percentages of Grade 9 mathematics learners achieving 50% or more are 2%, 2%, and 3% respectively (DBE, 2014, p. 9). These dire statistics indicate that very few of the country's Grade 9 learners are even close to achieving grade-appropriate levels of mathematic proficiency. Most were left behind, and are thereby excluded from any opportunity of making it into further specialist mathematics studies in the FET phase.

Even more crucially, in my view, however, is how to address the problem of children – perhaps especially from lower socio-economic backgrounds such as the children in Ms M's and Ms P's classrooms – not being especially adept at exercising productive (self-) control over the pacing of their learning. This devolves on questions of children's opportunity to develop the capacity for self-regulation which, as Leong and Bodrova (2006, unpaged) note, is an important aspect in the development of "cognitive competency". Where a classroom culture is essentially teacher-driven, learners' opportunities for exercising self-regulation may be shut down.

Bodrova and Leong (2008) define self regulation as "a deep internal mechanism that enables children … to engage in mindful, intentional, and thoughtful behaviors" (p. 1). They highlight research that suggests that children's early "self regulation behaviors … predict their school achievement in reading and mathematics better than their IQ scores" (Bodrova and Leong, 2008, p. 1). I identified this capacity for self-regulation (or rather its absence) as a problem in my classroom-based research into aspects of reading literacy development involving children from socio-economically disadvantaged circumstances (Robertson, 2012).

An interesting mechanism for helping learners develop self-regulation is reported by Schukajlow and Krug (2012). Working with Grade 9 learners, and using a combination of direct instruction and group work, these researchers investigated the effects on learners' self-regulation and sense of self efficacy of an approach which encourages learners towards finding multiple ways for solving particular mathematical problems. Schukajlow and Krug (2012) reported a good correlation between a multiple solution approach and an increase in learners' sense of self-regulation. In a follow-up study (Achmetli, Schukajlow & Krug, 2014), however, they were not able to confirm their earlier findings. They nonetheless reiterated their view that encouraging learners to make their own choices from a range of strategies in solving mathematics problems does not only "improve[s] students' mathematical knowledge" (2014, p. 1); the flexibility offered by this approach also carries the potential of contributing to the development of learners' capacity for self-regulation.

I observed Ms P's advocacy of a similar 'multiple solution' approach in some of her lessons. Ms P explained that this was one of the strategies she had picked up through her attendance at NICLE sessions, remarking: "It helps a lot. It helps a lot. And I'll also introduce it to my colleague." I did not link this practice with its potential for helping children develop self-regulation. My assumption was that it was simply a technique Ms P used to break away from the idea that there is only one 'right' way (algorithm) for tackling a mathematical problem. I find the idea that this may contribute also to developing learner agency appealing, as research indicates that many 'at risk' children start school without a well-developed capacity for exercising agentic self-regulation (Leong & Bodrova, 2006; Schunk, n.d.). Such children face what Raver and Knitzer describe as "cumulative and multiple stressors" in their lives (2002, p. 5). Some stressors identified by Raver and Knitzer (2002) include poverty, low levels of parental education, limited access to resources, substance abuse amongst family and community members, violence, and chronic illness, all of which are amongst the problems Ms M and Ms P mention as confronting many of their learners.

6.5 DISTRIBUTION, RECONTEXTUALISATION AND EVALUATION

Bernstein's concept of the pedagogic device provides the conceptual framework for understanding his conceptualisation of pedagogic discourse. Three hierarchically related rules govern the pedagogic device. They are distributive rules, recontextualising rules, and evaluative rules. These, as Morais (2002) explains, regulate *what* knowledge is transmitted (in terms of the requisite content and competencies to be acquired), and *how* this is achieved (most especially in relation to how particular realisations of learning are evaluated). I unpack each of these rules separately.

The distributive rules determine what is to be distributed by whom and to whom (Bernstein, 2000). As such the distributive rules have the potential to give rise to differing forms of consciousness (in terms of knowledge, skills, and the disposition to see and respond to things in various ways) on the basis of differential distribution to different groups. The distributive rules produce the recontextualising rules.

The recontextualising rules involve taking areas of knowledge and skills from outside the schooling system (for example, mathematical knowledge as developed by mathematicians) and relocating them within the schooling context (Bernstein, 2000). Part of the recontextualisation process involves too, decisions relating to the selection of guiding pedagogical principles (interpretations of how teaching and learning is best achieved).

The evaluative rules, which as noted earlier are crucially important for this study, provide the criteria against which a produced 'text' is to be judged legitimate/ acceptable (Bernstein, 2000), and thus what mathematics classroom talk is judged acceptable and promoted in different settings. Morais (2002) clearly shows the potential different forms of evaluation have for learning outcomes. I return briefly to this in the closing part of the present subsection.

It is through the pedagogic device that pedagogic discourse of varying kinds is produced. The three rules just discussed, which govern the pedagogic device, operate together *through* pedagogic discourse (Bernstein, 2000). In terms of Bernstein's theory, it is the concepts of regulative and instructional discourse that – jointly - produce pedagogic discourse. Regulative discourse (a discourse of social order) is the dominant discourse, in which is embedded the instructional discourse (the discourse of competence in particular knowledge and skill areas). Bernstein argued that in actuality it is wrong to view these as separate discourses: "In my view, there are not two discourses. There is only one" (2000, p. 32). Rather therefore than saying that 'regulative and instructional discourse jointly produce pedagogic discourse', it could instead be said that 'regulative and instructional discourse *combine* to produce pedagogic discourse'.

Different pedagogic discourses conduce to different pedagogic practices, and hence different educational outcomes. So, for example, and as I expand upon in Chapter 8, in Ms M's observed lessons learners responded mainly as she required, with earlier established mathematical answer patterns and phrases such as 'because (insert one fraction or number here) is bigger than the (insert the other fraction or number here): e.g. "Because the quarter is bigger than the eighth" (Lesson 1M, Turn 88). The absence of learner utterances connecting such answers to the earlier talk about the cake is notable (for example one might expect learners to say 'a quarter is bigger because we can see that sharing the cake between 4 of us gives us much bigger pieces than sharing the cake between 8 of us'. It was only really when Ms M asked the children a social-type question to do with outside of the classroom that 'novel' responses were evoked, albeit that such responses were of a markedly brief (one- or two-word) order. The following exchange from the same lesson is a case in point.

Turn	**Learner**	**Ms M**
3		Who doesn't like cake? Who doesn't ~
4	*[Child indicates that he doesn't like cake.]*	
5		You don't like it?
6	No, ma'am.	
7		You like -? What do you like?
8	Pizza, Ma'am.	
		(Lesson 1M, Turns 3-8)

Bernstein (2000) explains that it is possession of the recognition rule that enables acquirers to appreciate what sorts of things are required for a given context: "the special features which distinguish the context" (p. 17). This often 'invisible' aspect of schooling is something with which children from working class backgrounds may often struggle (as witness Bernstein's research conjectures across several decades, as well as ethnographic studies across different social classes such as that conducted by Heath (1983)). Hoadley's case study (2005) of four primary schools in South Africa's Western Cape Province illuminates similar struggles for children from different socio-economic and cultural backgrounds.

In the present study, while acquisition of the recognition rule would apply *mainly* to Ms M's and Ms P's learners, it needs also to be borne in mind that Ms M and Ms P are *themselves* acquirers also in certain respects (most notably in relation to acquiring the sorts of insights - in terms both of content and of pedagogical knowledge and expertise - most likely to enable them to become effective agents of change in the post-1994 reform and redress drive). The recognition rule is but a first step, however. The realisation rule needs also to be invoked. It is only through this that the requisite (legitimate) text can actually be produced: "recognition rules regulate what meanings are relevant ... realisation rules regulate how the meanings are to be put together to create the legitimate text" (Bernstein, 2000, p. 18). The most centrally important mechanism in a teaching/ learning context whereby both rules may be realised rests with the evaluation process (both formal and informal). Evaluation is at the heart of the entire transmission/ acquisition process: "Evaluation condenses into itself the pedagogic code and its classification and framing procedures and the relationships of power and control that have produced these procedures" (Bernstein, 2000, p. 18).

I end my discussion here of Bernstein's work on the distribution, recontextualisation and evaluation rules with some brief further mention of his theorising around *evaluation*, which as Morais (2002, p. 560) notes is "a crucial characteristic of pedagogic practice". She notes in particular that "understanding of evaluation criteria contributes to the production of legitimate text" (2002, p. 562).

Drawing on Bourdieu's construct of 'game', Jorgensen (2013) emphasised how important it is for learners' successful engagement that the rules of the 'game of schooling' be made explicit. This, she notes, is most particularly the case when working with learners who come from the more marginalised sectors of a society (Jorgensen, 2013). In the context of my study, the forms of evaluation I look at are in specific relation to oral text: how the two teachers indicate to their learners in the course of classroom talk whether or not they are on the right track. In terms of "what is constituted as mathematics [in Ms M's and Ms P's observed] lessons" (Adler, 2012, p. 8), therefore, I look for the particular evaluative criteria the teachers appear to be promoting through their respective responses to learners' oral contributions. This applies in relation to both the regulative and the instructional aspects of discourse that Ms M and Ms P make available in their mathematics lessons.

Included in Chapters 8 and 9 is some analysis of the extent to which each teacher makes her evaluation criteria explicit. As a general rule, the more explicit these are, the more likely it would be that Ms M's and Ms P's learners would be able to *recognise*, and thence, *realise*, what is considered legitimate; legitimate, that is, in the immediate classroom context, if not always within wider mathematical fora.

So, while certainly not in line with the sense in which Jorgensen (2013) was writing of the rules of 'the game of schooling', I did include earlier (Section 2.4.1) an extract from one of Ms M's lessons in which even she good-humouredly acknowledged that exchanges between herself and the learners were "becoming a sort of a game" (Lesson 13M, Turn 125). And yet, she allowed 'the game' to continue awhile, thereby 'evaluating' it as a legitimate element of the mathematics classroom; albeit that - in so doing – opportunities for more time spent on actual mathematical sense-making may have been missed.

In the 13M lesson extract that I included in Section 2.4.1 the 'game playing' was condoned over more than fifty lesson turns:

Turn	**Learner/s**	**Ms M**
95		… Before I spend one quarter of the twenty rand, I want to know how much is it.
96-146	*[Learners call out various suggestions.]* … one rand; seven rand; one rand, forty; fifteen rand; five rand; four rand; two rand, ninety nine; eight rand; fifty rand. … fifteen rand; nineteen rand; nineteen rand, ninety; nine rand; five rand.	(Lesson 13M, Turns 95-146)

The regulative discourse here appears to be that as long as you called out sums of money, no matter how far off the mark, you were 'safe'. Calling out random sums of money in this context seemed to be regarded as an 'acceptable' part of the instructional discourse. The CAPS curriculum's emphasis on sense-making (which in the CAPS IP phase for Mathematics is listed amongst the "essential mathematical skills" as an ability "to listen, communicate, think, *reason logically* [italics added]" (DBE, 2011, pp. 8-9)) was thus sacrificed to 'playing school'. What the children appeared to recognise was that what Ms M wanted here was 'a sum of money', but, in playing 'the game', the learners realised little actual 'sense-making' of the original problem they were asked to solve, namely: 'What fraction of R20 is R5?'. Harking back to Bodrova and Leong's claim that self regulation involves "mindful, intentional, and thoughtful behaviors" (2008, p. 1), it would seem clear also that condonance of this kind of 'game playing' inevitably reduces also, opportunities for such self-regulatory development.

I attempt in Figure 6.2, below to capture, and so summarise, the foregoing, somewhat complex, discussion of Bernstein's theorising around the structuring of educational knowledge (its organisation, distribution and evaluation). Into this, I have built in specific references to the context of the present study.

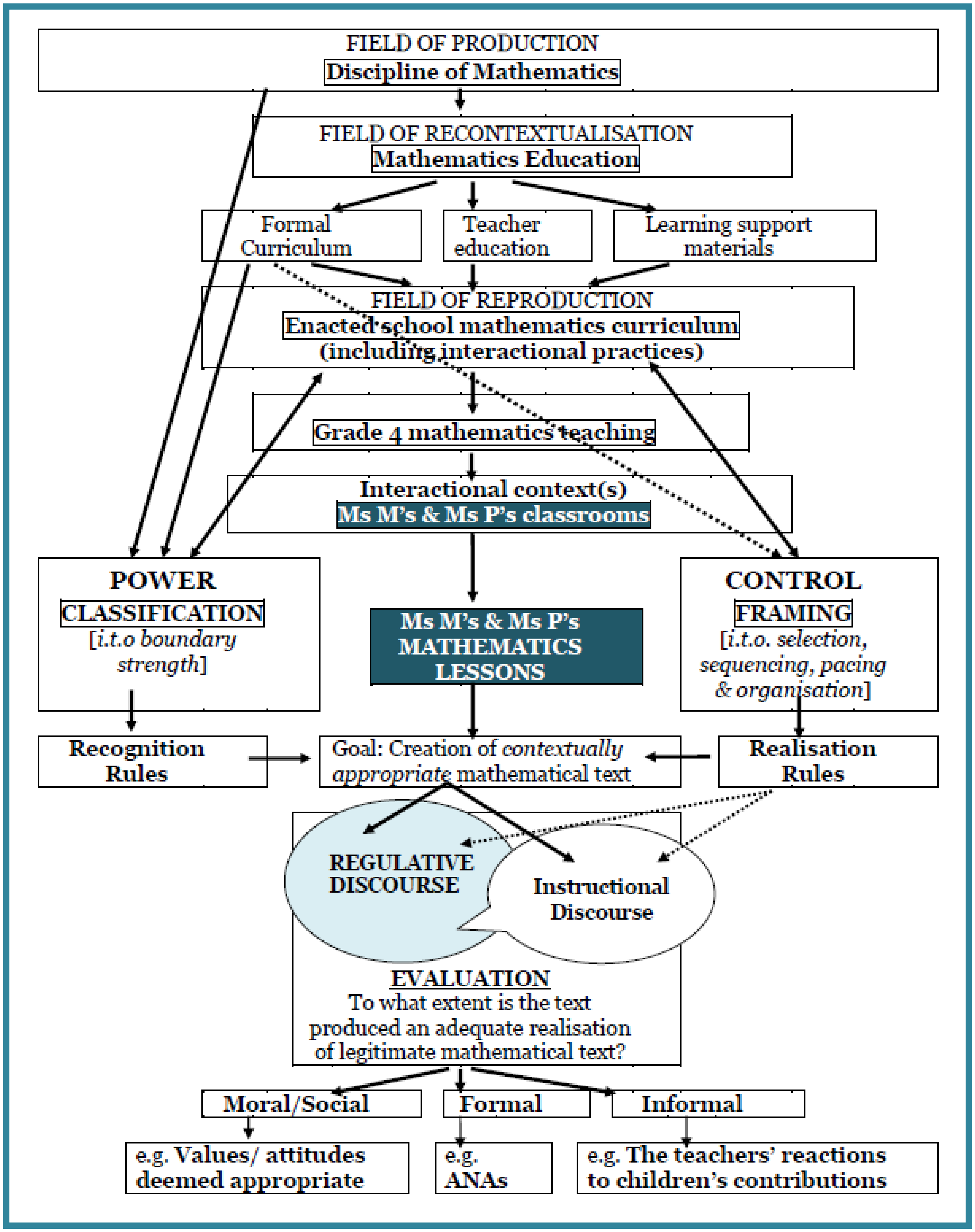

***Figure 6.2:* Applying Bernstein's ideas to Ms M's and Ms P's contexts**[62]

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62 I am indebted to Martin and Rose (2005) for the way the relationship between regulative and instructional discourse is depicted in Figure 6.2.

The following chapter marks the final stage of my transdisciplinary journey across the theoretical 'light sources' chosen for this study. In this chapter I outline those ideas from Halliday's linguistic work that I see as important to the present study. Halliday was for a time a colleague of Bernstein's at the University of London. Throughout his life, Bernstein held Halliday's ideas (as well of those of Ruqaiya Hasan, who also happened to be Halliday's wife) in high regard, explaining that Halliday had helped him "to think about linguistics in sociological terms and sociology in linguistic terms" (in Sadovnik, 1995, p. 396).

CHAPTER 7: DRAWING ON HALLIDAY

> *Language is not a domain of human knowledge … language is the essential condition of knowing, the process by which experience becomes knowledge.*
>
> (Halliday, 1993, p. 94)

7.1 INTRODUCTION

In the introduction to the first volume of his collected works, Halliday notes “weak boundaries have always been characteristic of my approach … I have never really thriven in a discipline-based structure of knowledge” (2002, p. 1). Instead, and as already alluded to in the concluding paragraph of Chapter 2, Halliday has opted throughout for a multi-faceted approach in the development of his theories about language:

> To the extent that I favoured any one angle it was the social: language as the creature and creator of human society, as expounded by my teacher J. R. Firth and by my friend and colleague Basil Bernstein. (2002, pp. 6-7)

Eggins (2004) notes that Halliday’s systemic functional linguistics (SFL) provides, not simply a theory about language, but also a set of tools with which to examine and describe language practices in their actual contexts. Listing the many ways in which SFL is used, Eggins observes that “underlying all [of] these … is a common focus on the analysis of authentic products of interaction (texts), considered in relation to the cultural and social context in which they are negotiated” (2004, p. 2). These points, together with the frequent links that Halliday makes in his work between language and learning, underscore the value of drawing on Hallidayan ideas in my analysis of the linguistic interactions taking place in Ms M’s and Ms P’s observed mathematics lessons. Of particular relevance here is the work also that Halliday and his colleagues (see, for example, Martin (1984) and Halliday and Hasan (1985)) have done on language register, principally - in the case of the present study - in relation to an oral mathematics register. In respect to the *oral* context, it is perhaps especially useful to go back to Table 2.5 of the Literature Review chapter in which the characteristics of ‘spoken’, as opposed to ‘written’, language are distinguished.

Halliday’s view of language as a system for expressing meaning provides a powerful alternative to a Chomskyan view of language. It was the Chomskyan view that prevailed over my undergraduate encounters with linguistics, during which time a great deal of our energies were expended on parsing decontextualised sentences. Whereas Chomsky’s linguistic theory focuses mainly on the *structural* aspects of language, in relation - mainly - to “an ideal speaker-listener" situation (Chomsky, 1965, p. 3), Halliday's work emphasises the *systemic* aspects of language and its use in natural contexts.

Halliday views innatist and cognitivist views of children's language development as being "essentially antisocial - or perhaps "asocial" to be more accurate" (2004, p. 133). Linguistics, for Halliday, involved studying, not the decontextualised structures of language, but rather, "how people exchange meanings by 'languaging'" (2003, p. 193); and such meanings are *socially* constructed. Aligning his thinking with that of Vygotsky and Bernstein, for Halliday, meaning and meaning-making then, is "a social and cultural phenomenon" (2004, p. 133). Halliday's interest lies in how language *functions* as a social semiotic resource from which language users learn to actively select, and *make choices*, in order to express and exchange meaning (1993).

Language serves two basic functions: it "construe[s] human experience" and, at the same time, it enacts "personal and social relationships" (Halliday & Mattiessen, 2004, p. 29). "Functionality," write Halliday and Mattiessen (2004), "is **intrinsic** to language … the entire architecture of language is arranged along functional lines. Language is as it is because of the functions in which it has evolved in the human species" [bold in the original] (p. 31).

7.2 LANGUAGE AS TEXT

Any spoken or written act produces text; 'text' being "any instance of language, in any medium, that makes sense to someone who knows that language" (Halliday & Matthiessen, 2004, p. 3). In a more detailed explanation, Halliday and Hasan (2013/1976) describe 'text' as follows:

> … the word TEXT is used in linguistics to refer to any passage, spoken or written, of whatever length, that … form[s] a unified whole. … [It] is a unit a language in use. It is not a grammatical unit, like a clause or a sentence; and it is not defined by its size. … A text is not something that is like a sentence, only bigger; it is something that differs from a sentence in kind. … [it is] best regarded as a SEMANTIC unit: a unit not of form but of meaning" [capitalisation the original]. (pp. 1-2)

A text, Halliday and Matthiessen (2004) note, "is the product of ongoing selection in a very large network of systems — a **system network** …the **system** … [being] the potential that lies behind the **text**" [bold in the original] (p. 33). This system is – in turn – 'instantiated' as text:

> A text may be a trivial service encounter, like ordering coffee, or it may be a momentous event in human history, like Nelson Mandela's inaugural speech[63]; in either case, and whatever its intrinsic value, it is an instance of an underlying system, and has no meaningful existence except as such. (Halliday & Matthiessen, 2004, p. 26)

Analysis of text can be approached in two main ways: either text as "object" or text as "instrument" (a vehicle for achieving a particular social purpose). While there is complementarity between these two approaches (Halliday & Matthiessen 2004, p. 3), it is the *instrumental* that I am primarily concerned with in this study. A 'text as instrument' approach seeks to uncover "what the text reveals about the system of the language in which it is spoken or written" (Halliday & Matthiessen, 2004, p. 3). Halliday and Matthiessen (2004) explain that 'system' and 'text' are "related through instantiation" along a cline: "the **cline of instantiation**" [bold in the original] (p. 27): text is that "unit in the flow of meaning ... taking place at the instance pole of the cline of instantiation" (2004, p. 587). (See Figure 7.1, below.)

The Longman Dictionary of Contemporary English defines 'cline' as a technical word used to describe "a series of very small differences in a group of things of the same kind". Google's definition of 'cline' as "a continuum with an infinite number of gradations from one extreme to the other" might be more appropriate in the present context (retrieved March 4, 2016, from https://www.google.com/search? q=cline&ie=utf-8&oe=utf-8).

As Halliday and Matthiessen explain, "system and text define the two poles of the cline — that of the overall potential and that of a particular instance" (2004, p. 27). In the case of Halliday's 'cline of instantiation' I would argue that describing the cline between an *actual* instance of text relative to the *potential* a particular linguistic system offers as involving 'very small' differences could in some cases be something of an understatement. I have in mind here two – and, in the case Ms M's and Ms P's Grade 4 mathematics learners - overlapping challenges:

- younger learners' capacity for producing system-appropriate text; and
- their having to do so in a second language situation.

Figure 7.1 below is a modification of Halliday and Matthiessen's (2004) diagram into which I have incorporated reference to the present study.

63 Given the context of the present study, it is indeed serendipitous that Halliday and Matthiessen (2004) should have chosen to use the inaugural speech made by our late President Nelson Mandela on the occasion of his investiture as the first Black president of a post-apartheid South Africa (May 10, 1994).

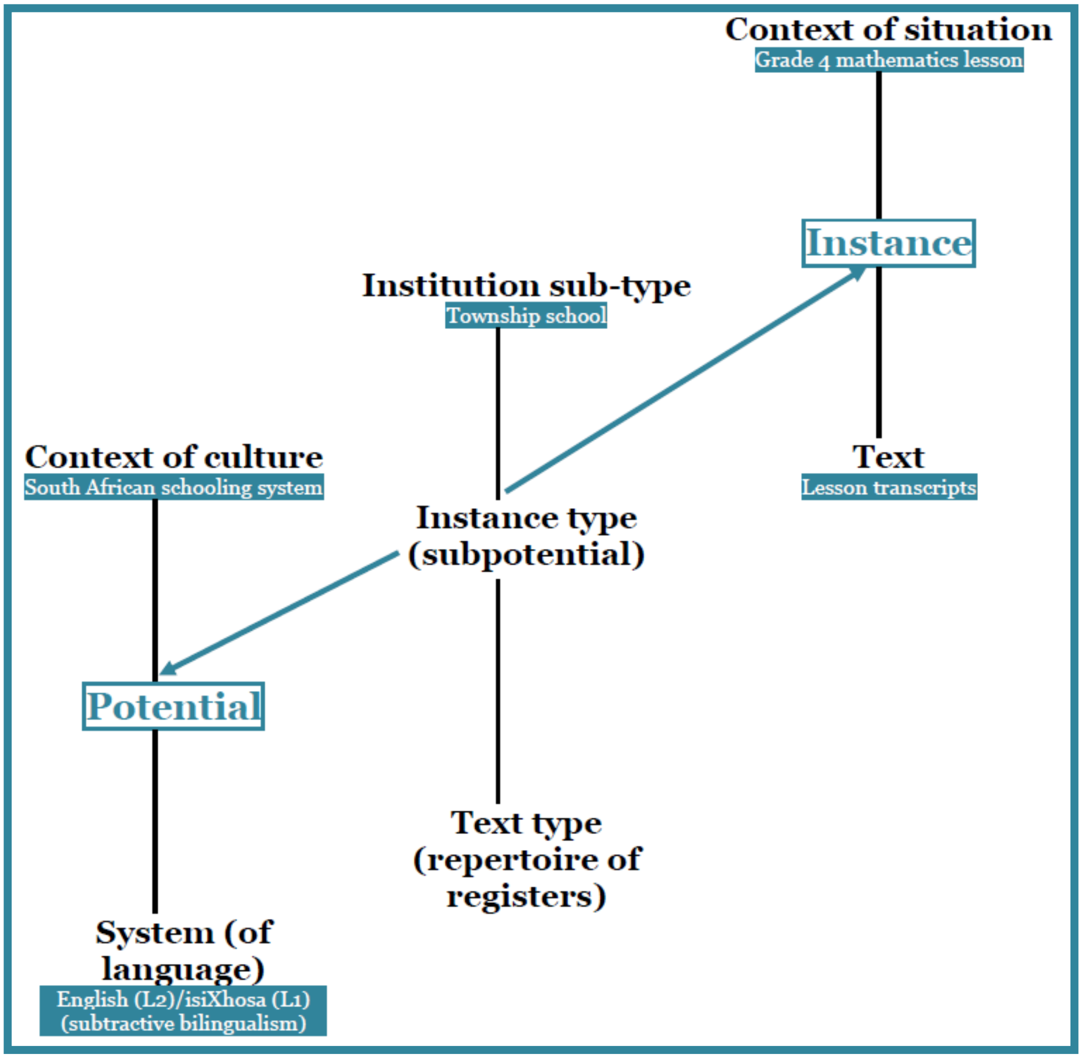


Figure 7.1: **The cline of instantiation** (after Halliday & Matthiessen, 2004, p. 28)

Discussion of the concepts 'context of situation', 'context of culture' and 'register' (which are included in Figure 7.1) comprises part of Section 7.8.

7.3 LANGUAGE AS SIMULTANEOUS STRANDS OF MEANING

As a resource for making meaning, language has, as Halliday and Matthiessen (2004) note, the capacity to "expand more or less indefinitely [to meet] the functions that language serves in human lives" (p. 24). The two overarching functions (metafunctions) that it serves are firstly, the ideational metafunction ("making sense of our experience"), and secondly, the interpersonal metafunction ("acting out our social relationships") (Halliday & Matthiessen, 2004, p. 29). The realisation of the ideational and interpersonal metafunctions is achieved via the third (textual) metafunction. This metafunction works to bring together the ideational and the interpersonal meanings in coherent ways. In Figure 7.2 below I visually capture the way in which Halliday's three linguistic metafunctions (strands of meaning) are simultaneously expressed in any spoken or written text (Halliday & Matthiessen, 2004). I have adopted the term 'strand' here from Eggins (2004). I find particularly appealing the way she describes these metafunctions as being "*simultaneous* strands of meanings" [italics added] (p. 2).

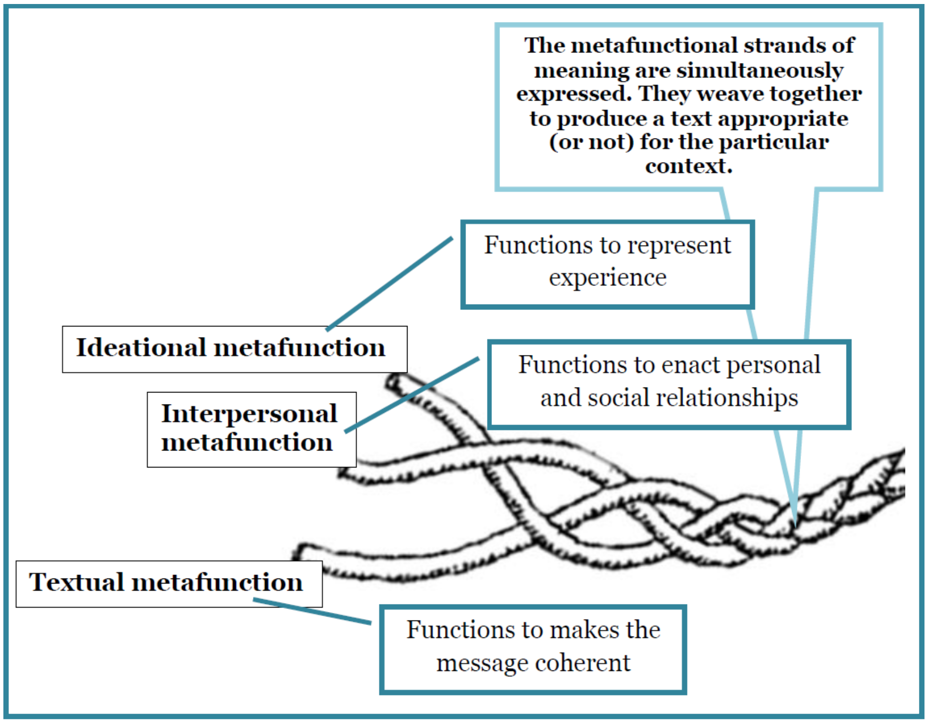


Figure 7.2: **The weaving together of strands of meaning**

In showing the metafunctions as I have, I respect Halliday's point that a text may or may not be "effective … for its own purposes", evaluation of which would require "an interpretation not only of the text itself but also of its context (context of situation, context of culture)" (1994b, p. xv). I make this point because, in looking at the transcribed texts of Ms M's and Ms P's observed mathematics lessons, and as alluded to in previous sections, not all of the text may appear to be 'effective' relative to the task of mathematical meaning-making. Some non-idealities - for example, the LoLT dilemma – inevitably act to constrain the teachers' efforts towards developing their learners' mathematical meaning-making capacities.

Where, for whatever reason, access to 'the system' is restricted (be that the system of a particular language (in this case English), or the system of mathematical expression in that language) the weaving together process may be compromised. Two questions then arise:

- How likely is it that the text produced *can* be entirely effective?

- Without adequate access to the discourse of mathematics how likely is it that learners can *realise* the full grade-appropriate meaning potential at the textual, the interpersonal and – most importantly - the ideational metafunctional levels?

Learners such as the Grade 4 children in Ms M's and Ms P's mathematics classrooms may construe mathematical meanings in entirely different ways from what may have been intended.

7.4 LANGUAGE AS A SYSTEM FOR CHOOSING HOW TO MAKE MEANING

In this section I reflect on Halliday's notion of 'selection' and on the related implication that 'choice' is always at work. As indicated in the introductory section of this chapter, my own undergraduate studies in linguistics were almost exclusively influenced by Chomsky's ideas about how language ought to be studied. I consequently entered this study as a relative neophyte regarding some specific aspects of Halliday's functional grammar. To bring me up to speed I sought help from a recently graduated linguistics masters student, Amy Richardson (simply referred to as Amy from here onwards). Because I audio-taped our discussion I am able in the following paragraphs to include direct quotes from it.

One of the SFL ideas I found especially troubling was Halliday's concept of 'language as choice'. "How," I asked Amy, "is this idea possible in the case of children learning through a language in which many of them are only barely proficient? What choices are such children actually able to exercise?" She assured me that everyone has choice when it comes to using language:

> Although their choice may be more limited than somebody with a greater linguistic repertoire, there is still choice. They could use a slightly different word, or emphasize different things, or they could stick to the word order of their home language. Every time they say something, there is a choice, even if it's not a conscious choice.

Amy then related the question of choice to the options teachers might exercise. She explained:

> There's a lot of choice for the teacher. She chooses, for example, to use commands or questions, when she could be swopping these around, or she could be using statements.

Prior to our meeting, I had e-mailed through to Amy a section of a transcript from one of Ms M's observed lessons. Based on what she saw from this small piece of data, Amy remarked: "This teacher uses a *lot* of commands. She's a very controlling teacher. That comes across very strongly in this text."

With Amy's help and further reading I have become more confident about what the concept of choice implies from an SFL perspective. As a "product of ongoing selection" from a linguistic system, the particular meaning that a text achieves "resides in systemic patterns of choice" (Halliday & Matthiessen, 2004, p. 23). Thus, whenever something is said (or written) one recognises that it could almost always have been expressed differently: a change to the sentence structure; a different choice of words; details could be added; details could be taken away, and so on. Further analysis of the choices apparently made in the course of Ms M's and Ms P's observed lessons is included in Chapters 8 and 9, but by way of quick illustration of the notion of different choices being available (and made) it is interesting to notice from transcripts of Ms M's and Ms P's lessons that – in terms of the interpersonal metafunction, for example – the two teachers address their learners in quite different ways. The transcripts show that Ms P almost invariably chose to use isiXhosa 'labelling' when addressing her learners: "Bhuti …" [young man]; "Bethunani …" [people]; "Mntunam …" [my child]. Ms M most often simply used pronouns (and almost exclusively in English): "You …", "All of you …". She would also sometimes address the children in the third person: "They say they are finished …". She also often made use of the collective (and subjective) pronoun 'we' into her classroom talk to try, perhaps, to invoke a sense of common purpose between herself and her learners (albeit that this may have been lost on many learners): "Now before we start, we will take in the books." And, as noted earlier, she also sometimes used the third person in referring to herself: "If you are done, Ms M will …". Such different choices point to the setting up of quite markedly different types of social relationship between teacher and learner(s) in the respective classroom contexts.

7.5 LANGUAGE FOR DIFFERENT PURPOSES AND AUDIENCES

Ideally, language users make their linguistic choices based on their understanding (consciously or otherwise) of their intended purpose and audience. Context plays a powerful part in influencing - *determining* even - the choices language users make. I use the following two tables to illustrate this point. Table 7.1 is taken from the academic/ professional literature. Table 7.2 is generated using a data sample from one of Ms M's observed mathematics lessons and from information obtained online.

Table 7.1: Ways of talking about the weather

Informal conversation between friends	Formal broadcast of a weather report
Nwabisa: Hi! How are you? **Katy:** Good. And you? **Nwabisa:** I'm fine. **Katy:** Sjoe! It's hot today, isn't it? **Nwabisa:** Ja, it's hectic.	**Weather forecaster:** Temperatures today are likely to reach as high as 38 degrees Celsius. Although there will be a fair amount of early morning cloud down towards the south, this is likely to burn off by midday. The rain belt off to the west is likely to produce a little more in the way of cloud overnight, which is likely to bring cooler weather by the weekend.

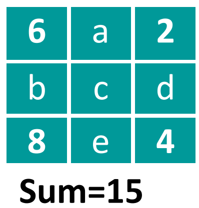
(Murray, 2009, pp. 194-195)

In this example, while the topic is the same for both texts, purpose, audience, and context are clearly different (Murray, 2009). Both texts gain their coherence (and their legitimacy) from the linguistic choices made by the speakers involved. A weather forecaster beginning a broadcast by saying, "Sjoe! It's hot today, isn't it?" would constitute a break from conventional register.

Table 7.2: Ways of explaining how magic squares 'work'

<table>
<tr><th>Grade 4 mathematics lesson material</th><th>Online entry
(https://en.wikipedia.org/wiki/Magic_square)</th></tr>
<tr><td>

Teacher copies the following grid onto chalkboard.



Ms M: Okay I have something there that we call a 'magic square'. That's to keep you thinking. So here it is written: 'Sum is equal to ~ what^? ~ 15'. What does that mean, Ms M[64]? This means if I add three numbers, I must get -?

Learners: [*in chorus*] 15

Teacher indicates all the directions - horizontal, vertical, diagonal – that need to be added to get the sum of 15. As she indicates each direction, the learners chorus the 'answer' (15).

Ms M: Now we know that if we are adding vertically, or if we are adding across, or even if we are adding from top ~ Fikile is busy now ~ wanting to know what number is missing. She is ready to give me an answer, but I am still talking. But you must know ~ where to start. Okay. I will label these ones, a, b, c, d, e. Then you must know where to start. It is a good idea to start ~. People are not listening. They are ready to give me the answer and rushing. And they are looking at everybody who is passing. Going up, going down. Let me close the door. Thank you! If there were curtains I was going to draw the curtains as well, but there are no curtains or blinds or whatever. There are none. ... Okay. Now my advice for you is ~ you are not listening ~ you start where there is only one number missing. Where can you start? a? b? c? d? or e? Luyanda, where can we start? a, b, c, d, or e? Where can we start?

Luyanda: a

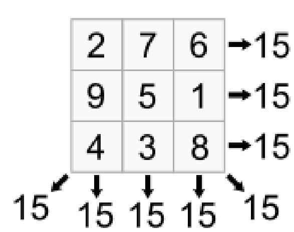
Ms M: a. So, because we have a number here, and a number there, there is only one number missing. Can we only start at a? Is that the only row where we can start? Akhona? Where else can we start?

</td><td>

In recreational mathematics, a **magic square** is an arrangement of distinct numbers (i.e. each number is used once), usually integers, in a square grid, where the numbers in each row, and in each column, and the numbers in the main and secondary diagonals, all add up to the same number.

A magic square has the same number of rows as it has columns, and in conventional math notation, "n" stands for the number of rows (and columns) it has. Thus, a magic square always contains n^2 numbers, and its size (the number of rows [and columns] it has) is described as being "of order n".

A magic square that contains the integers from 1 to n^2 is called a *normal* magic square. ... Normal magic squares of all sizes except 2 × 2 (that is, where $n = 2$) can be constructed. The 1 × 1 magic square, with only one cell containing the number 1, is trivial. The smallest ... nontrivial case, 3 × 3, is shown below.



</td></tr>
</table>

In this second example, topic (magic squares) and purpose (explaining how magic squares 'work') are the same, but audience and context are different, as is the mode (spoken, as

64 Here we see another example of Ms M's references to herself in the third person.

opposed to written). Notwithstanding some similarities in the information (the ideational strand) contained in the Ms M and Wikipedia extracts, there are thus distinct differences both in the style of language used for conveying such information (the textual strand) and in the implied relationships between 'audience' members (the interpersonal strand).

I engage further in Chapter 8 with the implications of the different strands of meaning evident in Ms M's observed verbal interactions with her learners, including her efforts at ensuring they stayed focused on the task at hand. For the moment, however, my purpose was simply to use the lesson text sample alongside the Wikipedia text sample as a means of demonstrating the way different linguistic dynamics play out as meaning is communicated in different contexts of usage.

7.6 LANGUAGE AS 'MEANING POTENTIAL'

From within any linguistic system for making meaning the choices that are made will determine the extent to which the full potential of a particular system is being realised. Figure 7.1 (Section 7.2) illustrated the cline between an actual instance of text and the potential offered within the system. In looking at the literature around using SFL as a tool for teaching learners about content area language (see, for example, Schleppegrell, 2011; 2012b; Derewianka, 2012; Gibbons, 2015) it became clear that my conceptualisation of 'choice' as residing with an individual learner was somewhat naive. I now recognise that 'choice' relates to *potential*, in particular, the potential offered by the system network. As noted in Section 7.4, with Amy's help I now understand that, while an individual user can exercise choice, the issue of choice goes well beyond individual users of a particular system network (the users in the present instance being Ms M, Ms P, and their respective Grade 4 learners).

The value of SFL in teaching and learning lies in helping the individual user to better understand how to take advantage of the potential the system network offers. This applies especially to L2 users of a language because they often lack the intuitive knowledge of the language that native speakers have. The greater a user's insight into the way the system operates, the more choice he or she is then likely to be able to exercise in deciding how most appropriately to express a particular idea, be this in general terms or in relation to a specific content area (such as, in the present case, the discipline of school mathematics). What this boils down to is that the choices made significantly influence the nature and quality of the meaning made (or in some cases, *not* made):

> By drawing systems [language systemicists] ... try to capture what choices speakers *could* make. ... it is only by knowing what someone *could* have meant that we can understand in full the meaning of what they *did* in fact mean. ... System networks capture the **meaning potential** available to speakers. [bold in the original] (Eggins, 2004, p.204)

Making appropriate choices from within a particular system of meaning involves a narrowing, or progressive limiting principle. To illustrate the point, initially I have used Eggins's analogy of ordering a restaurant meal. From the items on a menu, one is - often with the help of one's waiter - gradually shepherded towards a particular meal selection. The menu constitutes the system; the menu itemises the set of available choices.

I provide below (Figure 7.3) a modified version of Eggins's menu analogy, showing how, once one has entered a particular 'system of meaning', particular choices "lead to other choices" (Eggins, 2004, p. 196). Choices beget other choices. There is also what Eggins terms a certain "*logical priority* among choices" [italics in the original] here, moving one from "least" to "most delicate" (2004, pp. 196-197); from, for example, the choice of **steak** over fish towards a further narrowing down (or refining) of that choice: **rump** over fillet; **rare** rather than medium rare or well-done; **sauce** over no sauce; and make that **mushroom** (rather than pepper or barbeque) **sauce**. Linguistically speaking, 'delicacy' refers to the movement towards an increasingly (or, as the case may be, decreasingly) detailed level of refinement, precision or exactitude in the information provided in the text (Halliday & Matthiessen, 2004).

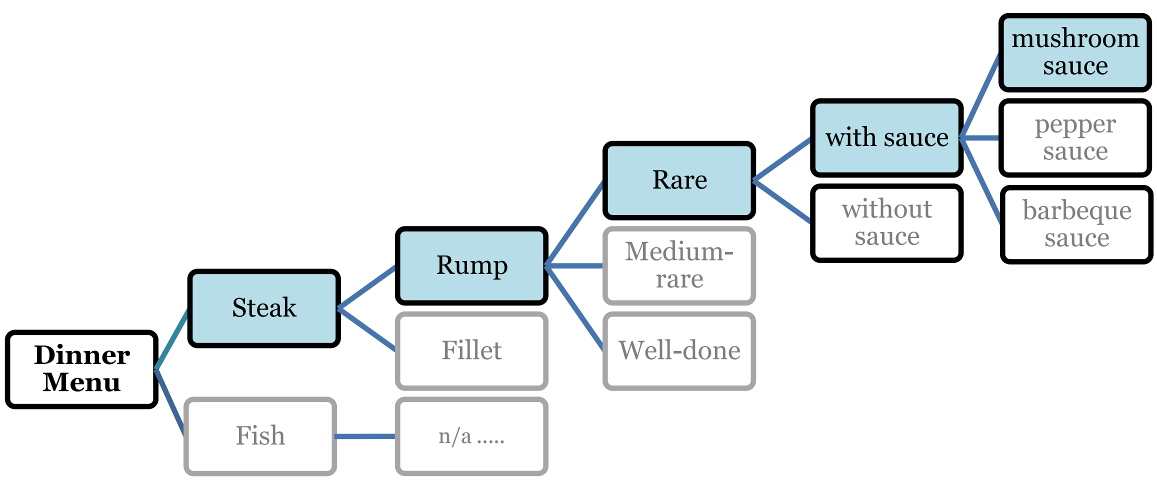


Figure 7.3: **Example of a system network** (adapted from Eggins, 2004, p. 198)

The point about "scale[s] of delicacy" in a system network (Eggins, 2004, p. 197) strikes me as in some ways having parallels with Vygotsky's idea of transitioning from the 'commonsense' towards the 'scientific'. I am taken back here also to a point made by Vygotsky that "a word in a context means both more and less than the same word in isolation: more, because it acquires new context; less, because its meaning is limited and narrowed by the context" (1986, p. 245). Moving along a scale of delicacy involves the same sorts of movement towards more specific and detailed choices which, in the case of, for example, school mathematics, would involve choosing more discipline-specific ways to talk (and think) about mathematics through using a 'mathematics register'. Playing, then, with Eggins's explanation of how choices beget choices as one moves in a logical priority from 'least' to 'most' delicate (2004), Figure 7.4, below, represents an example of a system network for an aspect of mathematical meaning (some specific properties of different shapes).

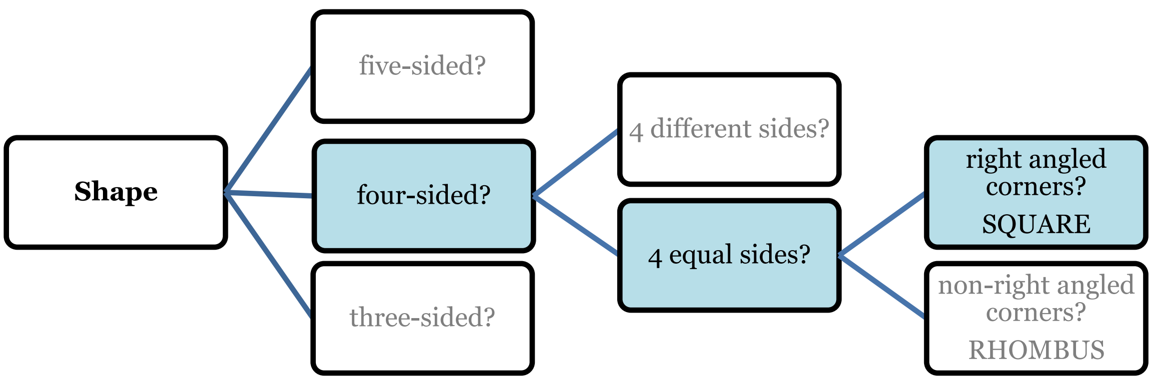


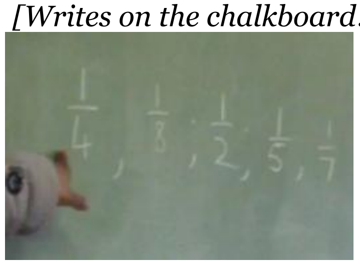
Figure 7.4: **Example of a progressive limiting of choice within a system of mathematical meaning**

I discuss Halliday's concept of mathematics register in the next section. Before doing so, however, I share the following extract from the first of Ms M's Grade 4 mathematics lessons that I observed. There is evidence here, I believe, of some transitioning towards a more mathematical style of meaning; that is, a more discipline-specific way of using language and other semiotic resources (for example, symbols and images) to talk about mathematical ideas. The lesson focus was fractions, and the transcript extract has, for the present purpose, been stripped of some of its original text. While it thus does not *fully* show Ms M's efforts to move her learners along a mathematical 'scale of delicacy' (ellipsis dots [...] indicate where some text has been removed), it does show how, having started with an imaginary, but real world, everyday, 'commonsense' experience, Ms M worked to try to gradually move her learners towards more formal, 'scientific' mathematical conceptualisations of fractions. In the extract we see her trying to establish how well the learners were able to:

- judge the relative size of various fractions (half/ third/ quarter/ fifth, and so on);
- use the correct symbolic representation (1/4; 1/3, and so on);
- understand, and use, the appropriate terminology for the numbers above and below the fraction bar (numerator/ denominator).

Shaded blocks indicate where learners responded in chorus, rather than individually.

Turn	**Learners**	**Ms M**
37		If I'm saying to you that there's this cake … *[Teacher writes ¼ on chalkboard.]* What do you call this fraction first? Lonwabo?
38	One-fourth.	
39		One fourth, or -?
40	One quarter.	
41		… One quarter. And then, Anathi, this one – what do you call this one? *[Teacher writes 1/8 on chalkboard.]*
42	One-eighth.	
43		One-eighth. And then, Lonwabo, Ms M is saying, "Lwazi, would you rather have a quarter of a cake?" You tell Ms M that you like cake so much. Tell me - would you rather have a quarter of a cake or an eighth of a cake? And why? Which one?
44	Quarter.	
45		A quarter. Why not an eighth?
46	[*silence*]	
47		Why not an eighth? Because you say you prefer to have a quarter not an eighth. Why? Why?
48	[*silence*]	
49		Why? … Bhutani – leave him alone. Don't tell him what he tells me. Please leave him.
50	[*silence*]	
51		Which one?
52	[*silence*]	
53		He does like to have a quarter, but he doesn't have an actual reason. Zintle – do you like cake or not?
54	Yes, ma'am.	
55		You do?
56	[*child nods*]	
57		Would you rather have a quarter of a cake or an eighth of a cake? A quarter of a cake ~ or an eighth?
58	Quarter!	
59		Why?
60	It's bigger.	
61		She says a quarter, because a quarter is bigger.
62	Yoh!	
63		She says a quarter is bigger than an eighth.
64	Yes. Yes.	
65		Is it true?

<table>
<tr><th>Turn</th><th>Learners</th><th>Ms M</th></tr>
<tr><td>66</td><td>Yes!</td><td></td></tr>
<tr><td>67</td><td></td><td>Really?</td></tr>
<tr><td>68</td><td>Yes!</td><td></td></tr>
<tr><td>69</td><td></td><td>Uh-huh? I’m not so sure. [Teacher moves to the fraction chart on the pin-board.]
<table>
<tr><td colspan="120">whole</td></tr>
<tr><td colspan="60">1/2</td><td colspan="60">1/2</td></tr>
<tr><td colspan="40">1/3</td><td colspan="40">1/3</td><td colspan="40">1/3</td></tr>
<tr><td colspan="30">1/4</td><td colspan="30">1/4</td><td colspan="30">1/4</td><td colspan="30">1/4</td></tr>
<tr><td colspan="24">1/5</td><td colspan="24">1/5</td><td colspan="24">1/5</td><td colspan="24">1/5</td><td colspan="24">1/5</td></tr>
<tr><td colspan="20">1/6</td><td colspan="20">1/6</td><td colspan="20">1/6</td><td colspan="20">1/6</td><td colspan="20">1/6</td><td colspan="20">1/6</td></tr>
<tr><td colspan="15">1/8</td><td colspan="15">1/8</td><td colspan="15">1/8</td><td colspan="15">1/8</td><td colspan="15">1/8</td><td colspan="15">1/8</td><td colspan="15">1/8</td><td colspan="15">1/8</td></tr>
<tr><td colspan="120">And so on …</td></tr>
</table>
Ntando, come and show me here. Come and show me. Show me here which one is a quarter. Which one is an eighth? Then we can agree now with Zintle if we are choosing this one. [Child comes up and indicates on the chart.]</td></tr>
<tr><td>94</td><td></td><td>… Okay, I’m going to add three more fractions.
[Writes on the chalkboard:


] …</td></tr>
<tr><td>104</td><td></td><td>Now, what is going on about all those fractions that you see? One, two, three, four, five. What is the same, what is common? All those fractions have something in common. Look at them and tell me what is it. All of them. …</td></tr>
<tr><td>105</td><td>The ones, ma’am, are the same.</td><td></td></tr>
<tr><td>106</td><td></td><td>All of them have one. What do you call those ones, Sipho? Do you still remember? What do we call them? This one has one, has one, has one, had one, has one. What do you call those ones? What is the name that you call them? What do we call them? All those ones – what do we call them? What do we call them? I don’t want to ask the same people again and again and again. Try, Unathi. What do we call those one’s? one, one, one, one, one – what do you call them? It begins with the letter ‘n’. …</td></tr>
<tr><td>107</td><td>Phew!</td><td></td></tr>
<tr><td>108</td><td></td><td>Letter ‘n’. I’m going to write it on the chalkboard. Maybe you’re going to think about it, once I start writing. It begins with letter ‘n’. You don’t tell anybody. Please don’t tell anyone. It begins with letter ‘n’. You’ve still forgotten? And then letter ‘u’.</td></tr>
<tr><td>109</td><td>[Lots of excited hands raised,</td><td></td></tr>
</table>

Turn	Learners	Ms M
	and some children calling out.]	
110		UhUh! Don't call! I can't ask all of you. I can't ask thirty four learners. I can only ask one. So I've written the first two letters of the word that I'm looking for. We are not counting. I just want the name.
112	*Children with raised hands – call "Teacher!"/ "Teacher!"*]	
113		Akhona?
114	Numerator.	
115		Thank you! [*Writes word in full on the chalkboard*.] And what about the number at the bottom?
116	[*Lots of excited calling out: "Yes, miss"/ "Yes miss"*.]	
117		Don't call me. Don't call me. I'll call you. What about the numbers at the bottom?
118	[*Frustrated sighs from some of those wanting to give the answer. "Teacher"/ "Teacher"*.]	
119	Nominator.	
120		UhHuh! She says 'nominator'. Now she has reminded you - some of you. UhHuh! De-nominator. [*Teacher writes 'denominator' on chalkboard*.]
121	"Teacher"/ "Teacher"	
127		... Any number that is on top – it can be one or two or three or any number – for as long as it is on top ... in every fraction, that number is the numerator, and the bottom one is the -?
128	Bottom.	
129		Bottom. This is the denominator, this one.

(Lesson 1M, Turns 37-129)

Examples of some of the transitioning towards greater mathematical 'delicacy' shown in this transcript extract are distilled out and indicated below (Figure 7.5).

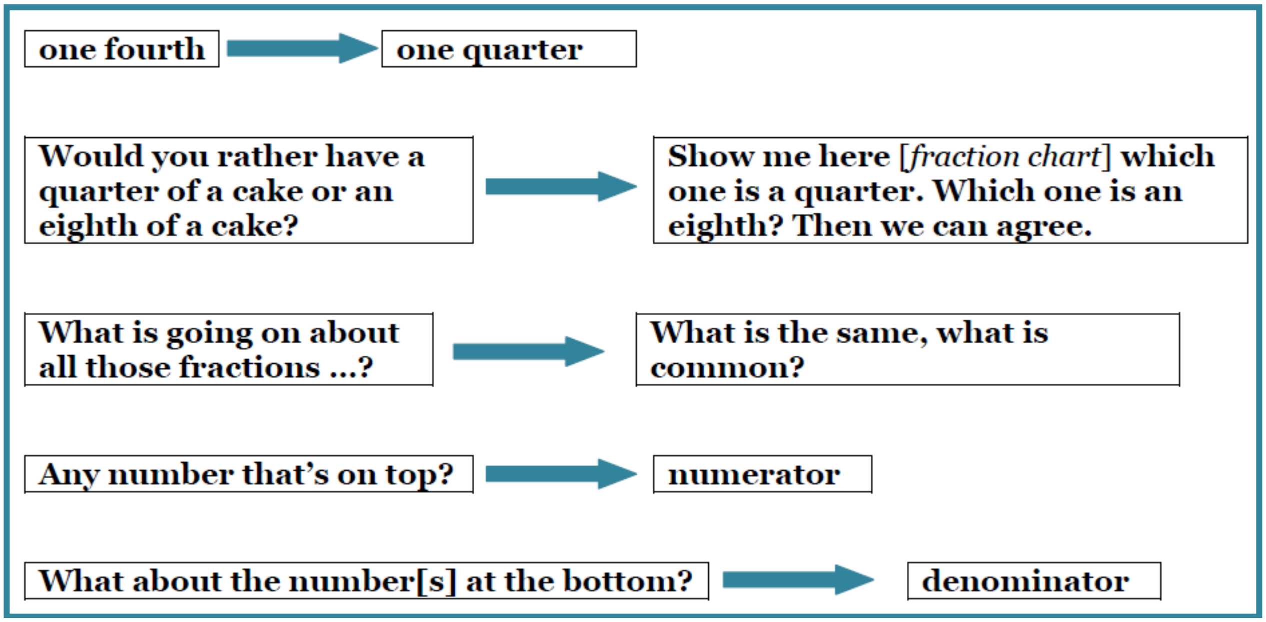


***Figure 7.5*: Transitioning from the 'commonsense' to the 'scientific'**

I mentioned in the Vygotsky chapter Maton's concepts of 'semantic gravity' and 'semantic density' (2011). The transitions from the 'commonsense' to the 'scientific' in Figure 7.4 illustrate decreasing semantic gravity together with an increase in semantic density. Ms M moves the lesson away from an everyday notion of the relative size of cake slices towards more explicitly mathematical conceptualisations of fraction sizes, together with the appropriate terminology. More meaning is condensed within single words (or phrases) representative of the sorts of meaning potential offered by a mathematics register, albeit that this also highlights the semantic complexity of much of this register.

7.7 FEATURES OF THE MATHEMATICS REGISTER

Lukin, Moore, Herke, Wegener and Wu (2011) describe 'register' as being central to Halliday's model of language, "not only in the sense of being important to the theory, but central also in the sense of 'at the centre of' the theory" (p. 188). As far as I have been able to establish, Halliday's presentation at the 1974 UNESCO Symposium: *Interactions between linguistics and mathematical education* marked the first time that he spoke of 'register' in specific relation to mathematics. In his symposium address Halliday explained that while "every language embodies some mathematical meanings in its semantic structure", not every language is necessarily "sufficient … [in terms of serving] the needs of mathematics education", particularly at post-primary levels of study (1974, p. 65). To serve "specialized functions” (1974, p. 64) a language needs to add new registers. In so doing, they expand their functional variation.

Halliday defined ‘register’ as follows:

> … a set of meanings that is appropriate to a particular function of language, together with the words and structures which express these meanings. We can refer to a ‘mathematics register’, in the sense of the meanings that belong to the language of mathematics (the mathematical use of natural language, that is: not mathematics itself), and that a language must express if it is being used for mathematical purposes. (1974, p. 65)

Halliday and Hasan subsequently provided the following, more generic - and *concise* - definition of register: “a variety [of language] according to use” (1985, p. 41).

Registers, as Halliday explained in his 1974 presentation, go beyond the introduction of new vocabulary items. They involve also using “new styles of meaning, ways of developing an argument, and of combining existing elements into new combinations” (1974, p. 66). Registers involve not just words (lexis), but also particular grammatical features (syntax). Halliday (1961) coined the term ‘lexicogrammar’ to encapsulate his view of there being a continuum (and an interdependence) between a language’s lexis and its grammar.

In the course of his presentation at the 1974 UNESCO Symposium Halliday outlined some features of a register for mathematical contexts. Table 7.3 below highlights six *main* ways in which, as he explained, new mathematical ‘thing-names’ are added to a mathematics register. ‘Thing-names’ are “ways of referring to new objects or new processes, properties, functions and relations” (Halliday, 1974, p. 65).

Table 7.3: Ways of expanding a language’s mathematics register

Bringing in new ‘thing-names’	**Example(s)**
Using old words in new ways	borrow, column, even, odd, prime (number), product, sum, row, …
Making new words out of a language’s existing word stock	clockwise, shortfall, …
Borrowing words from other languages	degree, fraction, multiply, subtract, …
Inventing completely new words	[*This, Halliday explained, “hardly ever happens”* (1974, p. 66).]
Creating locutions (phrases or compound words)	right-angled triangle, lowest common multiple, …
Creating words from the word stock of other languages (principally Latin and Greek)	co-efficient, denominator, isosceles triangle, parallelogram …

(Adapted from Halliday, 1974, pp. 65-66)

The examples of ‘thing-names’ listed in Table 7.3 are relatively straightforward ones. This does not mean that they cannot cause conceptual difficulty, however. In the third of Ms M’s observed lessons, for example, some misunderstandings arose when she wanted her Grade 4s to work out the *sums* of consecutive numbers. They would already have encountered the mathematical meaning: 'doing sums', but in the context of this consecutive number task this 'old' word now took on yet another meaning. Ms M struggled initially getting the children to remind her of the mathematical meaning of the term 'sum' in this context: Anathi, what do you do with the numbers the minute you hear the word 'sum'? It means what must you do with the numbers? Amongst the various suggestions learners offered was the correct one ('add'); but other of their suggestions (to 'make them whole', to 'make them weigh the same', to 'make them follow each other') indicated a lack of comprehension. In fact, there was a flaw in the way Ms M had phrased the task to her learners. In Section 8.3.10 of the next chapter I elaborate on the nature of this 'flaw'.

As Kotsopoulis (2007) explained, using old words in new ways can cause learners to "experience interference" (p. 301). I would add in the word 'conceptual' here (*conceptual* interference), because what Kotsopoulis is referring to here is the effect of using an everyday word for an entirely different purpose in the mathematics classroom (for example, the word 'table'). This sort of thing, she claimed, led to some of her learners complaining: "It's like hearing a foreign language" (Kotsopoulis, 2007, p. 301). How much more so might this be the case for learners in Ms M's and Ms P's classrooms, given that they are in the position of hearing such 'foreign' language *in* what for many *is* effectively a foreign language? This may become a particular challenging where compound words and phrases come into play ('Creating locutions ...'). These, I suggest pose significantly more of a conceptual and semantic hurdle. In terms of Maton's concept of 'semantic density' (2011), some mathematical locutions become extremely dense noun phrases. As such, they constitute prime examples of complexity (both linguistic and mathematical). Schleppegrell (2007) cites the following example. It's an algebraic problem: $a^2+(a+2)^2=340$, where, if translated from its symbolic rendition into words, would ask a learner to find "*the sum of the squares of two consecutive positive even integers* [italics in the original]" (2007, pp. 145-146). This particular noun phrase is one that Ms M's and Ms P's Grade 4s are extremely unlikely to encounter. I believe however that it illustrates well the point about the lexical, syntactic, semantic, *and* mathematical complexity of some dense noun phrases.

Another feature of a mathematics register that Halliday has helped draw attention to involves nominalisation via what he labels 'grammatical metaphor'. This is particularly a feature of written rather than spoken text, and it occurs when "processes and qualities are construed as if they were entities" (Halliday & Matthiessen, 2004, p. 637). The four mathematical operations, 'addition', 'subtraction', 'multiplication' and 'division' provide a simple illustration of this sort of thing. So, for example, the *process* of adding (for example, 2+2) is reformulated as an *entity* when the term, 'addition' comes into play. The verb ('add') becomes a noun ('addition'), and, in so doing, a *process* has been nominalised[65].

In closing the present section I briefly mention one other complication of the mathematics register. Unlike most other curriculum areas, the spoken language of mathematics "bears little resemblance to its written form … there is no one-one correspondence between the written and the oral" (Pirie, 1997, p. 229). Pirie provided the following example of how a particular mathematical meaning may be expressed along a continuum ranging from everyday language through to the equivalent symbolic representation.

Table 7.4: Example of a continuum of mathematical meaning expression

Common 'everyday' spoken forms		**Mathematically expressed spoken/ written form**	**Symbolic representation**
Four times three is twelve. ➔	Four threes are twelve. ➔	The product of three and four is twelve. ➔	3x4=12

(Adapted from Pirie, 1997, p. 229)

Halliday's characterisation of the mathematics register has been taken up in numerous subsequent articles dealing with the language of mathematics (see for example, Moschkovich, 2003; O'Halloran, 2005; 2010; Schleppegrell, 2007; 2011; 2012b; Temple & Doerr, 2012). As Schleppegrell (2007) noted, Halliday's articulation of the "notion of a mathematical register helps us understand the ways that language constructs mathematical knowledge in different ways than it constructs other academic subjects" (p. 140). The fact that such construction is more often than not *multimodal* (not just language, but symbols and images) is what makes for semantic complexity. O'Halloran (2015) observed that the Hallidayan notion of register is essentially a "*language-based* [italics added] conceptualization" (p. 64). She argued therefore for a strengthening of the notion of a '*multimodal register*' for mathematics to complement this conceptualisation.

65 In addition to technical vocabulary and dense noun phrases (which may or may not represent grammatical metaphor), there are other grammatical features characteristic of the mathematical register. See Schleppegrell (2007) for her discussion of these aspects.

One of the things that a Hallidayan *functional* approach to the study of language especially illuminates is the importance of matching linguistic choices according to context (that is, the intended purpose and audience). An appropriate mathematics register not only facilitates the kind of precision likely to enhances learners' meaning-making potential, it also provides opportunities for more effective alignment with the broader mathematical community, and thence participation in the more formalised ways of working in a mathematical context. From an SFL point of view, *context* is centrally important to determining what linguistic choices are most appropriate for expressing meaning in particular ways.

7.8 LANGUAGE IN CONTEXT

Halliday's SFL recognises three layers of context (often depicted in terms of what has been referred to as an 'onion diagram'). Meaning is realised - in a dialectical fashion - through all three of these contextual layers. In other words, every instance of meaning-making fits into all three layers simultaneously. The dialectic element here is that, in working together, each of these contextual layers simultaneously influences every other layer of context.

The text layer is created by and in turn creates the context of situation. Differently put, the context is visible *in* the text. So, for example, in the extracts from Ms M's fraction lesson in the previous section, the very fact that the text contains words such as 'fraction', 'one-eighth', 'denominator', suggests that what we have here is something to do with mathematics. The way it is Ms M's 'voice' that dominates the proceedings (it is she who is asking the questions; she who is demanding answers) suggests that this is a lesson text. But in the same way that the text suggests the context, so too does the context of situation largely pre-empt the text. Ms M is helping her learners towards using discipline-appropriate terms and she is directing proceedings in ways consistent with the ways in which lesson situations are most often construed: she creates a mathematics lesson through her choice of text, and she chooses to do it that way because of her perceptions about what constitutes a mathematics lesson.

And finally, it is possible to see how a particular context of culture creates and is in turn created and re-created by both the context of situation and by the text. The culture of teaching in many South African classrooms has for many decades tended towards largely teacher-driven, teacher-centred situations. As noted in the introductory chapter, it is only relatively recently that South Africa's curriculum documents have explicitly embraced more learner-centred teaching and learning theories. With reference to the saying 'Old habits die hard' it is possible to see in all of these layers a particular working out of particular ideologies (which in turn contribute to the construction of various ideological positionings). Hence, for example, the reform initiatives currently being attempted in South African curricula and classrooms have their roots in changed and changing ideologies about the style and purpose of teaching and learning. These ideologies are informed by both global and national developments. In the present instance, through NICLE, efforts are underway to assist primary mathematics teachers move away from teacher-led, behaviourist teaching/learning principles, towards more learner-centred, participatory - and hence, more democratic – principles, but many teachers find it hard to abandon their centrally controlling teaching styles in favour of allowing more freedom to their learners. I myself have experienced that as a teacher: it is much less challenging to one's sense of self-efficacy to keep a tight rein on lesson proceedings.

Figure 7.5, below, is the version of an 'onion diagram' I mapped out to help clarify these three layers of context relative to the present study. I illustrate each layer by reference to elements relevant to the study, located as it is within the broader South African educational context.

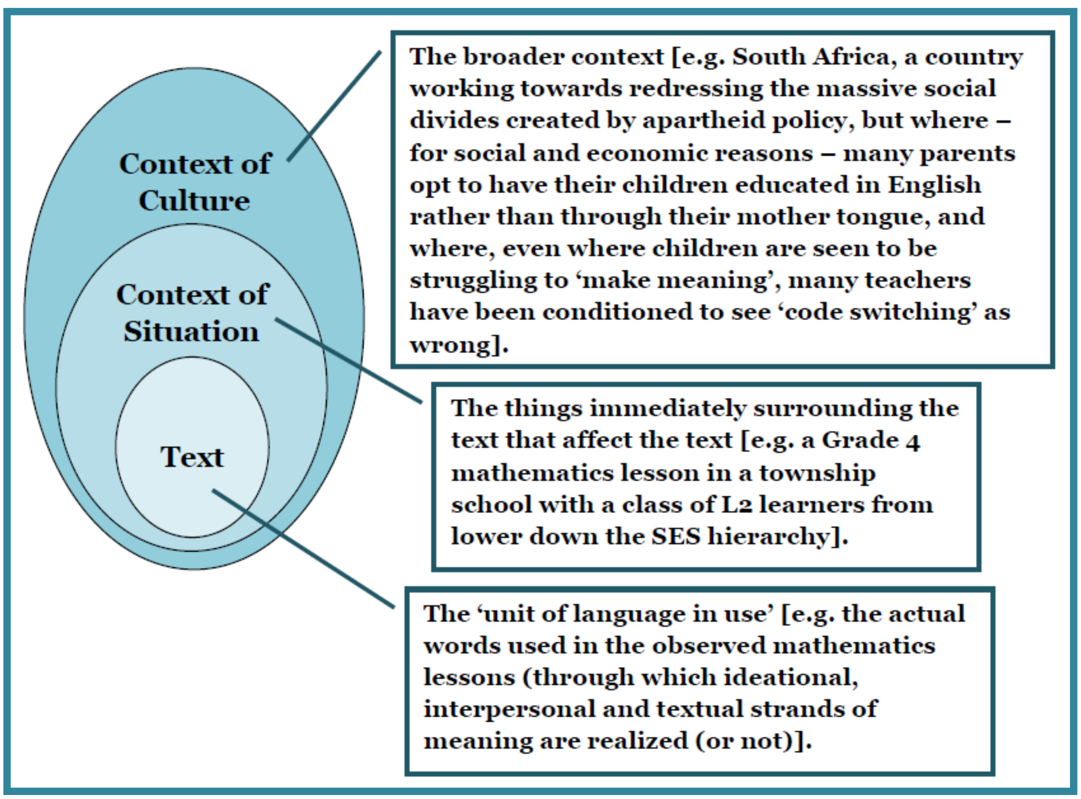


Figure 7.6: **The three layers of context**

In the final section of this chapter I focus on some of Halliday's work around the role language plays in construing (and thus constructing) learners' 'commonsense' and 'institutionalised' ways of knowing.

7.9 A "LANGUAGE-BASED THEORY OF LEARNING"[66]

Halliday's views on the links between language, learning, and social context are reminiscent of Vygotsky's views. Halliday argues that

> When children learn language, they are not simply engaging in one type of learning among many; rather, *they are learning the foundations of learning itself* [italics added]. The distinctive characteristic of human learning is that it is a process of making meaning - a semiotic process. (1993, p. 93)

Sounding particularly Vygotskian, Halliday closes this statement by noting that "the ontogenesis of language is at the same time the ontogenesis of learning" (1993, p. 93). Two decades previously, in a foreword he wrote for the second volume of *Class, codes and control* (Bernstein, 2003/1973), Halliday, commenting on findings from Bernstein's investigations into language use differentials across different social groups, noted that language "creates for some children a continuity of culture between home and school which it largely denies to others" (in Bernstein, 2003/1973, p. xiv). This finding, Halliday suggests, requires that we "think of language as meaning rather than of language as structure" (in Bernstein, 2003/1973, p. xv). Poignantly, he then observes that, "Every normal child has a fully functional linguistic system; the difficulty is reconciling one functional orientation with another" (in Bernstein, 2003/1973, p. xv).

My allusion to poignancy derives from watching Ms M's and Ms P's learners at play outside of lesson times. I mentioned this in my discussion of the distinction between BICS and CALP (Section 2.7). As noted, the children's lively, verbally-vibrant behaviours during these times stood in marked contrast to their verbal behaviours during the observed mathematics lessons. The 'fully functional linguistic system' displayed on the playground, albeit of a BICS order, threw into sharp relief their capacity to respond within the linguistically different 'functional orientation' of the classroom context. From L2 *and* CALP perspectives, these learners' communicational skills had been rendered more or less 'dysfunctional'.

66 I have taken this sub-heading directly from Halliday's 1993 paper ('Towards a Language-Based Theory of Learning').

Halliday ends his foreword to the Bernstein (2003/1973) text by suggesting that "the remedy … *may* lie, in part, in the broadening of the functional perspective – that of the school, as much as that of the individual pupil" (p. xv). Halliday's comment is consistent with an observation Bernstein himself made, namely that schooling systems are not always averse to pointing a finger of blame at presumed deficiencies in learners' social, cultural and/or economic backgrounds (1970). Bernstein noted that not only can this promote a stereotype of inferiority that suits the power base, but it can also deflect attention away from deficiencies in the system itself (and of society at large) and its failure to adequately cater for the needs of learners from diverse backgrounds (1970).

Part of the problems lies, as Halliday notes in a later article, in discontinuities between the "commonsense" learning of the home and the "institutionalized" learning of the school (1994a, p. 5). One factor at play here is that the former generally takes place orally, whereas much of the latter is realised via the written mode; but it also has to do with differences in the *nature* of these two forms of knowledge (Halliday, 1994a). Halliday identified four main points of difference between 'commonsense' and 'institutionalised' ways of construing experience. I have imported his points into table format below.

Table 7.5: Ways of construing experience: Commonsense versus institutionalised knowledge

Commonsense knowledge	**Institutionalised knowledge**
"fluid and indeterminate, without clear boundaries or precise definitions"	"determinate and systematic … organized into conceptual structures with defined properties and explicit interrelations"
"foregrounds processes: actions and events, including mental and verbal events"	"foregrounds things: persons and concrete objects, then later on increasingly abstract and virtual objects"
"typically construed as dialogue, and built up interactively, or "intersubjectively" by the … group"	"typically construed monologically, and built up by each individual"
"typically unconscious: we do not know what we know" [nor is there any formal assessment of commonsense knowledge]	"conscious knowledge … [which] can be rehearsed, and therefore monitored and assessed"

(Halliday, 1993, p. 6)

Halliday ends this 1993 article by noting:

> The prototypical resource for making meaning is language. Language also functions as the "signifier" for higher level systems of meaning … . In this perspective it seems appropriate that a general theory of learning, interpreted as

> “learning through language”, should be grounded in whatever is known about “learning language”. (p. 113)

Schleppegrell (2007) who, as the foregoing discussion should have made clear, is a staunch advocate of Halliday’s SFL, ended off *her* analysis of the linguistic challenges posed by the language of mathematics by writing “of course, the challenges of mathematics go beyond the language issues, but the linguistic challenges need to be addressed for students to be able to construct knowledge about mathematics in the ways that can ensure their success” (p. 156).

7.10 MOVING FORWARD

This chapter has dealt with Halliday’s contributions to our understanding of language in context. Against the backdrop of his scholastic ouvre, it is but the tip of the iceberg. Together with that of Vygotsky and Bernstein (discussed in chapters 5 and 6 respectively), we are helped towards a richer understanding of the centrality of language in ‘shaping’ the kinds of learning that take place, and - using Vygotsky’s, Bernstein’s, and Halliday’s ideas - are better able to articulate this understanding.

The penultimate part of this thesis (Part 5) moves into a more empirically-oriented analysis of how classroom talk is used within the mathematical teaching/ learning contexts in which Ms M and Ms P operate. The preceding chapters were seeded with some of the empirical data gathered from the observations of Ms P’s and Ms M’s Grade 4 mathematics lessons and from the interviews I held with them. In the next two chapters, I seek to align the classroom observation and interview data with insights from Chapter 2 (literature review) and from Chapters 4-7 (the framing theoretical lenses) to help me tell my story of Ms M’s and Ms P’s respective use of classroom talk, and of the ways in which aspects of this appear to either afford or constrain their learners’ mathematical progress. I emphasise again (as did Sfard and Prusak in relation to their analysis of immigrant Russian students’ mathematics) that I can only ever tell an incomplete story around the talk in Ms M’s and Ms P’s observed Grade 4 mathematics lessons. It is perforce *my* telling of the “story of [their] stories” (Sfard & Prusak, 2005, p. 20), not their telling.

Part 5: Analyses of classroom talk in the empirical field

SOME INTRODUCTORY COMMENTS

Illustrations from Ms M's and Ms P's Grade 4 mathematics teaching and learning contexts have been woven into the preceding parts of this thesis (Chapters 2, and 4 through 7) as I focused in on my first two research questions:

- Why is classroom talk seen to be so important relative to children's learning of mathematics, and what synergies between this and language/literacy development might there be?
- How might drawing on three different sources of theoretical insight (from Vygotsky, from Bernstein, and from Halliday) enhance our understandings of the crucial links between language and learning? In particular, what might they add to this case study exploration of teachers' use of classroom talk in support of their Grade 4 learners' learning of mathematics?

Through the analyses and narratives shared in the next two chapters I now introduce Ms M and Ms P more fully and coherently, and – in so doing - focus on the third and fourth of my research questions:

- What is the nature of talk in the observed Grade 4 mathematics lessons? How does such talk appear to mediate the learning of mathematics? In what ways do the teachers use their learners' emergent bilingualism as a resource for teaching and learning?
- What informs the participating teachers' classroom talk practices during their Grade 4 mathematics lessons? What do they identify as enabling/ constraining factors in relation to the oral interactions taking place during their mathematics lessons? What implications might these have for teachers working in similar contexts? And what implications might these have for issues of equity?

Discussions in the preceding chapters have argued that talk is integral to the learning process. A systemic functional model of linguistics views language as a 'resource for meaning', but the question then arises: "What 'meaning' is being made?" As Martin 1992) explained, a Hallidayan functional approach to linguistics seeks to "deconstruct" texts "in such a way as to draw attention to the semiotic systems they instantiate, with a view to critically evaluating the ideologies they construe" (p. 2). It involves looking at a text's metafunctions: the textual, the interpersonal, and the ideational (see Figure 7.2 in Chapter 7). As noted:

- The textual metafunction refers to the predominant *mode* through which meaning is being conveyed (in this instance, for both teachers predominantly through oral language).
- The interpersonal metafunction sets the *tenor* (the kind of interpersonal relationship/s implied to exist between the interactants). I observed, for example (Section 7.4 of the previous chapter), the quite different ways in which the two teachers generally addressed their learners, thereby presumably contributing to the overall tenor of their respective teacher/ learner relationships.
- The ideational metafunction is the *field* (the social activity type) that determines the communicational goals of exchanges between interactants (Eggins, 2004) (in this instance, the teaching and learning of Grade 4 mathematics).

Speakers constantly make choices, manipulating language to create different effects. In the next two chapters I show some of the ways in which the talk in Ms M's and Ms P's classrooms might have construed what it 'meant' to teach/ learn Grade 4 mathematics. I begin each chapter with brief recaps of some of the information shared about Ms M and Ms P in earlier sections. I add in other information not previously captured and then unpack some of the general characteristics of Ms M's and Ms P's respective use of classroom talk during the observed mathematics lessons.

Noting Nunan's observation that discourse can only ever be analysed "within the communicative context in which it occurs" (2013, p. 221), I contextualise my unpacking within the broader socio-economic and socio-political circumstances of which Ms M's and Ms P's classrooms are a part. As was shown in Figure 7.2 in the previous chapter, there can be considerable 'space' between overall linguistic 'potential', and the extent to which such potential is realised in particular instances of text. The actual text emerging is a function of both the 'context of situation' and, more broadly, the 'context of culture' (Halliday, 2007).

There are a number of ways to tackle classroom discourse analysis. I have chosen, for my analyses of the discourse in the observed mathematics lessons, to focus on two (interrelated) aspects:

- the overall patterns of verbal exchange in each teachers' classrooms; and then,
- Ms M's and Ms P's questioning patterns and the possible 'messages' their respective styles convey as to what constitutes mathematics learning.

In the context of analysing classrooms as communicative spaces, Sinclair and Coulthard (1975) are credited with first identifying the pervasiveness of IRF/IRE discourse sequences. It is their model of discourse analysis that I use in analysing the overall patterning of the talk taking place in Ms M's and Ms P's Grade 4 mathematics lessons. Having initially felt somewhat defensive about my decision to use this – seemingly dated – model, I noted the following comment from Michaels and O' Connor (2015):

> Close study of the IRE/IRF sequence has been and still is warranted: recent research has demonstrated that it continues to account for over two-thirds of teacher talk in most classrooms. (p. 349)

In analysing potential effects of Ms M's and Ms P's patterns of questioning, in addition to what is shown up through the Sinclair and Coulthard model, I apply a different, more question-oriented analytical strategy with a view to providing additional insights regarding the nature of talk in the observed lessons.

Three lessons for each teacher were selected for this detailed analysis. These were not necessarily the most interesting of the observed lessons. In choosing them I wanted to avoid any impression of having 'cherry-picked' lessons for analysis. For the exchange structure analyses, I used Ms M's first (Day 1) and last observed lessons (Day 10), and Ms P's third (Day 1) and sixteenth (Day 9) observed lessons[67]. In choosing these particular lessons I had in mind Simpson and Tuson's portrayal of observation as "the most intrusive" form of data collection (2003, p. 55). I thus thought it would be interesting to see whether there were any observable differences in the ways both teachers taught that might be put down to 'observer effect' at the beginnings and ends of the observation periods. In terms of the data from these lessons, I was not, however, able to detect evidence of difference (which does not, I acknowledge, allow me to claim its absence). I then took the seventh lesson for each teacher as a more or less mid-way point on which to base an analysis specifically of their respective questioning style. Transcriptions of all lessons are available in my Research Archive (see Appendix 5: Contents List: Data Archive).

In addition to the analyses of classroom discourse, I also identify and discuss some key themes I saw as emerging out of the observed teacher/ learner exchanges in both classrooms.

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67 Lesson 3 was on my first day of observation. The two preceding lessons were short (15 and 26 minutes respectively). Then Lesson 16 was the last *substantive* lesson of Ms P's that I sat in on. Lesson 17 was a shorter, repeat, version of Lesson 16. The children wrote tests on my final day of observation, and although I observed this process they cannot be labelled 'lessons' as such.

Finally, I present - in narrative style - the interview data from each teacher. The intention here is to respond to the sub-questions contained in my fourth research question: what it was that Ms M and Ms P identified as having influenced their classroom talk practices, and - in particular - what they saw as the enabling and constraining factors influencing this talk in the observed mathematics lessons. In opting for a narrative style, my goal is to foreground Ms M's and Ms P's voices, rather than my own. I augment this with 'evidence' of the mathematical learning that took place in their respective classrooms. This 'evidence' comes not simply from the various comments made to me by both teachers, but via the children's 2014 Mathematics ANA scores (as recorded in Table 1.1 of Section 1.9 of Chapter 1) and from SANCP's data base.

Because Ms M's chapter precedes that of Ms P, Ms M's is the longer of the two. Some of the groundwork on, for instance, Sinclair and Coulthard's exchange structure analysis method (see Section 8.3.1), and some generic discussion on questioning practices (see Section 8.3.4) is built into Ms M's chapter and then carried forward into the discussion in Ms P's chapter.

CHAPTER 8: Ms M's USE OF CLASSROOM TALK

> *Maths isn't only about numbers: add this, subtract this. There's lots of language involved. There's English language first of all: that is a challenge to these learners, and also the maths language itself. So, if one doesn't have English as a language and also the maths language ... there's no learning and teaching that is taking place.*
>
> (Ms M, 2014)

8.1 INTRODUCTION

I here briefly recap and expand upon some of the background information on Ms M and her school from earlier sections (notably Section 3.4: Setting and Participant Selection).

At the time of the observation period, Ms M had taught for seventeen years, ten of which had been at her present school. She was (and remains) in sole charge of her school's mathematics programme across Grades 4 to 6. Relative to many South African primary school teachers, she is well-qualified. As noted, she holds a four-year initial teacher education qualification (3+1), to which she subsequently added an Advanced Certificate: Education in Technology Education, and then a Bachelor of Education (Honours) degree, one-sixth of which comprised an elective course in Mathematics Education. Ms M does not have a post-secondary qualification in mathematics as such. She entered mathematics teaching through the Mathematics Education components of her various professional qualifications. In the first formal interview Ms M expressed a strong affinity for mathematics: "From college until my honours, I always did maths ... I like maths very much. That's what's my favourite subject." She then later explained, "I like working with numbers. Even now, if I could study maybe masters, definitely I will do maths. Definitely. I like working with numbers. ... and I want to give that interest to my learners" (Interview 1M, Lines 9-52).

Ms M had, from its inception, participated in SANCP's development programmes: as a regular member of its NICLE PD programme, and as a participant in the after school maths club sessions set up at her school for Grade 4 learners. This club was led by SANCP's Maths Club Coordinator, Dr Debbie Stott. Ms M participated as a 'learner', sitting alongside her learners, working as a member of a pair or group (depending on the task), and being invited from time to time, as were the children, to report back on whatever methods they had used in solving the various mathematical challenges included in the club activities.

The school serves children from relatively wealthier sectors of the township community and, as noted in Section 1.10, had recently re-classified itself as a Quintile 4 school. In consequence, it received less state support than was the case when it was a Quintile 3 school. The rationale behind the decision to seek re-classification was that this would increase the school's autonomy relative to the provincial Department of Education's administrative system.

8.2 Ms M's GRADE 4 MATHEMATICS CLASSES

Ms M had two Grade 4 classes in 2014: 34 and 31 learners respectively. According to her the learners were randomly assigned a class: "They were not put on merit or whatever – not even alphabetical order … not according to ability at all. That's what I was told when we were given the learners." (Interview 2M, Lines 11-13).

As was indicated in Table 1.1, the average percentage score on the Grade 4 ANA mathematics results for Ms M's 2014 cohort were low, though marginally above provincial and national averages (37.9% compared with 34.8% and 37% respectively). Although most of these learners scored less than 50% in the ANAs, a number of them did significantly better than this; three achieving a 70%+ score. Ms M's learners were also assessed as part of SANCP's monitoring and impact assessment. Grade 4 learners from its participating schools were orally assessed in May and August of each year. Given Ms M's school's 'straight for English' language policy, with English as the main LoLT right from Grade 1, her learners' SANCP's assessments were conducted in English. Amongst the instruments used was an adaptation of the instrument developed by Askew, Rhodes, Brown, Wiliam and Johnson (1997) which assesses learners' proficiency levels against Kilpatrick, Swafford and Findell's five strands of mathematical proficiency (National Research Council, 2001; see Figure 1.1 of introductory chapter). Table 8.1 below shows average scores for Ms M's learners for the 2011 and 2014 Grade 4 cohorts (2014 being the cohort I observed) on three of these five strands of mathematical proficiency. Pleasing improvements relative to each of the three strands across SANCP's intervention period are evident[68].

68 SANCP did also measure the other two strands (procedural fluency and productive disposition). See, for example, Graven and Heyd-Metzuyanim (2014) for their discussion around assessing productive disposition.

Table 8.1: Ms M's Grade 4 learners' average % scores on SANCP's mathematical proficiency assessments (2011+2014)

	Conceptual Understanding	Strategic Competence	Adaptive Reasoning
2011 cohort	29	15	20
2014 cohort	61	25	41
Change	+32	+10	+21

Data derived from SANCP Database

Because she did not have a dedicated mathematics teaching space, Ms M moved from one classroom to the next throughout each school day. Mathematics lessons for the two 2014 Grade 4 classes took place in their respective 'home' classrooms.

The layout for both Grade 4 classrooms was almost identical: four rows of two-seater learner desks, all facing towards the chalkboards; teacher desk in the front right-hand corner; windows down two sides of the room; some storage in the form of bookshelves and cupboards; and a pin-board along the mid-section of the back wall, as illustrated in Figure 8.1, below.

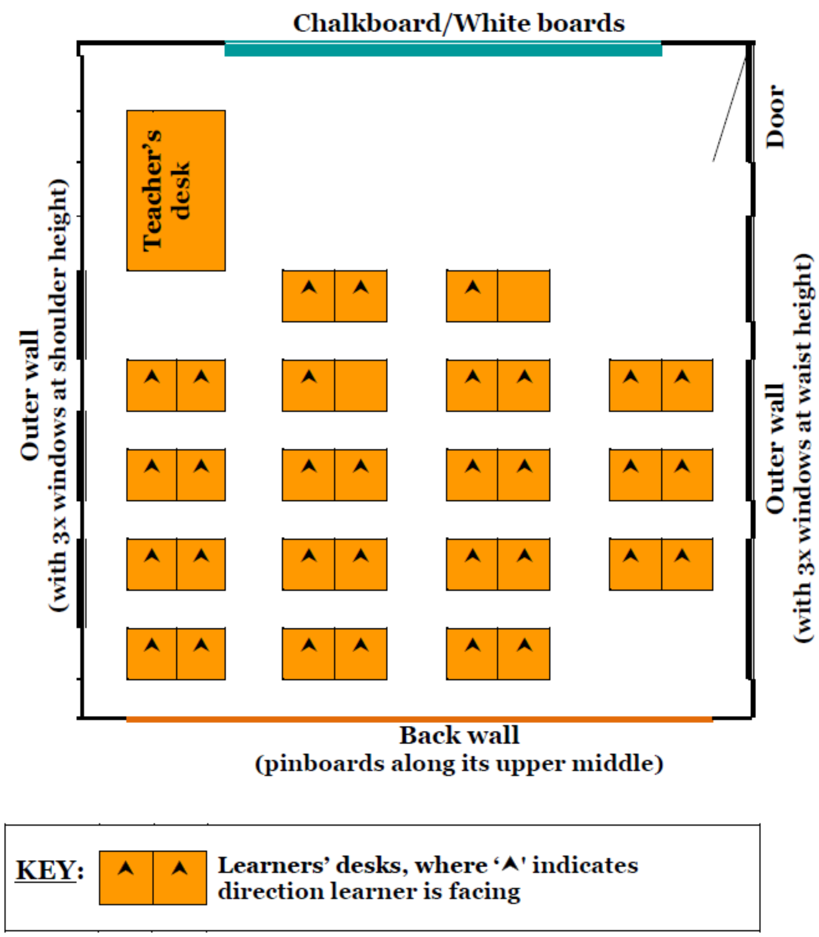


Figure 8.1: **Ms M's Grade 4 classroom layout**

Perhaps because they were not 'dedicated' classrooms, neither classroom was an especially 'print rich' setting, particularly as far as mathematics was concerned. In the one Grade 4 classroom there were some science and geography posters, but nothing in the way of mathematics.

Photo 8.1: Posters on display in the first Grade 4 classroom Ms M used

In the second classroom, there were two mathematics-related posters next to each other on the left-hand side of the pin-board (one of which being a fraction chart).

Photo 8.2: Mathematics-related posters on display in the second Grade 4 classroom Ms M used

The desk layout suggested an essentially teacher-centred approach. Given that Ms M did not have access to a dedicated mathematics classroom, this layout may not have been a reflection of her personal preference. That said, most of her observed lessons had either a whole class or individual-task focus, and discussion between peers was often discouraged. So, for instance, in the first of the lessons I observed, Ms M cautioned learners about working on their own:

> And you are doing your own work. No giraffes here. Neh? No giraffes. Long necks – they are all absent. You are doing your own work. Lunga – listen to what I have said. You are doing your own work. (Lesson 1M, Turn 216)

At the start of a subsequent lesson, Ms M had given the children a worksheet task to complete. They seemed to be struggling to settle down. She reproached them, saying:

> I don't see you working. I don't see you working. And you are working on your own. I didn't say this is pair work. I didn't say work with the person sitting next to you. You are doing all of this alone. And alone is alone. You ask the teacher, not the person sitting next to you. (Lesson 7M, Turn 1)

I observed 14 of Ms M's 2014 Grade 4 mathematics lessons, totalling about 11,5 hours. During the two-week observation period Ms M generally covered the same material for each class, either in the course of a day or across two days. The observation schedule is outlined in Table 8.2 below.

Table 8.2: Schedule of observed lessons (Ms M)

LESSON OBSERVATION SCHEDULE								
	Day		**Lesson**	**Time (mins)**	**Class**	**FOCUS**	**Record: Audio**	**Record: Video**
WEEK ONE	1	Monday	1	50	(1)	**Fractions** Parts of a whole Naming fraction parts (denominator/ numerator) Worksheet exercise: Fractions of a balloon Clarifying parts to whole.	✓	✓
			2	50	(2)	**Fractions** Mental math: counting in halves Parts of a whole Naming fraction parts (denominator/ numerator) Worksheet exercise: Fractions of a balloon	✓	✓
	2	Tuesday	3	50	(2)	**Working with number lines** Counting (in 11s/25s/15s/30s/20s/50s) along a number line The 'sums' of consecutive numbers **Fractions** Worksheet exercise: Filling in missing fractions on a number line Finding missing fractions; arranging fractions from smallest to biggest; identifying parts of a whole	✓	×
			4	45	(1)	**Working with number lines** Counting (in 1s/2s/11s/30s) on a number line	✓	×
	3	Wednesday	5	50	(2)	**Identifying place value** (thousands/ hundreds/ tens/ units)	✓	✓
			6	50	(1)	**Mental arithmetic - fractions – counting in halves/ thirds** **Filling in fractions on a number line; arranging fractions from smallest to biggest**	✓	✓
	4	Thursday	7	60	(2)	**Number patterns** – counting in 3s; 1000s; 25s.	×	✓
	5	Friday	8	50	(1)	**Magic squares**	×	✓
Weekend								

LESSON OBSERVATION SCHEDULE								
	Day		Lesson	Time (mins)	Class	FOCUS	Record	
							Audio	Video
WEEK TWO	**6**	Monday	**9**	50	(1)	**Mental arithmetic – adding/ subtracting** **Place value** **Adding in 10s; 100s; 1000s**	✓	✓
			10	45	(2)	**Mental arithmetic – adding/ subtracting** **Place value** **Adding in 10s; 100s; 1000s**	✓	×
	7	Tuesday	**11**	50	(1)	**Mental arithmetic – number sense** (e.g. What can you tell me about 6?’)	✓	✓
	8	Wednesday	**12**	110	(2)	**Fractions** Fractions of children in the class (present/absent; boys/ girls); Fractions of collections (¼ of 20; 3/10 of 30; ½ of 20’ ¼ of 16; 5/8 of 24; 3/6 of 18; 2/9 of 27)	✓	✓
			13	50	(1)	**Fractions** Fractions of collections (¼ of 20; 1/3 of 12; 2/5 of 10); Fractions of children in the class (present/ absent; boys/ girls)	✓	✓
	9	Thursday	**No lessons. Learners writing tests.**					
	10	Friday	**14**	50	(2)	**Magic squares**	✓	✓

8.3 SOME OBSERVED VERBAL PATTERNS IN Ms M’s LESSONS

The fact of Ms M’s school’s ‘straight for English’ policy does not mean that her learners did not have opportunities to use their L1 (isiXhosa) as a resource (albeit that isiXhosa was, in terms of the school’s language policy, designated the learners’ ‘first *additional* language’). I however observed Ms M using isiXhosa only relatively rarely during my time in her Grade 4 classroom (this notwithstanding her interview comment below).

> **S-AR:** You’ve … said if you explain something in isiXhosa, then they can understand better.
>
> **Ms M:** Yes.
>
> **S-AR:** How often do you find you have to do that?
>
> **Ms M:** Mostly all the time.
>
> (Interview 1M, Lines 137-141)

This comment indicates that Ms M was aware of the value of using isiXhosa in mediating her learners’ mathematics understanding. The fact that I observed very little of her doing so could have been because she did not, in my presence, want to be observed breaking her school's English as LoLT protocol.

Ms M is a competent user of English. Her 2014 Grade 4s, however, gave scant evidence of proficiency in English. As the observation data reveal, most of them made only limited use of English in the observed mathematics lessons. In fact, in contrast to the verbal exuberance they displayed in isiXhosa on the school playground, in *formal* classroom proceedings they spoke very little in either L1 *or* L2. My unobtrusive audio- and video-recording set-up did not allow me to accurately capture a great deal of learners' peer-to-peer talk during lessons, but, from what I was able to observe, overwhelmingly the default between peers was that they spoke in isiXhosa. Much of this talk was 'off-task' chatter. In their 'public' verbal responses to Ms M during whole-class teaching, however, learners almost exclusively used English, which was – as is shown in the next nine sections - extremely limited in its extent.

8.3.1 EXCHANGE STRUCTURES

Sinclair and Coulthard's exchange structure analysis (1975; 1992) is well-suited for capturing more teacher-led types of lessons. Raine (2010) likened its analytical approach to a "litmus test" of how communicative a lesson is: "It is," he explained, "self-admittedly, ill-suited to [an analysis of] more communicative interactions" (p. 19). This, however, is precisely why I chose to use the Sinclair and Coulthard approach in analysing the observed Grade 4 mathematics lessons. I quickly became aware that Ms M was amongst the many teachers who - caught on the cusp of newer more learner-centred approaches - continue in the struggle to modify their customarily more teacher- centred teaching habits so as to more closely align these with the approaches advocated in various curriculum reform initiatives.

A long-time friend and colleague of Halliday, Sinclair described Halliday as having been "the most profound influence on my academic development" (2004, Dedication, unpaged). It was, he wrote, Halliday who taught him to "trust the text; … [speaking] very strongly for a focus on the [text of] spoken language", so inspiring Sinclair's lifelong interest in analysing the structure of spoken discourse (2004, Dedication, unpaged). Coulthard (1992) explained that *his* entry into the discourse analysis arena came via his interest in Bernstein's work on links between social class, language usage and educational outcomes. His initial studies in linguistics were under Halliday; his subsequent doctoral studies were supervised by Sinclair. Both Sinclair and Coulthard spent a good part of their academic lives working at the

University of Birmingham, hence frequent reference to their work as having emanated from 'The Birmingham Group'. Sinclair and Coulthard's work (1975; 1992) has been strongly influenced by that of both Bernstein and Halliday. In this sense, I see a particular appositeness in using their model of discourse analysis to analyse the talk that took place in Ms M's and Ms P's observed mathematics lessons.

For their analyses of lesson exchange structures, Sinclair and Coulthard (1992) drew on Halliday's idea of a hierarchically ordered 'rank scale'. They explained that "the basic assumption of a rank scale is that a unit at a given rank … is made up of one or more units of the rank below" (p. 2): act ➔ move ➔ exchange ➔ transaction ➔lesson.

The *lesson* is the highest (or largest) unit of discourse[69]. It comprises a series of *transactions*. Transactions – in turn – are made up of *exchanges*, which - in turn – are made up of *moves*. The three moves Sinclair and Coulthard identified as most typically combining to make up a classroom exchange are I+R+F: "*initiation* by the teacher, followed by a *response* from the pupil, followed by *feedback*, to the pupil's response from the teacher" [italics in the original] (1992, p. 3). A move consists of one or more *acts* serving various interactive functions. They eventually settled on seventeen such interactional acts (Coulthard, 1992). Figure 8.2 below maps Sinclair and Coulthard's system from the rank of exchange down.

69 Coulthard (1992) described their assigning the highest rank to the *lesson* as "an act of faith" (p. 123) insofar as the ultimate structure of a lesson is determined by many factors, both inside and outside of an individual teacher's control. As Sinclair and Coulthard noted, even where a teacher may have a well-defined lesson plan, "a variety of things can interfere in the working-out of the teacher's plan in actual discourse" (1992, p. 34).

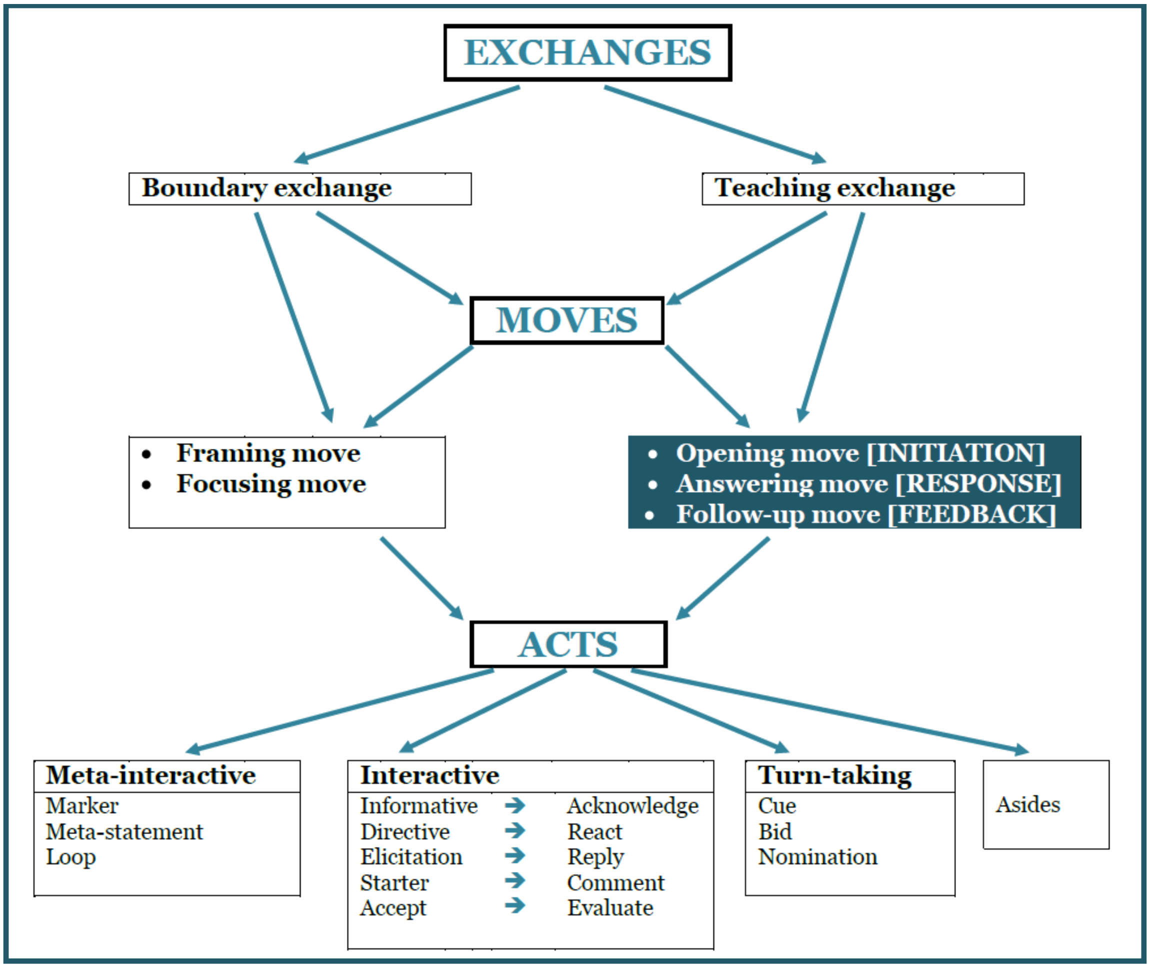


Figure 8.2: **Map of Sinclair and Coulthard's hierarchy of ranks from the rank of exchange down** (derived from Sinclair & Coulthard, 1992; Coulthard, 1992)

8.3.2 EXCHANGE STRUCTURES IN Ms M's OBSERVED LESSONS

As noted in the 'Introductory Comments' to this part of the thesis, I selected Lessons 1M and 14M for detailed exchange structure analysis. In Table 8.3 below I present the analysis of Lesson 1M's first two transactions, and the start of the third. In combination these represent 62 exchanges. As this five-page Table demonstrates, exchange structure analyses quickly become voluminous. Lesson 1M, for example comprised 429 exchanges in total; Lesson 14M 251 exchanges. (The full exchange analyses for both lessons are stored in my Research Archive. See Appendix 5: Contents List: Data Archive.)

The focus for Lesson 1M was 'Fractions', with Ms M initially foregrounding the everyday (the question of whether her Grade 4s favoured cake or pizza). Because all Initiation and Feedback Moves came from Ms M, and all of Response Moves from the learners, I have not provided labels 'T' or 'L' to individual utterances in the Table.

Table 8.3: Opening extract from analysis of exchange structures (Lesson 1M)

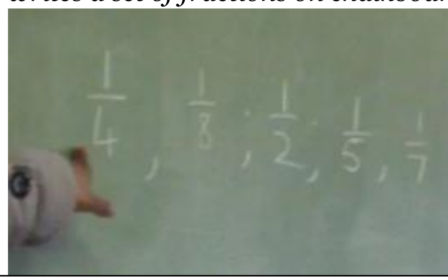
KEY:					
EN	=	Exchange Number	**S**	=	Social comment/ question
M	=	Management related	**NV**	=	Non-verbal response
D	=	Discipline related	**NR**	=	No response
C	=	Closed (display) question	^	=	Rising tone to cue learners in to providing an answer
O	=	Open (referential) question	~	=	Pause/ Uncompleted comment
P	=	Pedagogy related	**Coloured text**	=	Learners' chorused response

Lesson 1M		**MOVE**		**MOVE**		**MOVE**	
EN	**Exchange Type**	**[I] Initiation**	Act	**[R] Response**	Act	**[F] Feedback**	Act
1	**Boundary (1)**	Lonwabo, we have done fractions for quite a long, long, long time – last term.	Marker				
2	Informing	I'm not going to draw anything on the chalkboard.	Informative [P]				
3	Eliciting	But, if I'm saying to you that there's this cake, do you like cake?	Elicitation [S]	Yes ma'am.	Reply (individual)		
4	Eliciting	Who doesn't like cake? Who doesn't ~	Elicitation [S]	*Child pulls a face indicating he doesn't like cake.* [NV]	React (individual)		
5	Eliciting	You don't like it?	Elicitation [S]	No, ma'am.	Reply (individual)		
6	Eliciting	You like -? What do you like?	Elicitation [S]	Pizza, Ma'am.	Reply (individual)		
7	Eliciting	Which one do you like – pizza or cake?	Elicitation [S]	Pizza, Ma'am.	Reply (individual)		
8	Eliciting	Pizza? *[Teacher asks another child.]*	Elicitation [S]	Fish.	Reply (individual)		
9	Eliciting	You don't like pizza?	Elicitation [S]				
10	Informing	Because I'm saying pizza.	Informative [S]				
11	Eliciting	Pizza or cake, which one do you like? Pizza or cake, or none of them?	Elicitation [S]	Pie.	Reply (individual)		
12	Eliciting	Eh! She likes pie?	Elicitation [S]	Pizza, ma'am.	Reply (individual)		
13	Eliciting	Pizza?	Elicitation [S]	Both.	Reply	Both?	Evaluate

Lesson 1M		MOVE		MOVE		MOVE	
EN	**Exchange Type**	**[I] Initiation**	Act	**[R] Response**	Act	**[F] Feedback**	Act
					(individual)		
14	Eliciting	If you can be given, and then you are asked to take one, which one would you choose?	Elicitation [S]				
15	Informing	Because you can't take both. There's pizza. There's cake.	Informative [S]				
16	Eliciting	Which one would ~?	Elicitation [S]	Pizza.	Reply (individual)		
17	Eliciting	[Which one would] you choose, because you can't take both?	Elicitation [S]	Cake.	Reply (individual)	Cake.	Accept
18	Eliciting	Nyaniso?	Elicitation [S]	Pizza, ma'am.	Reply (individual)	Pizza.	Accept
19	Eliciting	Phumla?	Elicitation [S]	None.	Reply (individual)		
20	Eliciting	You don't know what you like?	Elicitation [S]	KFC	Reply (individual)	This one likes chicken!	Accept
				Laughter	**React (group)**		
21	Eliciting	You like the KFC one? You don't like Steers' ones, or Nandos' ones?	Elicitation [S]	***Laughter + suggestions***	**React (group)**		
22	Informing	I'm talking to Phumla. There are so many Phumlas in this class!	Informative [M]	***Laughter***	**React (group)**		
23	Eliciting	Bhutana? Which one?	Elicitation [S]	None.	Reply (individual)	None of them.	Accept
24	Eliciting	Okay, Lonwabo, if I have – which one would you choose? Cake?	Elicitation [S]	[*inaudible*]	Reply (individual)		
25	**Boundary (2)**	Okay.	Marker				
26	Eliciting	*[Teacher writes ¼ on chalkboard.]* What do you call this fraction first? Lonwabo?	Elicitation [C]	One-fourth.	Reply (individual)	One fourth	Accept
27	Eliciting	or -?	Elicitation [C]	**One quarter.**	**Reply (in chorus)**		
28	Directing	Please! You raise your hand. One person at a time. One quarter.	Directive [M]				
29	Eliciting	And then, Anathi, this one – what do you call this one? *[Teacher writes 1/8 on chalkboard.]*	Elicitation [C]	One-eighth.	Reply (individual)	One-eighth.	Accept
30	Eliciting	And then, Lonwabo, Ms M is saying, "Lonwabo, would you rather have a quarter of a cake?" You tell Miss M that you like	Elicitation [O+C]	Quarter	Reply (individual)	A quarter.	Accept

Lesson 1M		MOVE		MOVE		MOVE	
EN	**Exchange Type**	**[I] Initiation**	Act	**[R] Response**	Act	**[F] Feedback**	Act
		cake so much. Tell me - would you rather have a quarter of a cake or an eighth of a cake? And why? Which one?					
31	Eliciting	Why not an eighth?	Elicitation [O]	*Silence* [NR]			
32	Eliciting	Why not an eighth? Because you say you prefer to have a quarter not an eighth? Why? Why?	Elicitation [O]	*Silence* [NR]			
33	Eliciting	Why?	Elicitation [O]	*Silence* [NR]			
34	Directive	Bhutana – leave him alone. Don't tell him what he tells me, please. Leave him.	Directive [M]				
35	Eliciting	Which one?	Elicitation [O]	*Silence* [NR]		He does like to have a quarter, but he doesn't have an actual reason.	Evaluate
36	Eliciting	Thabiso – do you like cake or not?	Elicitation [C]	Yes, ma'am.	Reply (individual)		
37	Eliciting	You do?	Elicitation [C]	*Child nods.* [NV]	React (individual)		
38	Eliciting	Would you rather have a quarter of a cake or an eighth of a cake? A quarter of a cake ~ or an eighth?	Elicitation [C]	Quarter!	Reply (individual)		
39	Eliciting	Why?	Elicitation [O]	It's bigger.	Reply (individual)		
40	Informing	She says a quarter because a quarter is bigger.	Informative [P]	**Yoh!**	**React (group)**		
41	Informing	She says a quarter is bigger than an eighth.	Informative [P]	**Yes. Yes.**	**React (group)**		
42	Eliciting	Is it true?	Elicitation [C]	**Yes.**	**Reply (in chorus)**		
43	Eliciting	Really?	Elicitation [C]	**Yes.**	**Reply (in chorus)**		
44	Informing	Uh-huh? I'm not so sure. [*Teacher moves to the back of the classroom and draws children's attention to a fraction chart on the notice board there.*]	Informative [P]				
45	Directing	Ntando, come and show me here. Come and	Directive [P]	*Child points.*	React		

Lesson 1M		MOVE		MOVE		MOVE	
EN	**Exchange Type**	**[I] Initiation**	Act	**[R] Response**	Act	**[F] Feedback**	Act
		show me. Show me here which one is a quarter, which one is an eighth. Then we can agree now with Thabiso if we are choosing this one.		[NV]	(individual)		
46	Eliciting	What is that one?	Elicitation [C]	An eighth	Reply (individual)		
47	Eliciting	Where does it start? Where does it end?	Elicitation [C]	*Child points.* [NV]	React (individual)	Okay.	Accept
48	Eliciting	And then, where's your quarter?	Elicitation [C]				
49	Directing	Show me.	Directive [P]				
50	Eliciting	Where does it start? Where does it end?	Elicitation [C]	*Child points.* [NV]	React (individual)		
51	Eliciting	So Zintle, which one is bigger? A quarter? Or an eighth?	Elicitation [C]	A quarter.	Reply (individual)	*Ewe* (Yes). A quarter.	Accept
52	Eliciting	Who told me Phumla doesn't like cake? Which one would you choose, Phumla? A quarter or an eighth?	Elicitation [S/C]	A quarter.	Reply (individual)		
53	Eliciting	A quarter? Why?	Elicitation [O]	Because it is bigger.	Reply (individual)		
54	Eliciting	Although you don't like a cake, but you still want a bigger slice of the cake?	Elicitation [S/O]	Yes.	Reply (individual)	Even though you don't like it? Okay! Yoh! Yoh!! Yoh!	Accept
55	Eliciting	Silumko, which one would you choose? A quarter or an eighth?	Elicitation [C]	A quarter.	Reply (individual)		
56	Eliciting	A quarter? Reason?	Elicitation [O]	Because the quarter is bigger than the eighth.	Reply (individual)	The quarter is bigger than the eighth.	Accept
57	Informing	Then it's easy, because you can see there is the fraction and you can see how big the quarter is, how big the eighth is. That's why sometimes when you bring those birthday cakes, it's difficult for me because you only bring one – those round cakes from Pick 'n Pay. Then I have to cut, cut, cut, cut, cut for how many learners? For 34	Informative [P/S]	**Yoh! Phew!**	**React (group)**		

Lesson 1M		MOVE		MOVE		MOVE	
EN	**Exchange Type**	**[I] Initiation**	Act	**[R] Response**	Act	**[F] Feedback**	Act
58	Informing	Yes! Because some of you bring only that one round cake. Then Miss M doesn't even know because you are many so each person is going to get ~ [*Teacher indicates a tiny 'pinch' [of cake] with her fingers.*]	Informative [S]	*Some learners finish Ms M's sentence:* **A piece.**	**Reply (group)**		
59	Informing	UhHm. Yes! Because you are many.	Informative [S]				
60	**Boundary (3)**	Okay.	Marker				
61	Informing	I'm going to add 3 more fractions. [*Teacher writes a set of fractions on chalkboard*] 	Informative [P]				
62	Eliciting	Okay. Aphiwe, what's the first fraction? Aphiwe! The first one?	Elicitation [C]	Quarter	Reply (individual)	A quarter	Accept

In tallying the chorused responses in the lesson extract above, I noticed there were almost no chorused responses to Ms M's open-ended social-type questions, and, where chorused responses begin (from Exchange 20), many are everyday social reactions: laughter or expressions of surprise (Yoh!). The exceptions to these are:

Exchange 27: [one-fourth] or-? ➔ One quarter.
Exchange 41: She says a quarter is bigger than a eighth. ➔ Yes. Yes.
Exchange 42: Is it true? ➔ Yes.
Exchange 43: Really? ➔Yes.
Exchange 58: [re dividing a cake for 34 learners] ... because you are many, so each person is going to get ~ ➔ A piece.

In each of these instances, though, the level of cognitive demand in the exchange is low.

What the full exchange-type analysis provides evidence of in Lesson 1M was the extent of the dominance of Ms M's voice and the relative paucity of contributions from learners. Learner responses were generally limited: either brief (one or two word) answers to Ms M's questions, or chorused (equally brief), formulaic responses.

The lesson's first 24 moves are all in the everyday as Ms M quizzes the children on their preference (cake or pizza). The actual lesson focus 'Fractions' is then formally pursued. It starts with checking the naming of the symbolic representations of the fractions a 'quarter' (¼) and an 'eighth' (1/8) (Exchanges 26-29). The question as to the relative sizes of these two fractions is then introduced: "And then, Lonwabo, Ms M is saying, "Lonwabo, would you rather have a quarter of a cake?" You tell Miss M that you like cake so much. Tell me - would you rather have a quarter of a cake or an eighth of a cake? And why? Which one?" (Exchange 30). The learners' responses above appear formulaic in nature: 'Yes, ma'am'; 'No, ma'am'; or - with some exceptions (for example, 'fish', 'pie' and 'KFC') - repeating the preferences Ms M had on offer ('pizza' or 'cake'). Far from being a sign of linguistic deficit, however, such formulaic chunks, as Wood (2002) noted, could be construed as "basic to language development, processing, production, and learning" (p. 2), most particularly in L2 contexts. By "lightening the attentional and processing burdens of construction of utterances", formulaic language facilitates "fast and fluid communication" (Wood, 2002, p. 7). Certainly in this lesson, it enabled Ms M to get her Grade 4s off to an interactive and well-paced start.

Setting a brisk pace needs, however, to be off-set by an awareness of the importance of 'wait time'. Wait time, has - as noted by O'Connor and Anderson (2009) (see Section 2.3.5) and others (for example, Riley, 1986; Tobin, 1987; Black & Wiliam, 2010/1998) - been consistently identified as an important element in teaching. Dadds (2001) writing of a trend in Britain towards what she termed "the `hurry along curriculum' ... in which `coverage' has become a more dominant planning and teaching issue for teachers than learning" (p. 49), observed that, "when teachers slow down their response time ... benefits begin to emerge. Children who are slower to respond begin to participate more effectively. Teachers' questions and responses become more thoughtful and responsive, as do the children's" (p. 50). The particularly important aspect of wait time is the message it conveys, namely that time spent carefully reflecting before speaking is an important part of meaningful participation in learning. Chapin, O'Connor and Anderson (2009) observed that "if we do not use wait time consistently and patiently, [learners may] give up and fail to participate" (2009, p. 18). Ms M did not always fully exploit the value of wait time. In fact, in some of her observed lessons - perhaps in her drive to push the pace –she sometimes even answered her own questions before her Grade 4s had fully had the chance of doing so. In my experience it is not necessarily so much that learners may 'give up' as that they 'suss out' a teacher, and come to know that if they do not answer, the teacher will eventually capitulate and answer for them. I cannot say whether Ms M acted as she did because she assumed her learners were not going to (for whatever reason) answer, or whether she was reluctant to allow – or felt she *could* not afford - a longer 'wait time'.

8.3.3 Ms M's GRADE 4s' OBSERVED VERBAL OUTPUT

The children's responses to Ms M's various 'informatives', 'directives' and 'elicitations' in Lesson 1M are captured below in Table 8.4. In the course of 50 minutes of teaching/ learning time, the short, often monosyllabic nature of learner contributions is marked. Highlighted in **bold** are the four exceptions to this pattern. Highlighted in **colour** are where learners responded in chorus. The four learner contributions breaking the short, frequently monosyllabic, and chorused pattern were:

Turn 82 [Exchange No. 53]: 'Because it is bigger' (4 words);
Turn 88 [Exchange No. 56]: 'Because the quarter is bigger than the eighth' (8 words);
Turn 104 [Exchange No. 83]: 'The 1's, ma'am, are the same' (6 words); and

Turn 143 [Exchange No. 115]: ‘Because it does not have the same number at the bottom’ (11 words).

All learner responses made were in direct response to Ms M’s prompting, with little evidence that children were engaging in what Barnes (1976) termed ‘exploratory talk’, even of a most elementary sort, not even in the above-listed longer responses. There were also no self-initiated verbal contributions from the Grade 4s, barring a couple of exclamations of, for example, surprise, or, of being impressed (*Phew!* and *Yoh!*), plus occasional laughter.

Table 8.4: Children’s responses (Lesson 1M)

NON-VERBAL				
Gestured responses: *child nods/ child points /child pulls a face/ laughter* No response: *silence*				
VERBAL				
A half	**F**	None	Seven	**Yes**
A little bit hard	**F**	**Not**	Seven	**Yes**
A number	**F**	Numerator	Seven	**Yes**
A piece	**F**	**Numerator**	Seven	**Yes**
A quarter	F	**Numerator**	Seven	**Yes**
A quarter	Fifteen	**One**	**Seven parts**	**Yes**
A quarter	Fifth	One	**Shaded**	**Yes**
A seventh	Fish	One over two	Shaded and	**Yes**
A whole number	Five	**One quarter**	unshaded	**Yes**
A whole number	**Fraction**	One-eighth	Six over three	**Yes**
An eighth	**Half**	One-fourth	**Teacher!**	**Yes**
Balloon talk	Half	**Phew!**	**Teacher!**	**Yes**
Because it does	Half	**Phew!**	**Teacher!**	**Yes**
not have the	Half	Pie	**Teacher!**	**Yes**
same number at	Half	Pizza	**Teacher!**	Yes
the bottom	Half, ma’am	Pizza, Ma’am	**Ten**	Yes
Because it is	**Homework**	Pizza, Ma’am	**Ten**	**Yes, ma’am**
bigger	It was easy	Pizza, ma’am	**The ones,**	**Yes, ma’am**
Because the	It’s a number,	Pizza, ma’am	**ma’am, are the**	**Yes, miss**
quarter is bigger	ma’am	Quarter	**same**	**Yes, miss**
than the eighth	It’s bigger	Quarter	**Third**	**Yoh!**
Both	KFC	Quarter	**Thirty four**	**Yoh!**
Both	**Nine**	**R**	Three	
Bottom	**Nine**	**R**	**Three**	
Cake	Nine	**R**	**Three**	
D	Nine	**R**	**Three**	
Demerits	**No**	**R**	**Three**	
Denominator	**No**	**R**	Two	
Denominator	**No**	**R**	Two	
Easy	No, ma’am	R	Two parts	
Eighth	Nominator	Rubber	**Two parts**	
English	None	**Seven**	Two-sevenths	
CHORUSED ‘READ-ALOUD’				
If these balloons could talk, they might say the words that are given in code at the bottom of the page To decode: Over each fraction in the code, write the letter of the balloon with that fraction shaded in (Turn 158).				

Data from Table 8.4 contribute to the next Table (8.5). What this Table reveals is an increase in the number of chorused as opposed to individual responses relative to that that emerged from the analysis of those first 62 exchanges captured in Table 8.3.

Table 8.5: Tally of learners' verbal contributions (Lesson 1M)

LEARNERS' RESPONSES	Tally
Individual responses (an 'answer' solicited by the teacher)	66
Chorused responses (i.e. an 'answer' that almost the entire class choruses)	73
Reactions (solicited or otherwise, including laughter)	14
TOTAL	**153**

I suggested in the previous section that, because the opening section of Lesson 1M operated mainly at the 'everyday', social level, there was less potential for chorused responses of 'school' (mathematical) text. Relative to the lesson as a whole, however, the 'individual' to 'chorused' ratio emerging from Table 8.5 data is 73:66 (slightly more chorused than individual responses). A higher incidence of chorused over individual responses is something other South African classroom research has noted. Hoadley (2012) observed this sort of "privileg[-ing of] the collective" (p. 198) in her observations of classroom interaction in working class schools in the Western Cape. Chick (1996) assigned the term 'safe-talk' to the collective chorusing he observed in a KwaZulu-Natal Grade 7 mathematics lesson. It was, he suggested, a means whereby teachers and learners were able to maintain dignity even in the absence of meaningful learning.

In contrast to often negative judgements of chorusing, research by Clarke, Xu and Wan (2013) suggested that inviting the "spoken rehearsal" of key mathematical terms and phrases can be positive. These, in a Bernsteinian sense (2000), could be seen as 'legitimate text', and – as such- may be seen as an important form of "scaffolding ... and/or acculturation" whereby, through guided participation, learners are afforded the opportunity to "speak mathematically" (p. 14). So, while none of Ms M's learners' verbal contributions were anything other than what might be termed 'recitational', echoes of previously heard 'mathematical scripts', and none could be considered original (in the sense of a novel, unexpected departure from pre-scripted mathematics classroom text), they could, taking Clarke, Xu and Wan's point, be seen as having merit relative both to the children's ongoing SLA and to their learning to speak mathematically.

In considering Halliday's cline of instantiation (Halliday & Matthiessen, 2004) in relation to the range of types of 'moves' and 'acts' listed in Figure 8.2, it is clear that the children's verbal contributions in the 'instance' were a long way from those that were potentially available for speaking mathematically. If, further, this is linked with Krashen and Terrell's stages of SLA (1995) (as outlined in Table 2.3 of the Literature Review chapter), it suggests that, in terms of their verbal contributions, Ms M's Grade 4s' levels of L2 proficiency sat somewhere along a continuum between Pre-production (silent, receptive) and Early Production (speech emergent) phases. Without taking into account the distinction Cummins makes between BICS and CALP (1979), the children's observed communication in their L2, after, in most cases, three and a half years of exposure to an L2 LoLT, must best be described as limited. Their L2 utterances are repeats of the teacher's phrases or expressions that they have heard before. They are not novel utterances, producing any form of new mathematical narrative (such as, for example, 'I see that that piece is smaller; 'I notice that the number at the bottom is bigger'). The question here would be, "What opportunities had Ms M's learners been afforded to practise this kind of novel, exploratory talk?" As Mercer and Littleton (2007) note, "many children may not appreciate the significance and educational importance of their talk with one another [or with the teacher] … They [may] assume that the implicit ground rules of the classroom are such that teachers want 'right answers', rather than discussion" (p. 67). Independently of any 'messages' Ms M may have conveyed about the forms of answer she required, use primarily of the learners' limited L2 further constrained any likelihood of their engaging in more dialogical and exploratory verbal interactions.

8.3.4 Ms M's OBSERVED VERBAL INPUTS

Turning to Ms M's observed verbal inputs I first illustrate in Table 8.6 examples of different sub-types of initiating exchange she used in Lesson 1.

Table 8.6: Examples of initiating exchange sub-types used (Lesson 1M)

EXCHANGE TYPE	EXAMPLE
Boundary markers	Now. Okay. Grade 4s what is going to happen now ~
Informing exchanges	
Disciplining objective [D]	You don't even write, Aphiwe. You are not listening.
Management objective [M]	I don't want to ask the same people again and again and again.
Pedagogical objective [P]	This one has 1, has 1, has 1, had 1, has 1.
Social objective [S]	Rock and roll. Hmm?
Directing exchanges	
Disciplining objective [D]	[*A child is fiddling with some plastic bottles near him*.] Leave those bottles there. Leave them. Leave them.
Management objective [M]	[*Several learners are calling out*.] Please! You raise your hand. One person at a time.
Pedagogical objective [P]	Ntando, come and show me here. Come and show me. Show me here which one is a quarter, which one is an eighth.
Eliciting exchanges	
Closed (display) question [C]	What do you call those 1s? What is the name that you call them? What do we call them?
Discipline question [D]	What is in your mouth Ayabonga? What is in your mouth, Ayabonga? Huh?
Management question [M]	[*A child cannot reach a number written on the chalkboard*.] Oh, is it high for you?
Open (referential) question [O]	Why do you say half of this? Reason?
Pedagogy question [P]	You see? And then you must also do what ^?
Social question [S]	But, if I'm saying to you that there's this cake, do you like cake?

In Table 8.7, below, I provide a breakdown of all of the initiating exchange types Ms M used in the first and fourteenth observed lessons. (Full lesson transcripts are stored in my Research Archive. See Appendix 5: Contents List: Data Archive.)

By far the biggest category in both lessons was Ms M's eliciting exchanges, all of which were questions. In the next section I focus on Ms M's use of questions. At this point, however, I note simply that - overwhelmingly - the questions she used were *closed*.

Table 8.7: Breakdown of exchange types (Lessons 1M + 14M)

	Exchange type	Tally	Sub-type	Sub-total
Lesson 1M	Boundary markers	12		12
	Informing exchanges	96	Management objective [M]	33
			Pedagogical objective [P]	50
			Disciplining objective [D]	10
			Social objective [S]	3
	Directing exchanges	92	Management objective [M]	33
			Pedagogical objective [P]	49
			Disciplining objective [D]	10
	Eliciting exchanges	225	Management question [M]	23
			Discipline question [D]	4
			Pedagogy question [P]	9
			Open (referential) question [O]	29
			Closed (display) question [C]	140
			Social question [S]	20
	SUB-TOTALS	**425**		425
Lesson 14M	Boundary markers	6		6
	Informing exchanges	88	Management objective [M]	34
			Pedagogical objective [P]	46
			Disciplining objective [D]	8
			Social objective [S]	-
	Directing exchanges	51	Management objective [M]	18
			Pedagogical objective [P]	28
			Disciplining objective [D]	5
	Eliciting exchanges	105	Management question [M]	20
			Discipline question [D]	5
			Pedagogy question [P]	12
			Open (referential) question [O]	9
			Closed (display) question [C]	58
			Social question [S]	1 (*child's Q*)
	Aside	1		1
	SUB-TOTALS	**251**		251
	TOTALS	**676**		**676**

The next Table (8.8) shows the breakdown of Ms M's utterances into categories: management; discipline; pedagogy; and then question type.

Table 8.8: Categorisation of exchange types (Lessons 1M + 14M)

CATEGORY		Tally			
		Lesson 1M		Lesson 14M	
Discipline-oriented comments/ questions		24	24	18	18
Managerial comments/ questions		89	**220**	72	**160**
Pedagogical comments/questions		108		86	
Social comments/ questions		23		2	
Qs	Open (referential)	29	**166**	9	**67**
	Closed (display)	140		58	

As Table 8.8 shows, the majority of Ms M's comments/ questions were of either a pedagogical or a classroom management sort, with some social banter added, mainly to help ground discussion in real world settings, such as her allusions to dividing up birthday cakes, pizzas, loaves of bread and so on. Closed, display-type questions predominated. Discipline came through as a minor issue in both lessons. Below is an extract from Lesson 14M showing one such instance. As previously, the shaded block indicates a chorused as opposed to individual response from learners. The **bold text** indicates Ms M's disciplining of one of her learners.

Turn	Learner/s	Ms M
132		Which numbers are together? Which numbers? Grade 4s? Okay. What are these numbers? [*Teacher points to the thousands*.]
133	Twenty one	
134		And these three numbers? [*Teacher points to the hundreds, tens and units*.]
	Four-hundred-and-ninety-two.	
135		[*Teacher breaks off to chide a learner*.] **Nocwaka is so busy. Nocwaka is very busy. She was sitting there. She was sitting here. Now she is sitting there. Why do you want to move around? Now you are suddenly sitting here. Do you want me to change you again?** Okay. So those who didn't get it, they must please. [*Teacher points to the magic square on the board*.] I want to see that on Monday. Having filled in all the numbers one to nine, and getting what ^? Fifteen. (Lesson 14M, Turns 132-135)

Across all lessons, in fact, there were relatively few occasions when Ms M had to caution a child for misbehaviour. Particularly impressive was the skilful way in which she would weave in a disciplinary comment without it significantly disturbing the pedagogical flow.

8.3.5 Ms M's QUESTIONING PATTERNS

Teachers use questions in two main ways: *either* to direct and control classroom discourse *or* to steer the development and refinement of their learners' thinking skills (Murray & Nhlapo, 2001). Good questioning is a powerful means of mediating learning through developing and refining learners' thinking. However, notwithstanding such power, research consistently shows that teachers tend to pitch their questions at fairly low-levels of cognitive demand (predominantly closed, display type questions) (Mercer, 1995, p. 28). Such questions foreground that which has *already* been taught over further *extensions* of learners' thinking and reasoning abilities.

The challenge of pitching questions in ways that extend learners' capacity for thinking and reasoning is inevitably compounded in L2 teaching and learning situations such as Ms M's. In relation to directing and controlling L2 classroom discourse, Wong Fillmore's investigations demonstrated the value of firm classroom management; traditional, teacher-fronted lessons; and clearly-boundaried and consistently-applied classroom routines for learners (not simply in terms of their SLA) (1985). Wong Fillmore's findings pointed to a potential symbiosis between classroom control and pedagogy: a consistent framework, with regular procedural patterns, she noted, made it easier for L2 learners "to detect the structural regularities of the language" (1985, p. 39). Routines free learners from having to attend to classroom basics, allowing them to then direct attention towards more cognitively-demanding aspects of classroom tasks. Key points emphasised by Wong Fillmore are that:

- Ideally, questions should elicit more than simply one-word answers;
- Questions are best directed towards specific learners rather than having learners compete to answer;
- Questions should match the proficiency levels of individual learners so as to lessen the anxiety of the weaker learner[70];
- It is helpful to repeat and/or reconfigure correct responses from learners, preferably embedding each correct response in a full sentence. (1985, pp. 41-42)

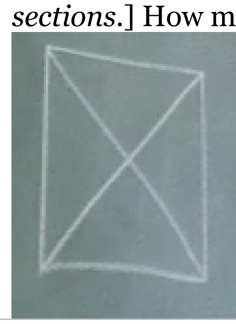
Teachers' questions also serve evaluative purposes, integral to mediating learners' cognition. They are perhaps *the* central mechanism for assessing, and thence advancing, learners'

70 This is consistent with Krashen's 'affective filter' hypothesis (2009).

thinking. Mehan (1979b) distinguished between *acknowledgement* question-answer IRF sequences and *evaluation* question-answer IRF sequences. *Acknowledgement-type* sequences are merely that – acknowledgements with minimal feedback to learners on how qualitatively close a particular response may have come to the desired one. Acknowledgement-type sequences, Mehan argued, do not significantly advance learners' thinking (1979b). I mentioned in the final paragraph of Section 8.3.1 Ms M's tendency to answer her own questions: something she did on thirteen occasions in Lesson 1M alone. This certainly served to short-circuit the advancement of learners' thinking, in much the same way as *acknowledgement* question-answer IRF sequences rather than *evaluation* question-answer IRF sequences might do.

In tallying up Ms M's acceptances relative to evaluations from the exchange analyses of Lessons 1M and 14M the ratio was 76:34. Ms M gave 76 'accept' feedbacks and 34 'evaluation' feedbacks. Many of her acknowledgements were achieved simply by directing the same question to another learner or by moving on to ask a different question. Explicit evaluations were rare. This echoes Westaway's finding (2017) regarding the relative rarity of either 'evaluation' or 'feedback' responses from the Foundation Phase mathematics teachers she observed in the course of her study with FP teachers in the Eastern Cape. It echoes also Hoadley and Muller's identification in their discussions around Bernsteinian sociology of "explicit evaluation" as a "critical" (though often absent) pedagogical mechanism for addressing educational inequalities across social class divisions (2010, p. 73). And, most recently, research evidence noted by Abdulhamid and Venkat (in press) pointed to "complete absences of evaluation at all of student offers" in some of South Africa's lower quintile primary mathematics classrooms (p. 1).

The following exchange sequence is interesting in that it contains just one direct acknowledgement from Ms M (Turn 84) which (through tone and emphasis, and the word 'yes') indicated to learners that she had at last got from them the answer she was after. Up until this turn, however, she repeatedly used the same question (in which evaluative feedback moves were implicit not explicit), trying to get learners to express the answer in the more precise terms *she* wanted. The exchange sequence shows how, having initially misread the reasons for their teacher's multiple reiterations of the question, one child *eventually* recognised (and realised) (after Bernstein, 2000) what it was that Ms M was wanting from him and his classmates. At the same time, however, it can be seen that many other learners had in fact *also* recognised and realised the correct answer (mathematically) albeit not with the *linguistic* 'answer-it-in-a-full-sentence' exactitude Ms M was requiring of them. Ms M's withholding of any acknowledgement that some of their offerings had in fact been *mathematically* correct clearly threw learners off the mathematical scent. It led them to make increasingly desperate guesses as they tried to give her the answer she sought. (Shaded blocks indicate chorused, as opposed to individualised, responses.)

Turn	**Move**	**Learner/s**	**Ms M**
67	**I**		How many quarters make one?
68	**R**	Three.	
69	**I/E**		How many quarters make one?
70	**R**	Four.	
71	**I/E**		How many quarters make one?
72	**R**	Four.	
73	**I/E**		How many quarters make one?
74	**R**	Four. Three.	
75	**I/E**		How many quarters make one?
76	**R**	Four	
77	**E/I/E**		Phew! How many quarters – nobody has said – how many quarters make one?
78	**R**	Four. Three. Four. [*Loud, elongated enunciation of 'four'*.] Four.	
79	**E/I**		Four? [*Teacher draws a square on the chalkboard, dividing it diagonally into four sections*.] How many parts are those? 
80	**R**	Four.	
81	**F**		They make what?
82	**R**	They make two. They make one. They make one. They make two.	
83	**R**	Four quarters.	
84	**E**		Four **quarters** make one, yes.

(Lesson 2M, Turns 67-84)

In linguistic terms, in answering Ms M's question 'How many quarters make one', learners early on correctly identified and responded to the *theme* of the question: 'How many quarters ...' (the *rheme* being '… make one') (after Halliday & Matthiessen, 2014, p. 88). Ms M's insistence that they answer her in a full sentence appears not to have been motivated by *mathematical sense-making* considerations, however. It seemed to be *pedagogically* (and perhaps also, *linguistically*) motivated. Few reading this will have forgotten their own teachers' insistence on the use of full sentences in responding to comprehension questions. One word answers, even where correct, could seldom pass unscathed.

Ms M's practice here speaks directly to Wong Fillmore's first and fourth bulleted points (1985), namely that, especially in the case of learners still in the process of acquiring their L2, questions should 'elicit more than simply one-word answers'; and, that ideally, 'correct response[s] [ought to be embedded] in a full sentence'. Notwithstanding its interruption of a natural flow of 'conversation' between teacher and learners, it may help learners towards greater mastery of more CALP-type written-*like* forms of response.

In everyday face-to-face BICS-type encounters, assuming the presence of the requisite paralinguistic cues, 'four' would have been a natural response to the question 'How many quarters make one?' How much more communicatively economical, and at no semantic cost, would it be to respond - as did many of Ms M's learners – "Four"? But what Ms M compelled (propelled, almost) learners towards, was making things completely explicit; to *include* in their answer, the redundant CALP-type information that 'quarters' were the unit at issue. Many of her learners struggled, however, to grasp w*hy* it was that Ms M kept insisting on a different answer to what many of them knew to be 'correct'.

It is possible that what Ms M was doing – consciously or unconsciously – was preparing learners for the formal types of written question they might encounter in, for example, a Mathematics ANA test situation. In this case, it would be interesting to know whether learners might have been better able to comply with her expectations, had she, at the outset, provided more explicit guidance on the *form* in which she wanted them to answer. She could have simply said, for example: "Thank you. 'Four' is correct, but now I want you to tell me four *what?*" I noted in the Bernstein chapter, Jorgensen's point about how important it is - especially for children from marginalised communities - that teachers do not take for granted that learners necessarily know what is expected of them. Making expectations "open and explicit" increases the likelihood of more learners being able to engage with a task (Jorgensen, 2013, p. 332-333).

Another thing Ms M may have had in mind was that repetition might benefit her young learners in SLA terms. As Murray and Nhlapo (2002) noted, teachers' questions contribute also to the SLA process. From an SLA perspective, then, Ms M's six repetitions of the question ('How many quarters make one?') *might* be seen to constitute also increased L2 input *and* some negotiation of meaning. I noted in Section 2.1.1 (Literature Review chapter) Krashen's arguments (1981; 1982; 2009) around the centrality of comprehensible *input* for SLA. I noted too interactionist theorists' tempering of this emphasis, and their argument that production of comprehensible *output* was equally important for SLA (Skehan, 2001; 2003; Swain, 1985). It is in this respect, Long (1983) argued, that teachers' questioning practices become especially important.

'Negotiation of comprehensible input' (or negotiation of meaning) Long saw as an essential bridge between 'input' and 'output', and thence ongoing SLA. "Noticing a problem 'pushes' the learner to modify his/her output" (Swain & Lapkin, 1995, p. 372), which is precisely what Ms M pressed her learners to do in the above exchange sequences. *Eventually* she succeeded in getting one learner to modify his output to match the more written-*like* form she wanted. Ongoing modification of L2 learners' output, it is argued, contributes to its becoming more comprehensible. This applies not simply from the perspective of enhancing learners' use of L2, but *also* mathematically. Such 'negotiation' implies both a dialectical and a dialogical type of exchange. It affords learners opportunities for refining both the linguistic and the mathematical precision of their output. The asking and answering of questions, then, is seen to be core to providing learners with such opportunities to produce output, however initially brief and/or inexpert their responses may be (and to receive a modicum of – albeit not especially 'explicit' – feedback on how closely they were coming to matching the required 'form').

What the use of Sinclair and Coulthard's exchange structure analysis in the analysis of two of Ms M's observed lessons revealed was that the biggest category of utterance was that of the teacher's '*eliciting* exchanges'; all of which took the form of questions. As to whether Ms M's questions were mostly of an 'open' (or referential) category, or of a 'closed' (display) type category, a ratio of 38:198 for Lessons 1 and 14 emerged from the analysis. Put differently, 16% (less than one-fifth) of Ms M's questions were open, most were closed. As Long and Sato (1983) explained, the distinction between a display question and an open, referential one is that the former seeks answers already known to the teacher and children therefore may be simply 'funnelled' towards providing the required response, whereas with the latter, a teacher is genuinely seeking information. As such, open questions carry the potential to “elicit … more communicative language use than do display questions” (Long, 2017, p. 6). In the next Table I provide examples of questions from Lessons 1 and 14 to which I assigned an ‘open’ (or referential) label.

Table 8.9: Examples of Ms M’s more ‘open-type’ questions (Lessons 1M + 14M)

	EXCHANGE	OPEN QUESTION
Lesson 1M	Exchange 30:	Would you rather have a quarter of a cake or an eighth of a cake? And why? Which one?
	Exchange 33:	Why not an eighth? Because you say you prefer to have a quarter not an eighth? Why? Why?
	Exchanges 41-43:	She says a quarter is bigger than an eighth. Is it true? Really? *
Lesson 14M	Exchanges 122-123	Is that one different to that one? Is it different? How is it different? [*Ms M was here referring to two learners’ magic squares: a row of 8+4+3=15, versus a column of 3+4+8=15*.] *
	Exchange 223-237:	How is yours different to that one? How? How? [*Ms M was here wanting learners to understand place value and to distinguish thousands from the hundreds, tens and units by writing 1 003 (rather than 1003, as they were doing up until that point)*.] *

* The ‘openness’ of these questions could probably be challenged.

It seemed that what Ms M was trying to do through the above questions was to push her learners to reflect more deeply mathematically, and not simply to produce a ‘display’ type response, but the children’s answers are anything but deep or extended.

Following up on the first two of Ms M’s ‘open’, referential questions in Table 8.9, and looking back at these in the context of the exchange structure analysis (Table 8.3: Exchanges 36 to 44), it became obvious that her “Why?” questions in fact provoked anything but complex and sustained outputs. They were met with silence. It was only as she then returned once more to a real-world context (Table 8.3: Exchange 36: “Thabiso – do you like cake or not?”) that she was able to elicit a response, albeit a brief: “Yes, ma’am”. (Shaded block(s) indicate chorused responses.)

EN[71]	TEACHER INITIATION	LEARNER RESPONSE
36	Thabiso – do you like cake or not?	Yes, ma'am.
37	You do?	*Child nods.*
38	Would you rather have a quarter of a cake or an eighth of a cake? A quarter of a cake ~ or an eighth?	Quarter.
39	Why?	It's bigger.
40	She says a quarter because a quarter is bigger.	Yoh!
41	She says a quarter is bigger than an eighth.	Yes. Yes.
42	Is it true?	Yes.
43	Really?	Yes.
44	Uh-huh? I'm not so sure. [*Teacher draws children's attention to the fraction chart on the notice board there.*]	(Lesson 2M, Exchanges 36-44)

My reading is that it was such brief responses from learners that forced Ms M to retreat into a 'safe-talk' zone (after Chick, 1996) of simpler, less cognitively demanding questions (e.g. 'Which one is bigger?'). Had Ms M perhaps herself modelled for her learners the kind of thinking-aloud that might facilitate the answering of 'Why' questions (for example: *Now, let me think for a moment, this cake ~ what if we had to share it with 8 people instead of four people? Would each person get a bigger or a smaller piece, I wonder? Hmmmm? Which would be bigger? One-eighth of the cake? Or one-quarter of the cake?)* this might have gradually better placed learners to respond in ways other than 'It's bigger' or 'Because it is bigger' (Lesson 1M, Turns 60 and 82 respectively). In the next section I discuss Ms M's modelling of metacognition. None of these examples, however, show her modelling *mathematical justification* (ways for tackling 'Why?' questions). Ms M herself acknowledged the difficulty her learners had in providing justification for answers: "Hayi! It's always difficult to give reasons, even for simple things" (Interview 2M, Line 458). Ms M was not observed modelling *mathematical generalisation* either. She did not use her 'Why?' questions to provoke chains of reasoning that might then have led learners towards a better grasp of generalised mathematical principles. There was only limited movement back and forth across the 'mode continuum' between 'everyday' BICS-type talk (the dividing up of a cake into more/ fewer pieces) and formal, 'academic' CALP-type talk. The CALP-type talk, however, was mainly of a 'naming of parts' order (for example, use of the word 'denominator' in place of 'the

71 EN = exchange number

number at the bottom'). Exploration of the generalised CALP-type mathematical principle that, in comparing unit fractions, 'the bigger the denominator, the smaller the fraction' never actually seemed to materialise. Ms M's focus, it seemed, was fixed mainly on guiding learners towards formal expressions of mathematical fact (e.g. 'A quarter is bigger than an eighth'). (See Robertson and Graven (under review) for further elaboration of this point. In this paper it was however noted that movement across the 'mode continuum' may have required higher levels of L2 proficiency than many of Ms M's learners appeared to have attained. In light of this, it was further hypothesised that greater use of the learners' L1 might have facilitated easier movement between BICS- and CALP-type discussion.)

An implication of Bloom et al's hierarchy of cognitive levels (1965) (see Figure 2.4 in the Literature Review chapter) is that the asking of higher-order questions is more likely to stimulate higher-order thinking. From an SLA perspective (and not Ms M's mathematics teaching/ learning perspective), Lantolf and Johnson argue, however, that rather than focusing on *question types*, there should be a focus on the "*mediational quality*" [italics added] of questions (2007, p. 888). Questions, they argue, have the power to act as "symbolic linguistic tools that semiotically mediate, assist and scaffold [the kinds of] mental activity" necessary for language learning (Lantolf & Johnson, 2007, p. 888).

With these sorts of issues in mind, I analysed some of the questions Ms M used in the seventh of her observed lessons (chosen, as noted, because it sits halfway between the first and last of her lessons). A copy of the full lesson transcript is in Appendix 6. My question analysis was based on a classification framework developed by Bellon, Bellon and Blank (1992). Although that dates back almost twenty-five years, the appeal of this framework is its clear diagrammatic representation of the multiple purposes teachers' questions serve (see Figure 8.3, below). Bellon et al. assigned these purposes to four categories: managing the classroom; instructing; encouraging participation; and assessing learning.

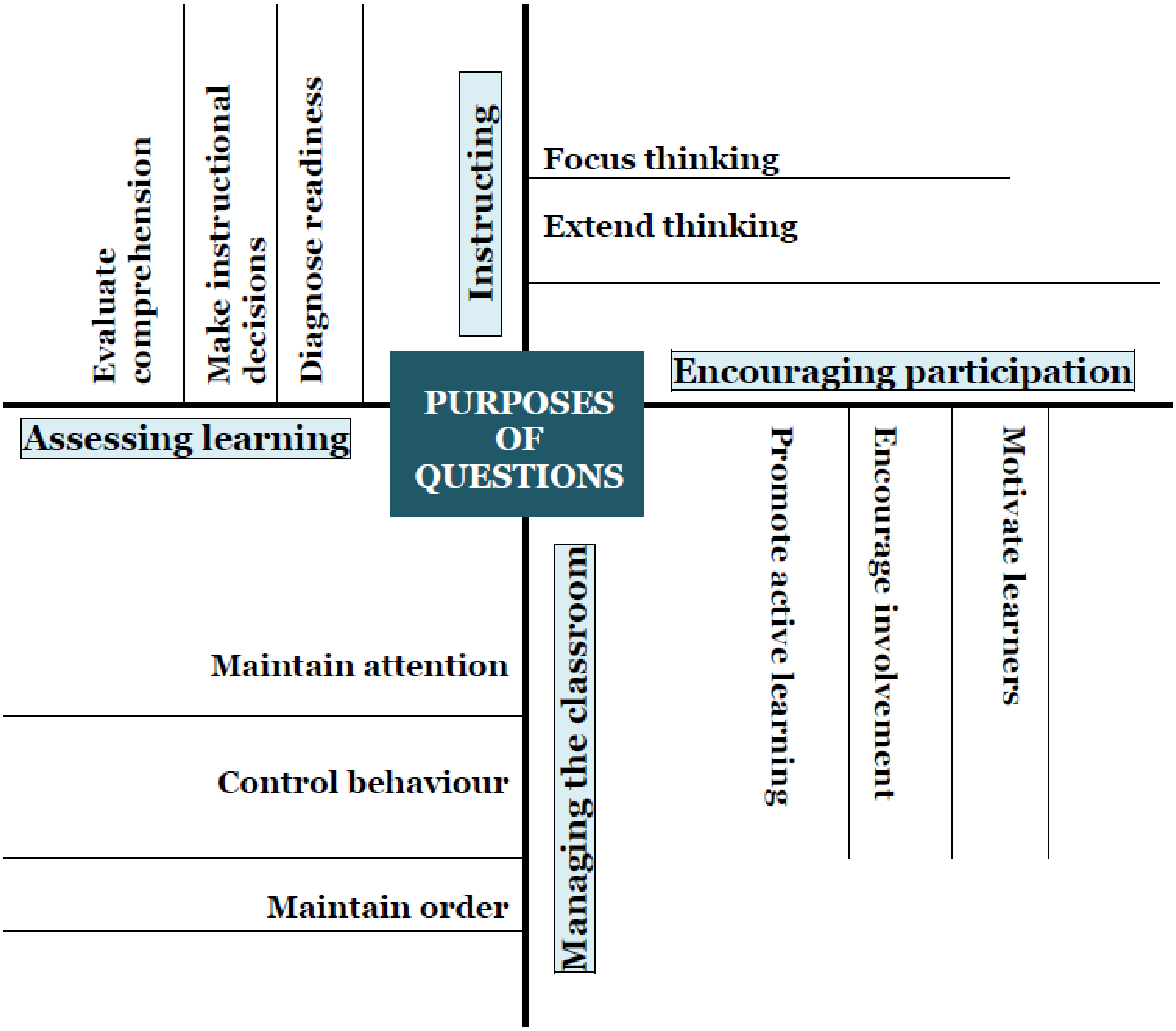


Figure 8.3: **Framework for categorizing the purposes of teachers' questions** (adapted from Bellon et al., 1992, p. 312)

In the next Table I provide my analysis of Ms M's Lesson 7 questions according to this framework. For each 'category /purpose' I provide representative examples of Ms M's questions. (I acknowledge, however, that I did not always find it a straightforward matter to assign a question to a particular category.)

Table 8.10: Analysis of Ms M's questions according to category and purpose (Lesson 7M) (after Bellon et al., 1992)

CATEGORY	PURPOSE	Question tally	% (rounded)	
Instruction	**To focus thinking** *What is the first number, Grade 4s?* (Turn 7)	**46**	**35**	**57**
	To extend thinking *So what you must do all the time? What must you do all the time to get the next number?* (Turn 23) *Why do you say so?* (Turn 59)	**30**	**23**	
Formative Assessment	**To evaluate comprehension** *You understand how does it work?* (Turn 3) *Is there anyone who doesn't see that?* (Turn 53)	**4**	**3**	**3**
	To make instructional decisions	**-**	**-**	
	To diagnose readiness	**-**	**-**	
Encouragement	**To promote active learning**	**-**	**-**	**20**
	To encourage involvement Achieved mainly through nominating individual learners: *Nombulelo, what is the first number?? And the next one? Fezile, the third one?* (Turns 25-29)	**27**	**20**	
	To motivate learners	**-**	**-**	
Management	**To maintain attention** *Are you done?* (Turn 7)	**1**	**1**	**20**
	To control behaviour *He's busy talking. ... Oh, so you understand everything, Anathi? So I must stop talking?* (Turn 25)	**8**	**6**	
	To maintain order *If I say, "Stick this in your book" what does it mean? I'm saying, "Stick this in your book." Then what does that mean?* (Turn 121)	**17**	**13**	
	TOTAL	**133**		

What Table 8.10 shows is that the least well-represented category of questions was in relation to formative assessment. Just four of Ms M's 133 questions (3%) fitted this category. Instruction-oriented questions, mostly requiring procedural recall, were the dominant category of question (57%). Of these, slightly more questions seemed to *focus* rather than *extend* learners' thinking.

When Ms M asked her Grade 4s a question, her communicational purpose seemed less about seeking information than to establish if a learner (or learners) knew the required answer to that question and could then provide it in the required form (for example, not 'four', but 'four quarters make one'). An over-representation of instruction-type questions relative to assessment-type questions aimed at mediating learners' thinking and sense-making is characteristic of 'transmission' rather than 'constructivist' views of knowledge. I earlier described Ms M as being amongst those teachers who are 'on the cusp of newer more learner-centred approaches': approaches which challenge positivist views of knowledge as a *fait accompli* and behaviourist strategies for inculcating said knowledge. The emphasis instead is increasingly on strategies for developing greater learner agency. Given the backlog in Ms M's Grade 4s' conceptual understanding and the undoubted barriers the L2 LoLT created, part of her challenge undoubtedly lay in knowing how best to relinquish at least some of the control (and responsibility) across to her learners. 'Modelling' provides a powerful mechanism for taking learners behind the scenes and showing them some 'tools' of *how* to think and *how* to make better personal sense of the concepts they encounter in the classroom. As I discuss in the next section, one such 'tool' increasingly being recognised as core to effective learning is metacognition.

8.3.6 Ms M's MODELLING OF METACOGNITION

I alluded in the Literature Review chapter (Section 2.4.1) to Ms M's modelling of metacognition in her classroom talk. I was surprised to learn - when I began reading more deeply about it - that the term 'metacognition', which the Collins Dictionary defines as "thinking about one's own mental processes", was such a comparatively new word[72]. Its "widespread prominence" (Moses & Baird, 1999, p. 533) in educational literature is attributed to Flavell (1979). Based on his and others' work on children's thinking, Flavell observed that "young children are quite limited in their knowledge and cognition about cognitive phenomena, or in their *metacognition* [italics in the original], and do relatively little monitoring of their own memory, comprehension, and other cognitive enterprises" (1979, p. 906).

My appreciation of the importance of metacognition came via literature on reading comprehension. Frequent reference is made here to the value of teaching young readers the sorts of self-regulating metacognitive strategies for monitoring their reading comprehension that would enable them to recognise and then address breakdowns in comprehension (Carrell, 1984). Konaré (1994) argued, however, that all too often the *product* of the reading act (comprehension) receives more teaching attention than does the actual *process* (comprehending); a view echoed by local literacy researchers, Pretorius and Machet (2004). In many of their research site schools they observed much stronger "reliance on the teaching

72 In fact, MSWord's 'spell-check' function does not seem yet to even recognise 'metacognition' as a 'legitimate' word!

of the more technical decoding skills of reading (i.e. learning the alphabetic principle and 'translating' written symbols into meaningful language)" with "far less attention given to reading for comprehension" (p. 47). And yet, as Griffith and Ruan (2008) explain, "modeling and teaching developmentally appropriate metacognitive skills to young children can greatly enhance their abilities to acquire early literacy [and numeracy] skills and empower them to become problem solvers and independent readers" (p. 10) [interpolation mine].

Schoenfeld (1992) was amongst the earliest to highlight the value of metacognition in relation to "learning to think mathematically" (p. 334). His work is cited in more recent discussions of metacognition in relation to mathematical problem solving research (for example, Goos, Galbraith & Renshaw, 2002; du Toit & Kotze, 2009; Schneider & Artelt, 2010). Schoenfeld described metacognition as a kind of 'umbrella term' to do with "*resource allocation* during cognitive activity and problem solving" [italics added]:

- resources for mentally "monitoring and assessing progress" in solving a mathematical problem;
- resources for then mentally *acting* on the feedback one receives from this process (Schoenfeld, 1992, pp. 354-355).

More recently, Sfard (2015), in critiquing some elements around the growing emphasis on classroom talk (or, as she termed it, the 'talking classroom'), cautioned against letting the value of "the inaudible self-dialogue" slip off the pedagogical radar: "No matter how much we interact with those around us, conversations with others will not produce learning unless interspersed with our quiet conversations with ourselves" (p. 254). While she did not in her critique use the term 'metacognition' the idea of 'inaudible self-dialogue' seems to me to come quite close. Reverting to Schoenfeld then, he made the point that developing the necessary self-regulatory skills to engage in effective metacognition requires "the "right" instructional context" and "appropriate kinds of modeling and guidance"; a "challenging and subtle" task for teachers to achieve (Schoenfeld, 1992, pp. 357-358). Reporting on successes in the teaching of metacognitive strategies, Moses and Baird (1999) note that these are most likely where "individuals are explicitly taught how a strategy works and the conditions under which to use it, and if they attribute performance gains to the strategy" (p. 534).

Bandura's work is frequently cited in discussions around *modelling* as an instructional strategy. "In the social learning system," he wrote, "*new patterns of behaviour can be* *acquired …. by observing the behaviour of others*" [italics added] (Bandura, 1971, p. 3)[73]. A form of metacognition I observed Ms M modelling was her voicing of her thought processes (often with the inclusion of embedded direct speech). The Table below contains examples of Ms M's 'think alouds'. Shaded blocks indicate those turns where she acted as a sort of ventriloquist, speaking *for* the learners, as compared with where she spoke directly *for herself* as a mathematical thinker.

Table 8.11: Examples of Ms M's modelling of metacognition

Lesson (Turn)	**Ms M's 'think-aloud'**
2 M (289)	Once you've tried to read, and, "Hey! What is here? I don't know what I've written. Something's wrong", go back to the fractions.
3 M (249)	The sum of two consecutive numbers is seven. I wonder? What are those numbers?
3 M (375)	What is the number that is missing? I see zero here, one quarter, two quarters. Then what is missing? Let me see. I can't see. What is the missing number?
7 M (25)	You don't just think of a number, "Okay, I think of four hundred. What if I add four hundred? I will just add four hundred." Why four hundred?
7 M (49)	You can continue with the pattern on and on and on without even, "Oh, what is eight times what ~? Yoh! What is it?"
7 M (55)	So you don't even think, "What shall I add? Oh, one hundred. Oh, one thousand." You don't even think about that because you can see.
12 M (15-17)	Now, you are telling me only one learner was absent, and in this class altogether you are … thirty one. And then, I wonder, what fraction is that? I wonder what fraction is that.

Bandura wrote that "a person cannot learn much by observation if he does not attend to, or recognise the essential features of the model's behavior … . Simply exposing persons to models does not in itself ensure that they will attend closely to them" (1971, p. 6). As I did not see Ms M ever *explicitly* drawing her learners' attention to what she intended to achieve through her 'think-alouds' I have no means of knowing whether any of the learners *noticed* her modelling.

73 Scrolling through the (quite idiosyncratically arranged) bibliography to Bandura's 1971 article I found no mention of Vygotsky, though one is instantly struck by similarities relative to Vygotsky's ideas around ZPD, and learning from more knowledgeable others. I am mindful that Bandura was writing at a time when Vygotsky's work had not yet fully reached the west. Also I have not consulted Bandura's more recent writings in which he may well have alluded to Vygotsky's influence on our understandings of learning and thought.

As briefly alluded to in the Halliday chapter (Section 7.4), Ms M sometimes chose to use the third person in referring to herself (and also at times to learners, also). (The examples I gave there were; "If you are done, Ms M will …" and "They say they are finished …".) Without making any definitive claim, I do wonder whether this might perhaps represent some oblique (perhaps entirely unconscious) form of metacognition: a modelling of what, for her, seemed a more legitimate, more formal, more objectified and more context- independent kind of text, detached as it was from the intimacy of a more personal 'you-'/ 'me-'/ 'us-' type pronoun usage. In the next section I give brief attention to how Ms M sometimes struggled to get her learners to operate in more mathematically-oriented and formal registers, obliging her to bring the 'everyday' into play.

8.3.7 Ms M's USE OF THE 'EVERYDAY' TO ACCESS THE 'SCIENTIFIC'

Bernstein (2000) drew attention to the struggle some learners may experience in relation to recognizing what sorts of things are appropriate in a given lesson situation. This he found to be particularly the case for children who come from working class homes where literacy practices may not have been especially foregrounded. This may then interrupt the pedagogical flow. In Lesson 1M, Ms M was observed drawing on her Grade 4 learners' everyday knowledge of cakes and pizzas as a kind of entrée to different fraction sizes of a whole. In Lesson 2M, Ms M used a metaphorical loaf of bread to mediate learners' attempts at counting in halves. As the following transcript shows, Ms M began the lesson in the mathematics register. When it seemed, however, that learners were unsure as to what it was she was asking of them, she invoked the familiar everyday image: 'half loaf of bread' (Turn 11, below) whereupon learners were able to progress. (As before, shaded block(s) indicate a chorused response. **Bold** highlights Ms M's grounding in the everyday.)

Turn	**Learner/s**	**Ms M**
3		Now, I want you – you are going to count in halves. What is the next number after ½? Half, Thandi?
4	Ten.	
5		No! Half, Aviwe?
6	¼	
7		Half, Aviwe?
8	One.	
9		A half, and then after the half, what number follows?
10	One.	
11		**Think of a loaf of bread, a half, and then one. And then from that half, I add a half again.**
12	One and a half.	

Turn	Learner/s	Ms M
13		One and a half! Every time you give me the right answer, what do you do? You sit down. One and a half. After one and a half, Phumla? [*And so on.*]
		[*And then later Ms M again invokes the everyday image of a half loaf of bread ...*]
131		... How many halves make one? How many halves make one? How many halves? How many halves? You have a loaf of bread, and then you cut this loaf of bread into halves. Now. How many halves are you going to get from that loaf?
132	Ma'am. Ma'am. [*Many learners want to answer.*]	
133		You go to the shop. You buy a loaf of bread. It may be brown. It can be wholewheat. It can be white. How many halves, Sinalo, are you going to get from that loaf?
134	Two halves.	
135		Two! So how many halves in a whole?
136	Two halves	
		(Lesson 2M, Turns 3-13)

Ms M's motive in re-introducing the bread image (Turns 131 through 133) is rather puzzling insofar as the children seem by then to have got the mathematical point. That said, she is not unique in using real world examples in this way in the teaching of fractions. I well remember my own teaching of fractions to my Grade 5 learners, and using the example of dividing up an apple into equal slices. Concern, however, has been expressed about doing this because it may for some learners complicate (or distract their attention *away* from) the scientific.

As noted in Chapter 6 (Section 6.5) "the special features which distinguish the context" (Bernstein, 2000, p. 17) are part of what he termed 'recognition rules' and these rules are not necessarily equally 'visible' to all learners. The work of Holland (a colleague of Bernstein's) highlighted distinct social class differences in children's potential to discern the school-linked recognition rules. Holland's research (1981) suggested that working-class children's capacity to classify food types tended mostly to rely on context-dependent principles and to draw on personal and particularistic meanings, linked to everyday use. By contrast, middle-class children generally displayed greater mental flexibility. They were able to recognise, and work with, both the everyday *and* with the more 'scientific', context-independent meanings privileged within a school context. (Research by Cooper (1998) and by Cooper and Dunne (1998) revealed similar findings.)

Heath's ethnographic studies across different social classes in America (1983) revealed similar differentials in children's capacity to tap into school-oriented recognition rules. Closer to home is Hoadley's case study (2005) across different primary schools in the Western Cape, which similarly revealed these sorts of differences. See also Hoadley and Muller (2009).

Counter-arguments in favour of ensuring greater continuity between everyday and school knowledge have, however, been raised to better accommodate children who struggle to differentiate between these two kinds of knowledge. Writing of the intersection of cultural knowledge and mathematics knowledge, Nasir, Hand and Taylor (2008) note the paradox whereby learners need to be able both to "challenge existing hierarchies of knowledge" and at the same time "be competitive in a system that relies on such hierarchies" (p. 228). Sfard (2016) – sparked in part by her work with Adler (see Adler & Sfard, 2017) – has questioned the impact 'imported' mathematical knowledge and practices may have on learners' capacity to engage meaningfully, rather than ritually in their mathematics learning. She highlights the importance of interrogating "divides that perpetuate (unintended) oppression" (2016, Slide 47 of 47). This is a paradox that Ms M certainly faces, albeit that her learners are currently operating at a much more junior level: certainly her learners engaged enthusiastically with their cake versus pizza preferences, but I am unsure whether this supported their subsequent engagement with more formal mathematical concepts, and the extent to which their development of CALP (Cummins, 1979) might have been compromised. More compromising perhaps was the fact that – in Ms M's view – many of her Grade 4s entered her mathematics classrooms conceptually unready to meet the demands of the Grade 4 mathematics curriculum. As I discuss in the next section, Ms M made frequent reference to these basics not having been sufficiently developed during these learners' FP years.

8.3.8 Ms M'S CHALLENGE IN (RE-)MEDIATING CONCEPTUAL BACKLOGS

In our discussions, both formal and informal, Ms M expressed concerns about how best to mediate Grade 4 curriculum coverage and pacing expectations with the need to respond to what she diagnosed as a lack of readiness in many learners for coping with such expectations. In both of our interviews she expressed the view that many children entering her Grade 4 mathematics classrooms were underprepared. Thus, in the first interview she remarked:

> The basics aren't there. … In Grade 4, I know that at least this, and this and this should have been covered in the Foundation Phase. But I find that it's not there.

> So it means that I have to go back to the Foundation Phase maths, and try to help them. … If I say they are in Grade 4, they should be knowing this and this and this … [but then] I can see they don't understand, I have to go back. (Interview 1M, Lines 167-175)

And then, in the second interview, ruing the slow pace at which she was able to move forward with her Grade 4s, she commented:

> I'm in the Grade 4 class [but] it's as though I am teaching to the Grade 2s. … You find that, I mean, one place, one exercise is done maybe over 2 days. Same exercise, simple exercise, not even a long one – a short one, is done over 2 days. I think I'm going nowhere. I'm doing nothing. Because I think how can I move on when they don't understand. Sometimes I think it's easy. But to them, it's not easy, and then you find that one or two learners have mastered it, and what do I do? Ow! I feel like I'm lost. I still have to find ways. What can I do? (Interview 2M, Lines 60-68)

In a sense then, in Bernsteinian terms (2004), it could perhaps be argued that it was the learners' mathematical conceptual backlogs that 'controlled' the pace rather than any proactive decision as such on Ms M's part to hand any pacing control over to the children.

Ms M's assessment of her Grade 4s mathematical proficiency levels mirrored with what was noted in the Introductory chapter (Section 1.10), namely that a majority of South Africa's mathematics learners, markedly those attending Quintile 1 to 4 schools, lag behind grade standard (Adler & Pillay, 2017; Schollar, 2008). Conceivably it was this that pressured Ms M towards a greater degree of teacher-fronted instruction at the expense of more learner-centred, but time-consuming ways of mediating (or *re*-mediating) her learners' existing levels of mathematical proficiency.

I alluded, in the Literature Review section on second language acquisition (Section 2.4.1), to an episode of Ms M's learners apparently 'playing' as opposed to 'doing' school. I included there an extract from her thirteenth lesson in which many learners were calling out random answers, answers which suggested they had little real sense of how to engage with the *mathematical* intent behind Ms M's questions. In further support of this conjecture, I now use data extracted from the sixth of Ms M's observed lessons. Ms M had started the lesson with getting the children to count in halves, which - after some initial confusion – they managed to do. Next she wanted them to count in thirds, her efforts towards which are shared in the following exchange sequence. (As previously, a shaded block indicates a chorused response.)

Turn	**Learner/s**	**Ms M**
87		We are still busy counting in fractions. Now you are going to tell me what fraction is missing. Because I'll be counting, so you are going to tell me. I will be counting in thirds. One third. Two thirds. One. One and one third. What's next? I said, "A third. Two thirds. One. And then one and one third." What's the next one? [*She points at a learner in the back of the classroom.*]
88	One and six.	
89		Hmmm? One and six? What's the next one? Phumla?
90	Three thirds.	
91		What's the next one? Sipho?
92	[*no response*]	
93		What's the next one? You didn't listen to me. What's the ~ Fezile.
94	Four.	
95		[*Moves to chalkboard.*] I said, "One third, two thirds, one, one and one third."
96	[*no response*]	
97		I'm writing now because you can't listen. [*Teacher writes the fractions*: [1/3, 2/3, 1, 1 [and] 1/3]. "I said, one third, two thirds, one, one and one third." I want the next one. I'm back here again. [*She indicates first row of desks.*] I'm back. Why is it always going to be Nandi who always has to give me an answer? Why? Hmm? Lonwabo?
98	Six.	
99		Six, Lonwabo?
100	Twenty-one.	
101		No. Pani?
102	[*Other children indicate they know the answer*: Yes, Miss! *but there is no response from Pani.*]	
103		Yoh! Siphokazi?
104	Two thirds.	
105		For the last time, same question. For the last time now. [*A number of learners have their hands up. Teacher asks one of them for the answer.*] Bulelani?
106	[*no response*]	
107		... Lindiwe?
108	One third.	
109		One third is there already. Hayi! [*'No' in isiXhosa.*] One third is there already. Hayi! [*'No' in isiXhosa.*] It's already there. No. Eh,
110	[*Many learners have their hands up, wanting to answer.*]	
111		Lungi?
112	[*no response*]	
113		Grade 4s, how many thirds make one? How many thirds? I'm asking anybody. How many thirds make one? I'm asking anybody.

Turn	Learner/s	Ms M
114	Three. Three. Three.	
115		How many thirds make one? Lungi?
116	Three.	
117		Three. So if we have three thirds, we have what? One.
118	One.	
119		This one is in place for how many thirds? For three thirds. Lungi?
120	Three thirds.	
121		And then one and one third, and then what? Do we have two already? No, it's one and one third what… Next. Back to this row. Mmm. Lungi?
122	One sixth.	
123		Yoh! We are still counting in thirds. Ahhh… Eh-heh,
	[*Many learners have their hands up, wanting to answer.*]	
		Siya?
124	Three thirds.	
125		Three thirds?
126	[*Many children have their hands up to answer.*]	
127		Thabiso?
128	Three six. [*Several others have their hands up to wanting to be noticed.*]	
129		Thirds. We are still counting in thirds. Fezile?
130	Three thirds.	
131		Yoh! Hayi! [*'No' in isiXhosa.*] One and one third. And, and ^~ two thirds. (Lesson 6M, Turns 87-131)

Looking at some of the stretches of text in this transcript extract in relation to some of Ms M's verbal input, I cannot but help wonder if some of the learners' apparently random responses might be put down to, for want of a better description, 'aural confusion'. To illustrate my point here I wish to refer to a part of a fraction worksheet I have copied and pasted into the next section. Part b. of the explanatory example on this worksheet lists a set of fractions in order from smallest to biggest reads as follows:

$\frac{1}{2}; \frac{2}{2}; \frac{3}{2}; \frac{4}{2}; \frac{5}{2}; \frac{6}{2}; \frac{7}{2}; \frac{8}{2}$

Visually, the semi-colons there very clearly mark the separation *between* each fraction. Like commas, semi-colons add 'breathing spaces' to sentences. They are, in fact, more accurately used to organise blocks of thought or logical groupings. Most people use commas [and/or semi-colons] to ensure that meaning is clear"[74]. With similar intent, in transcribing the aural text of this and all the other observed lessons, I have inserted a range of punctuation marks to group and separate words so as to help make the meaning clear for a reader. Below is a *repeat* of Turns 87 through 101, but without punctuation indicators (including capital letters indicating the start of a new sentence). I have highlighted in **bold** those sections that I regard as potentially aurally confusing (the main one being allusions here to 'one').

Turn	Learner/s	Ms M
87		we are still busy counting in fractions now you are going to tell me what fraction is missing because I'll be counting so you are going to tell me I will be counting in thirds **one third two thirds one one and one third** what's next I said **a third two thirds one and then one and one third what's the next one** [*she points at a learner in the back of the classroom*]
88	one and six	
89		hmmm **one and six what's the next one** Phumla
90	three thirds	
91		**what's the next one** Sipho
92	[*no response*]	
93		**what's the next one** you didn't listen to me what's the ~ Fezile
94	four	
95		[*moves to chalkboard*] I said **one third two thirds one one and one third**
96	[*no response*]	
97		I'm writing now because you can't listen [*teacher writes the fractions*: [1/3 2/3 1 1 [and] 1/3] **I said one third two thirds one one and one third I want the next one** I'm back here again [*she indicates first row of desks*] I'm back why is it always going to be Nandi who always has to give me an answer? Why, hmm? Lonwabo?
98	six	
99		Six, Lonwabo?
100	twenty-one	
101		No. Pani? (Lesson 6M, Turns 87-131)

Now, obviously Ms M's intonation, gestures, facial expressions, pauses would have *contributed* to making her input comprehensible, though, it is significant, I believe, that not one of the learner responses here suggests comprehension. Putting myself in the shoes of a listener with limited L2 proficiency, I asked myself how easily I would have found it trying to

74 Retrieved October 27, 2017, from http://www.ef.com/english-resources/english-grammar/comma/

make sense of the counting pattern Ms M was asking me to follow. Take for instance the following text (extracted from Turn 87):

> **one third two thirds one one and one third** … **a third two thirds one and then one and one third what's the next one**

What I might have heard would 'read':

> **1 third 2 thirds 1 1 and 1 third a third 2 thirds 1 and then 1 and 1 third what's the next 1**

It could be difficult, I suspect, to discern a pattern here were I insufficiently alert to the significance of the pauses between the groups of words. The *prosodic* patterns these pauses added to the meaning of the spoken L2 (assuming I was aware of them) would have helped me separate out appropriate 'chunks' of sound: (one third/ *pause*/ two thirds/ *pause*/ one and one third/ *pause*/ …). While a mathematical person would 'read' it as such without difficulty, there are no grounds for assuming that a non-mathematical person (or a Grade 4 L2 learner of limited mathematical and *L2* proficiency) would be similarly capable of doing so.

Turn 97 is the point where Ms M appears to have suspected her learners may have been experiencing precisely this sort of aural difficulty: "I'm writing now because you can't listen. [*She writes the fractions on the chalkboard*: [1/3, 2/3, 1, 1 [and] 1/3]. … ." But even after she has done this, the children continue to struggle to grasp the 'counting in thirds' pattern she was requiring from them. Their struggle to 'make meaning' of what Ms M was requiring of them gave rise to the following expression of her frustration:

> Grade 4s, you have been doing fractions since Term 2, now this is Term 3, and you are still busy with fractions. So, please, whatever we did last term, it's not that it's a new term then we should just forget: "Hayi [*'No' in isiXhosa*.] – it was for Term 2." No! It still continues to Term 3. We continue to Term 4. We still continue into Grade 5. It's not Grade 4, and then we are in Grade 5, and then have to forget about what we did in Grade 4. "Ah, no! We did it in Grade 3. I can't use Grade 3 work in Grade 4. Now we're having another phase in another grade." It doesn't work like that. It *doesn't* work like that. You have to understand whatever you learn, you build on to whatever. So there's nothing that we say, "This was for Term 1. Then we just forget. It has nothing to do with Term 2. Nothing to do with Term 3." [Lesson 6M, Turn 153]

Given it is unlikely that the children were consciously 'playing' rather than 'doing' school, the misunderstandings that came through in some of the learners' responses to Ms M's promptings point either to deficits in their underlying mathematical conceptual framework or to quite profound linguistic difficulty in *accessing* the requirements of the task, and, perhaps to both of these were at play. In this I am reminded of Wong Fillmore's citing (2007) of a 2005 comment made to her by Schoenfeld relative to an L2 learner's difficulties in mathematical sense-making: "You can't know what he knows mathematically unless he is given an opportunity to show it, which means being given problems whose statements he can understand" (p. 343). Accessing the requirements of a mathematical task might, as I suggest in the next subsection, be further compounded by a lack of working memory capacity to give the attention required for following through on Ms M's instructions.

8.3.9 A POTENTIALLY INCAPACITATING VERBAL OVERLOAD?

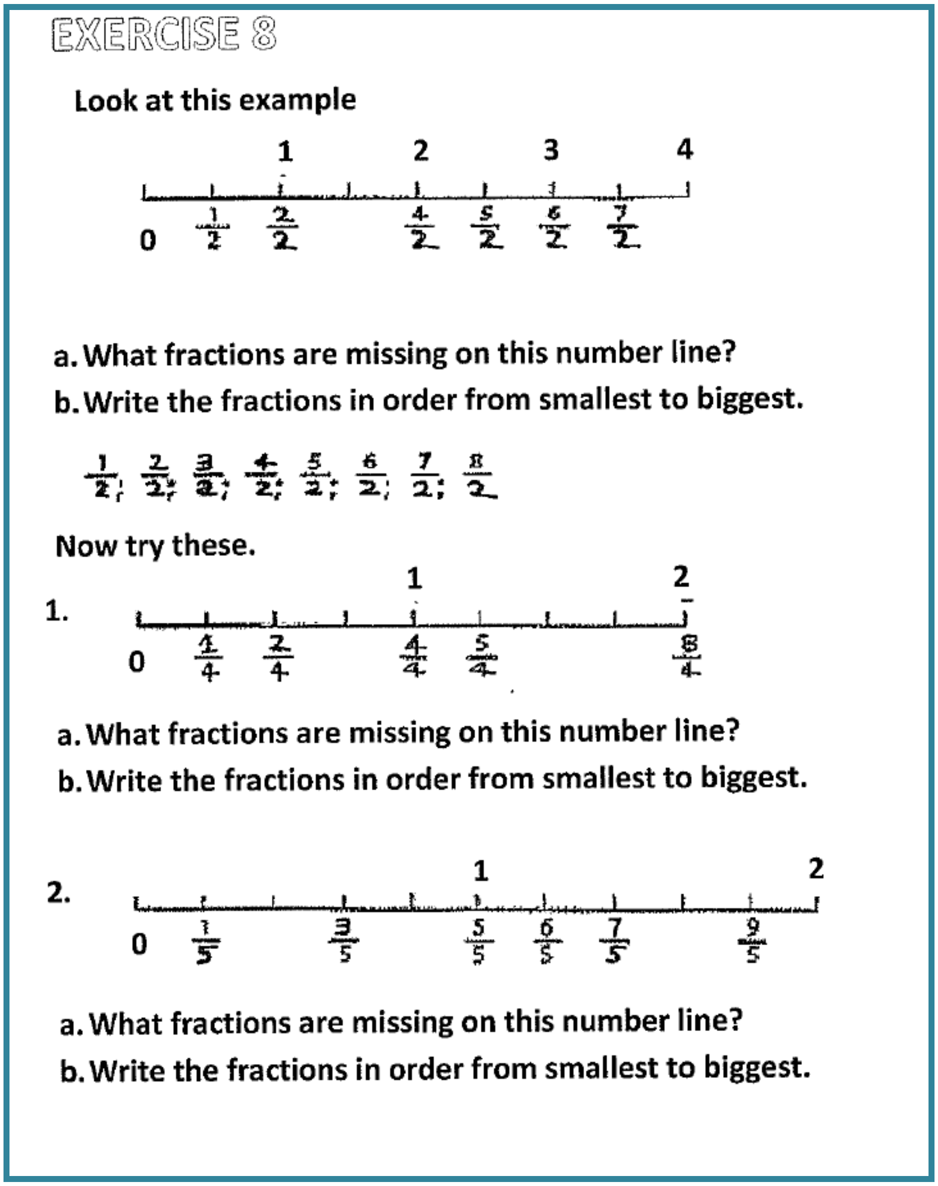
Much that was covered in the Literature Review chapter highlighted - in both the mathematics education literature and the language learning literature- the importance, of tempering teacher-centredness with opportunities for facilitating learner participation in sense-making processes: sense-making in terms of content; sense-making in terms of understanding teachers' instructions.

An important element in making sense of incoming information is 'working memory'. Baddeley (2003) described working memory as "a temporary storage system that underpins our capacity for thinking" (p. 203), and, in similar, but slightly different, and more recent, terms, Cowan (2014) referred to it as "the small amount of information that can be held … and used in the execution of cognitive tasks" (p. 197). Abadzi (2008) reporting on findings from cognitive neuroscience in relation to implications for definitions of literacy[75], noted that the "*functionally literate* are [those] who can decode a message within the limits of their working memory" [italics added] (p. 597). She was here writing of decoding written text. I contend, though, that 'decoding' of aural text is equally a challenge in the case - perhaps especially – of younger L2 learners.

That Ms M's learners were having to cognitively (and aurally) process not only the mathematics text but to do so also through an L2 in which they are far from having yet developed a great deal of automaticity, would inevitably have constituted a significant assault on the storage capacity of their working memories. I use the following excerpt from the sixth of Ms M's observed lessons to illuminate the scale of this verbal overload, and the unfortunate

75 Abadzi also wrote briefly of cognitive neuroscience finding's possible implications for definitions of functional numeracy, but noted that "neuro-cognitive research on numeracy is still underway, and there are (as yet) few clear [pragmatic] applications that schools can put to use" (2008, p. 598). Given the date of this publication, of course, I acknowledge this circumstance may have changed significantly, but I have not made an effort yet to track down any such new developments.

fall-out therefrom. The lesson focus was again on fractions. Halfway through the lesson Ms M had set her learners a work sheet task, the first part of which is copied and pasted in below.


EXERCISE 8

Look at this example

1 2 3 4

0 $\frac{1}{2}$ $\frac{2}{2}$ $\frac{4}{2}$ $\frac{5}{2}$ $\frac{6}{2}$ $\frac{7}{2}$

a. What fractions are missing on this number line?

b. Write the fractions in order from smallest to biggest.

$\frac{1}{2}$; $\frac{2}{2}$; $\frac{3}{2}$; $\frac{4}{2}$; $\frac{5}{2}$; $\frac{6}{2}$; $\frac{7}{2}$; $\frac{8}{2}$

Now try these.

1\. 1 2

0 $\frac{1}{4}$ $\frac{2}{4}$ $\frac{4}{4}$ $\frac{5}{4}$ $\frac{8}{4}$

a. What fractions are missing on this number line?

b. Write the fractions in order from smallest to biggest.

2\. 1 2

0 $\frac{1}{5}$ $\frac{3}{5}$ $\frac{5}{5}$ $\frac{6}{5}$ $\frac{7}{5}$ $\frac{9}{5}$

a. What fractions are missing on this number line?

b. Write the fractions in order from smallest to biggest.

Figure 8.4: **Worksheet extract (Lesson 6M)**

During seat-work, in which time Ms M would normally circulate, providing one-on-one monitoring and guidance (not all of which I captured), I observed that she spoke to individual learners mainly in English. My impression, however, was that overwhelmingly, learners exhibited reluctance to respond (in either English or isiXhosa). Their most extended (lesson-oriented) verbalisations were when – as she did on occasion - Ms M got them to read out loud the instructions from a textbook or worksheet task. Mostly, however, the learners said little in response to Ms M's one-on-one efforts at prompting.

In the transcript extract, below, Ms M had stopped to check the work of a learner seated in one of the front desks. Prior to this point, she had *repeatedly* told the Grade 4s to write the missing fraction/s *on the number line* and to write the fractions in order from biggest to smallest "*in your book* because that worksheet has not enough space" (Lesson M6, Turn 204). Her instructions do not seem to have got through to the child in the extract below.

Turn	**Learner**	**Ms M**
223		Something else must be done here. Something is missing here. What is missing? Did you arrange these fractions from smallest to biggest? Did you arrange these ones from smallest to biggest? Did you arrange these ones from smallest to biggest? [*Ms M breaks off to address the class*: Read the questions, Grade 4, please. Read the questions Grade 4s. ~ Please!] [*She turns her attention back to the child*.] It is here, or what ^? Did you arrange these fractions from smallest to biggest?
224	*[inaudible]*	
		1a. Read 1a.
225	*The learner reads:* 'What fractions are missing on the number line?'	
226		Did you answer that one? Did you answer that one? Hmm?
227	I must put it there.	
228		Did you answer that one? Did you answer that one? Really? What is this? [*Ms M points to the worksheet pasted in the child's exercise book*.] What did you think you were doing when you were doing this? Why did you decide to fill in the missing fractions here? [*Ms M again gestures to the child's exercise book*.] Did you read the question first? Or did you just decide to ~. Read this question to me. Why did you fill in the missing fractions here? Did you just decide, just fill them in just because there was a space? Hmm? It wasn't 'just …'. Read the question. [*Before the learner can do as she was told, Ms M continues speaking*.] Because what you have done here, you have answered what 1b? Hmm? You see? You see? Heyi! And then I said, b [Ms M again points to the worksheet.] Since there's not enough space here, you must do that where ^? Here! [*Ms M indicates the child's maths exercise book*.] And then you go to b. Read b. Read b now.
229	*The learner reads*: 'Write the fractions in order from smallest to biggest.'	
230		Okay. Which fractions ^? These ones. And then read 2a.
231	*The learner reads*: 'What fractions are missing on the number line?'	
232		Then you fill them in where ^? On the number line. You see?
233	*The child leans back*	

Turn	**Learner**	**Ms M**
	in her seat and nods at Ms M.	
234		And then you arrange them where ^? In your book. Because there is not enough space. I don't want untidy work. That's the reason for me. (Lesson 6M, Turns 223-234)

Looked at in isolation, it is clear from the extract that the child had neither fully grasped nor fully followed Ms M's instructions. Looking at the extract in its wider context, however, an enormous 'information-overload' (principally, but not exclusively, in terms of asides relating to classroom management) became apparent. To borrow Macdonald's waterfall metaphor (1990, 2002), many learners were at risk of being so awash in the torrent of Ms M's talk that the actual task instruction message got drowned out.

Ms M's expressed concern in Turn 234 perhaps warrants brief comment. It could suggest somewhat greater concern for neatness of presentation than for evidence of mathematical proficiency: "I don't want untidy work. That's the reason for me" (Lesson 6M, Turn 234). The focus of Ms M's feedback in the above IRF exchanges, it would seem, was more on the *form* (and placement) of the answers than on the mathematical concept at hand, that of ordering fractions, and the correctness of mathematical solutions. This replays the exchange sequence reported earlier (Section 8.3.4) where, even though learners correctly gave 'four' as the number of quarters making one, Ms M would not relent until they gave her the 'complete' form: 'four quarters make one'. What was being evaluated here had little to do with *mathematical* correctness. What seemed to be taking precedence was the production of legitimate form. In her defence it might be argued that she was hereby pushing learners to focus on explicit language usage rather than on mathematics as such, perhaps in preparation for the CALP-type formalisms of assessment (as per the way questions are phrased in, for example, the ANA mathematics papers).

8.3.10 POTENTIALLY LIMITING ONE-SIDED 'NEGOTIATION'?

In this final section of Section 8.3 I re-use the above lesson extract (6M, Turns 223-234), as well as an extract from Ms M's third observed lesson, to animate the idea: 'negotiation of meaning'. This phrase is encountered both in mathematics education and in language teaching literature. The only 'unique' verbal contribution the learner produced in the above lesson extract (albeit in direct response to Ms M's soliciting of it) was Turn 227: "I must put it there." The rest of her verbalisation comprised the child reading aloud – on command – the worksheet instructions. Ms M did the all of the rest of the talking, as she repeated instructions and questions.

Negotiation of meaning (or as Long (1980; 1983) initially phrased it, 'interactional modification'), that important mechanism in SLA whereby, through various means, input is made comprehensible (after Krashen, 2009), can take the form of, for example, clarification requests and comprehension checks. In SLA theory, however, learner - rather than teacher - negotiation is seen to be core. As Pica (1994) explained it, "learning of L2 structure *evolves out* [italics in the original] of communicative use" (p. 494). Three elements essential to SLA that Pica identified were that (a) learners have "comprehension of message meaning"; that (b) they have "opportunities to produce *comprehensible output* [italics in the original]"; and, that (c) they give "attention to L2 form" (1994, p. 501). These, in combination, facilitate not just SLA, but – more importantly for a non-language teacher in Ms M's position – improve comprehension and increase the likelihood of entering into a learner's (or learners') ZPD (Vygotsky, 1930; 1978; Meira & Lerman, 2009). Because Ms M is not a language teacher, but a mathematics teacher, her emphasis in the lesson extract above was on trying to make clear to the learner what *she* wanted her to understand, or do, or both. This she attempted through reiteration and rephrasing and questioning (frequently self-answered). While these verbal offerings might - at a stretch - be seen as indicative of a sort of negotiation of meaning, Ms M here acted as sole negotiator. It was not a verbal engagement so much as a stream of instruction. Ms M appeared not to be conscious of the importance of a two-way process in either *averting* or *repairing* breakdowns in communication. Further, the negotiation was not a negotiation of *mathematical* meaning. It was a negotiation of meaning in terms of what *she* (Ms M) saw as constituting appropriate (legitimate) *forms* of mathematical answer (again, perhaps, by way of preparing her learners for their language encounters on the ANA mathematics question paper).

Ms M's exchanges with this one learner were not unique. In other observed instances of her interactions (both one-on-one and whole-class) it appeared that the main difficulty she (and thus her learners) faced was that many of the children appeared not to have fully grasped what it was that they were supposed to be doing which brings me to the third of her observed lessons.

I included in the previous chapter (Section 7.7) some discussion arising from this third lesson. Ms M wanted her learners to remind her of the mathematical meaning of the word 'sum' in the context of 'the sum of two consecutive numbers'. I discussed Halliday's mathematics register category 'Using old words in new ways'. For Ms M's Grade 4s probably their 'old' of the word 'sum' would have been in terms of their 'doing maths sums'. Ms M now wanted them to apply another, probably newer (to them) meaning to the word. Her learners' answers demonstrated considerable initial uncertainty about this. (Shaded blocks indicate chorused learner responses.)

Turn	**Learner**	**Ms M**
247		*[Ms M had got the children to all stand up.]* Now – let me check. You only sit down when you give me the answers. Yebo? The sum – I want to check if you still remember this – the sum of 2 consecutive numbers ~
248	Yes, ma'am. *[Many children are eager to answer even though Ms M's question hasn't yet been completed!*]	
249		Is 7. I wonder - what are those numbers? Very easy.
250	Yo! Yo! Ma'am! Ma'am! *[Many learners are eager to catch MS M's attention.]*	
251		If you call me, I'm not going to call you. Ndega, the sum – u-sum – what do we do when we hear the word 'sum' – what do we do with the numbers? What do we do? You don't call me, Bukelwa. What do we do with the numbers?
252	Add.	
253	It will be a half.	
254		Really? Ayanda, what do you do with the numbers the minute you hear the word 'sum'? It means what must you do with the numbers?
255	You must make them whole.	
256		AhHah?
257	Make them whole.	
258		How can you make them whole? Give them less?
259	Ma'am! Ma'am!	
260		You must give them less, huh?
261	They must weigh the same.	
262		Weigh the same? How?
263	Ma'am! Ma'am! Yoh!	
264		Yoh, Yoh, Yoh! When you hear the word 'sum' what must be done with the numbers? What must we do with the numbers? (Lesson 3M, Turns 247-264)

Ms M's attempts at 'negotiating' what 'sum' meant eventually cued one learner into articulating the following (for Ms M) 'correct' action (namely, summation):

Turn	Learner	Ms M
265	You must make them follow each other, ma'am. [*The child, not irrationally, is here first honing in on the word 'consecutive', rather than 'sum'.*]	
266		Follow each other? Then what will you do with them?
267	Then you add them.	
268		Thank you! The minute you hear the word 'sum' what do you do with the numbers ^? We ~?
269	We add them.	
270		We add them. Nothing else. We add them. We add them. Nothing else. We add them. Now I'm saying the sum of 2 consecutive numbers is what? – is 7? So what do you do with the numbers to get 7? We add them.
271	We add them.	
272		But can we add any number that adds up to 7?
273	No.	
		(Lesson 3M, Turns 265-273)

Ms M is not unique in her effort here of trying to imprint 'key words'. Mathematics teachers across the world teach their learners to take cues from key words in problem solving. So widespread, in fact, is this practice that decorative 'Math Cue Words' classroom posters are commercially available, as witness the following sample. Using key words can, however, also sometimes be to the detriment of learners' mathematical sense-making. The struggle to make sense of the language of mathematics, to negotiate a problem's mathematical meaning (as in this instance, when Ms M wanted her learners find the *sum* of two consecutive numbers) could result in the teacher short circuiting the struggle by making recourse to a 'rule'. So, for example, Ms M had advised her Grade 4s to add "*the minute you hear the word 'sum'.*"

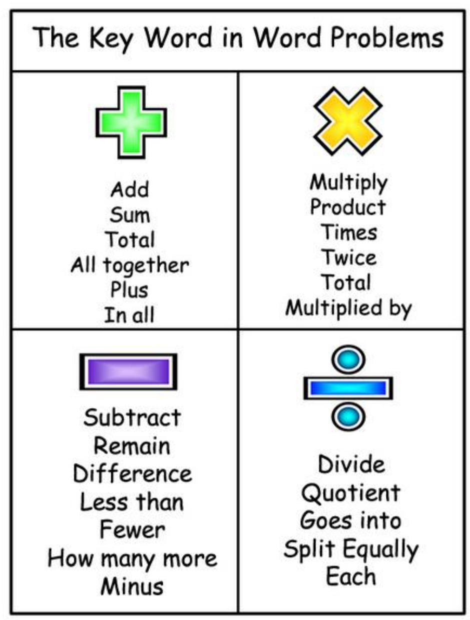


Figure 8.5: **Example of a 'cue words for maths' poster** (retrieved November 17, 2017, from google.com)

The danger is that a blanket application of a rule cannot be relied upon. For example, in a problem such as 'The sum of 6 and a number is 10', which numbers should learners 'add'? In applying the rule here, an unwary learner might - not unreasonably – say '16'.

Nesher and Teubal (1975) noted that though cue words are sometimes helpful, there is a risk also of their becoming obfuscatory. Citing work by Jerman on the role of verbal cues in solving arithmetic problems, they noted that cue words only act as “a cue for [a] specific operation”; they act as *distractors* “when they are not a cue for this operation” (p. 41). In the case of the arithmetic problem Ms M posed her Grade 4s, it would seem her use of ‘sum’ falls into the latter category. Ms M’s description of the task as ‘Very easy’ (Turn 249, above) was, for the children, in fact not the case. The word ‘sum’ here acted as a distractor (at least initially). Ms M’s learners simply could not follow the recommended action (adding the numbers “*the minute you hear the word ‘sum’*”). How could they? They did not yet have numbers to add.

As the transcript showed, it was several lesson turns before Ms M cued her learners into the word ‘sum’. Even then, however, their offers indicated ongoing conceptual difficulties. These, I believe, derived more from incomplete *semantic* access than from any actual inability to reason mathematically. As the next few turns from the lesson indicate, the children were eventually able to hone in on the mathematical reasoning.

Turn	**Learner/s**	**Ms M**
274		Which numbers must we add together to get seven? Which numbers? What kind of numbers? Sithembele, do you want to learn or not?
275	Learn ma’am.	
276		You want to learn? Then what is your problem? Then what is your problem? Siya?
277	Three and four.	
278		Three and four. Is she right? **Hayi!** [isiXhosa: ‘No’] Themba – his hand is still up. What are you going to say, eh, Themba?
279	*[Child declines. Some children laugh.]*	
280		[*Teacher chides those who are laughing*.] Uhuh, Uhuh. What are you going to say, Themba?
281	Five and two, ma’am.	
282		Are they consecutive numbers?
283	No.	
284		Themba – you want consecutive numbers, so the correct answer is three and four. I’m asking Siphosethu. The sum of two consecutive numbers is nine.
285	Four and five.	(Lesson 3M, Turns 274-285)

Although I have here commented from a language teaching/ learning perspective, the source of the struggle to arrive at (negotiate?) a shared meaning of, in this instance what 'sum' meant, would not be mono-dimensional. As Ms M remarked informally after the very first lesson observation session, "Grade 4s have problems. Either it's the language or it's the basics." In the next (penultimate) section of this Ms M chapter I present – via a narrative format – some of Ms M's own thoughts regarding enabling and constraining factors impacting on her Grade 4s ability to participate more effectively in mathematical sense-making.

8.4 Ms M's PERCEPTIONS ABOUT HER GRADE 4 LEARNERS (Interview data)

In the following two subsections I present the data obtained from my two interview sessions with Ms M, the first of which - as noted in Section 3.5 of the methodology chapter – took place prior to the lesson observation period; the second, on the afternoon of the penultimate day of the observation period. I noted in the methodology chapter (Section 3.8) England's advocacy for working at incorporating "the voices of "others" without colonizing them in a manner that reinforces patterns of domination" (1994, p. 81). To foreground Ms M's voice, I present the interview data in narrative form. As Sfard and Prusak note, a narrative form does not "treat the stories as windows to another entity that stays unchanged when "the stories themselves" evolve"; rather it is "interested in the stories as such, accepting them for what they appear to be: words that are taken seriously" (2005, p. 21).

The data presented in the next two sections represent parts of the story Ms M has chosen to tell about herself in response to the various questions I put to her in the course of the interviews. Ultimately, however, I recognise that the construction of her story here throughout this thesis inevitably remains 'my story of her story' (after Sfard & Prusak, 2005, p. 20).

8.4.1 INTERVIEW 1: Ms M

In this first section I provide a "narrative rendering" (Sfard & Prusak, 2005, p. 17) of my first interview with Ms M. The interview took place in May 2014, nine weeks before the start of the observation period. I had already negotiated my entry into the school with Ms M and her Principal, but for a variety of reasons it was arranged that I should only begin the actual lesson observations in late-July 2014.

The first part of this first interview involved some biographical details, most of which I included in the introductory section of this chapter. We then moved on to Ms M's early experiences in relation to her current teaching post. On first joining the school, Ms M explained that she discovered she was expected to teach Grade 3 – something which she said she found daunting initially: “I thought how will I cope with the Grade 3s, because I’ve never taught the little ones?” (Interview 1, Lines 29-30). A more experienced FP colleague came to her aid, and, “through her help, then everything was fine for me. … as if I was trained for Foundation Phase, although I wasn’t” (Lines 30-33). She subsequently moved on up to teach IP mathematics and science. As of 2013, due to an expansion in pupil numbers at the school, Ms M has been in sole charge of the school’s mathematics teaching for Grades 4, 5 and 6. She now teaches only mathematics, and is striving to inculcate in her learners the same interest in mathematics that she herself has. She indicated that not all of her learners shared her positive attitude towards the subject. She surmised that this was perhaps partially due to a perception - brought from, amongst other places, home - that mathematics is a difficult subject. By way of illustration, she indicated that some parents projected their own sense of inadequacy regarding mathematics onto their children: “Parents will say, “Yoh! I don’t even know maths. I didn’t know maths at school, so my child, so that’s how my child is like this, even at school” (Lines 65-66).

For Ms M, success in mathematics came down to just two things: having the interest to do well in it, and the impact of the teacher. She did, however, identify language as a significant source of difficulty also. She explained that all of her learners were Xhosa-speaking, but that the language of learning and teaching [LoLT] in her mathematics classes was English. Besides the discrepancy between the children’s home language and that of the LoLT, she noted that “maths also has its own language … I think that is a main problem” (Lines 74-75). To justify her argument that language sometimes got in the way of her learners’ mathematical understanding, Ms M recounted how, where her learners had done badly on a test, if she later read through the test paper items with them and explained what was needed, the children understood perfectly. She also recounted how she would encourage them to try to unpack questions – especially from word problems – writing things down, drawing diagrams and pictures: “Whatever you read, try and put it down, so that it makes sense. You can’t work things in your head … it’s easy to solve a problem if you see it written down, pictures, whatever” (Lines 87-89).

Ms M also then mentioned that at the beginning of the year the school had had to introduce a second Grade 4 class to accommodate an influx of learners from other schools. She noted that this, for many of these children, was their first experience of English as LoLT, and that a number of them were finding this a struggle: “I ask myself, “Will I be able to cope with these learners?” Because they couldn’t understand anything. I had to teach, and then come back to them and say everything in isiXhosa” (Lines 107-109). When I asked her how often she had to do this, her reply was, “Mostly all the time” (Line 141). In speculating whether it could be an ability issue rather than a language issue with these children, Ms M seemed to come down on the side of language being the main problem. She did also remark, though, that many parents seemed to think that once they had placed their children in the school’s care (at – according to Ms M - a 70-fold greater financial cost than what they would incur were they to send their child to an average township school), they could abdicate responsibility regarding their children’s learning development: “[they] think that because their children are here, all is well. Then they can move back. The teachers are there. They will do wonders to their children. Which is not true” (Lines 126-128).

Two other sources of difficulty with mathematics were noted by Ms M, both of which she believed emanated from the way it had been handled in the FP. Firstly she indicated that her learners were not fully ready for the demands of Grade 4 mathematics, meaning that, to quote Graven (2015b), it was a case of “going back in order to go forward” (p. 1). Ms M felt also that some children were struggling to get used to different teachers for different subjects as compared with their experiences in FP, but struggling also with the increased pace of learning expectations for IP. She suggested that the pace in FP lessons may have been slower than optimal, which meant that - come the IP - children could not match teachers’ expectations: “You find them, even 5 problems, for the whole period – they can’t finish. It means for 2 days they’re doing one thing. Two days. One thing. Five sums only” (Lines 190-192).

In light of her comments about the children’s pace, I asked Ms M whether she had tried out some of the NICLE workshop ideas on ways of increasing children’s numerical fluency. She said she had, but cautioned that introducing new strategies takes time: “It’s not a once off thing that they see. … it’s not easy. They won’t see it in one lesson or two lessons. It’s gradually they will develop” (Lines 209-215).

I closed off the interview by asking Ms M what sorts of things she felt she had gained from her membership of NICLE. First and foremost she identified the resources given out at the various sessions, many of which she shared with her colleagues once back at school. She mentioned too that she found it useful sharing insights with fellow NICLE members: “We are many teachers from different schools sharing our experiences - good and bad ones. Then we learn from one another" (Lines 229-231). She also mentioned the value of learning about new teaching strategies that had the potential to enhance learners' engagement with mathematics, not just in terms of understanding but also the enjoyment aspect, helping learners recognise "that maths is something that they enjoy, not as a stressful subject, or whatever, whatever, so that they could see it as something that they want to learn" (Lines 234-235).

8.4.2 INTERVIEW 2: Ms M

The second interview took place as the observation period was almost at its close. I had by then observed just short of 11 hours of Ms M's Grade 4 mathematics lessons. I now wanted – more formally – to gauge from her what *she* saw as the main linguistic challenges to her teaching. As I felt it might have been counterproductive to metaphorically corral Ms M within language territory, I let our interview discussion flow also in other directions that she identified as relevant. My sense is that - ultimately - all of the factors she chose to share in the interview may be seen, to greater or lesser extents, as interrelated.

Many of the issues Ms M raised either reiterated those she had raised in the first interview, or else I have cited them elsewhere in other sections of the thesis. Not everything from this second interview, therefore, is included here. (The full interview transcript is stored in my Research Archive. See Appendix 5: Contents List: Data Archive.)

My main focus for the following "narrative rendering" (Sfard & Prusak, 2005, p. 17) of the second interview is language, and how Ms M saw it as impacting on her Grade 4 mathematics teaching. Rather than working chronologically as I did for Interview No. 1, I work thematically as follows:

- Ms M's views on links between language and mathematics;
- Her own experiences of learning in and through an L2;
- Her sense of why her Grade 4s struggle with using L2 in their mathematics lessons;
- Her use of code-switching for these lessons;
- Her views on what constrains her learners from higher levels of verbal participation in these lessons.

8.4.2.1 Ms M's views on links between language and mathematics

The following statement (part of which I have already used in my epigraph for this chapter) indicates how core Ms M saw language to be to learning mathematics:

> … without language there won't be any learning. UhUh. … Language is very important, because maths isn't only about numbers: add this, subtract this. There's lots of language involved. There's English language first of all: that is a challenge to these learners, and also the maths language itself. So, if one doesn't have English as a language and also the maths language, then it's just something. There's no learning and teaching that is taking place. (Lines 53-60)

In later discussing the slow pace at which her Grade 4s were moving, Ms M linked this not simply with language *per se*, but also with poor foundational knowledge (a point I noted in section 8.3.5 but which I expand further upon in section 8.4.2.5, below). "It's difficult," she said, "for them to understand a concept. It's so difficult. The concept is not there. The language is not there. So that's why it takes so long" (Lines 140-141).

When I then asked her to expand on what she meant by 'a concept', she hesitated. When I then suggested maybe she could choose just one concept as an example:

> Ah. What fraction is shaded, maybe? They should know what a 'fraction' is. If I say one fraction is shaded, one of them will write 1. Is 1 a fraction? How does a fraction look like? Or, if I say what are the 'factors of 4? Or what are the 'multiples of 6'? 'Multiple' - if you don't know the word 'multiple', what does it mean? How can you give me the multiple when you don't even know the word 'multiple'? What does it mean? So you see? (Lines 154-159)

In articulating her frustration at her learners' struggle with the meanings of concepts such as 'fraction', 'factor;' and 'multiple', she, at the same time seemed herself to feel trapped by an imperative to use the discipline-specific (as – presumably – against 'everyday') language: "I have to use them, because this is mathematical language" (Line 159). In seeking to probe further, I asked Ms M how she would distinguish between 'a concept' and 'a vocabulary item?' to which (as noted in Section 2.4.4 of the Literature Review chapter, and repeated here for the convenience of readers) she replied: "Is it not the same maybe? Almost the same? It's almost the same" (Lines 160-161).

On reflection, I realised this was a tough question I had put to Ms M. I would certainly struggle to respond to it. I subsequently consulted Vygotsky's writings to help me clarify the distinction. "Word meaning," he wrote, "is an elementary "cell" that cannot be further analyzed and that represents the most elementary form of the unity between thought and word". The Longman Dictionary of Contemporary English similarly defines 'word' as *the shortest unit of language that people can understand if it is said or written on its own*. It is, however, upon such meaning, that a concept ("a generalisation") may then be built (1986, p. 212; 197). I suspect Vygotsky might have commended Ms M on her response!

Implicit in Ms M's various comments around links between language and mathematics is acceptance of, or at least no challenge to, English's place relative to mathematics teaching and learning. Indeed, when explicitly asked about the legitimacy of using English as LoLT despite it not being learners' L1, Ms M replied, "For me I think there's nothing wrong" (Line 103).

8.4.2.2 Ms M's personal experiences of learning through an L2

Ms M saw responsibility for managing the challenge of transitioning to English as lying partly with parents. She cited her daughter as an example (Grade R in L1, and, from Grade 1 onwards, L2):

> I knew as a parent what I was responsible for because I know my daughter was at [*names a township school*]; everything done isiXhosa, then she went to [*names a former Model-C English-medium preparatory school*], so I was teaching her sounds ... . I knew I was responsible. And then maybe within a term – the 2nd term – she was fine. So I think the parents, we also have to play a role. (Lines 106-110)

I wondered whether this suggested she was in favour an English LoLT more broadly. I asked, "So, if you could wave a magic wand and say, "I'm in charge of what language is used," you would choose English?" My thought was wide of the mark. "Ah! Ha!" she said, "I would choose for me ~ I think isiXhosa is fine" (line 115). Reflecting on this later, it struck me that Ms M and her child exemplify Cummins's 'common underlying proficiency' hypothesis (2000). Unlike her Grade 4 learners' 'straight for English' route, both Ms M and her daughter had had the advantage of doing their initial literacy and numeracy development through L1. I cited in Section 2.4.3 Cummins's point that "conceptual knowledge developed in one language helps to make input in the other language comprehensible" (2000, p. 39). Here is how Ms M made this same point:

> In primary I was learning things in isiXhosa. It wasn't difficult for me when I got maybe in higher primary and then there was English. It was not a strange language that I couldn't learn. For me it was just – I could fit in - because the

> knowledge was there. Everything was there. It was only the language. For me, it was just easy. (Lines 116-120)

8.4.2.3 Ms M’s sense of why her Grade 4s struggled in using L2

Learners’ exposure to English and opportunities to practise it outside of the classroom, Ms M seemed to think was limited. English was the language of the parental workplaces and the children’s classrooms, isiXhosa the language once home: “They [parents] always speak English at work, and the learners they only speak English here at school. That’s the end. Without any reading books or whatever at home” (Lines 92-94).

A degree of abdication of responsibility on the part of parents was something Ms M alluded to in both interviews, but more than that she blamed the learners themselves. She described how she had tried to persuade children to improve their English through reading:

> I ask the parents to please – they must have some reading books for English, just phonics, and Xhosa reading books also … but you find that the learners didn’t do anything. … They watch TV, play-station or cell phones - of which you’ve warned them not to do because they should rather buy reading books. Buy them to try and improve in English. And you know those kids. Because some of them – some of them can’t even read the very first word. (Lines 48-52; 96-99)

Similar, though not specifically relating to language, was Ms M’s view on parents’ oversight of homework. I had during the observation period, seen her frequent vexation at children not having done their homework. Below are transcript extracts from just some of the many instances I observed her berating learners for this:

- We have been fighting, fighting, fighting from Term 1. We are still fighting in Term 3. Homework is not done in this class. No. No. No. No homework. (Lesson 1M, Turn 385).

- How will you know whether, if you understand this or not if you didn’t do your homework? One, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen – more than half of the class: No homework done. I will stop giving you homework, that’s all. Because I’ll give you some more homework today, and then the next day, the same story. (Lesson 3M, Turn 6).

- Stand up if you didn’t do homework. Stand up. Stand up. … [*Several children get to their feet*.] Thabiso doesn’t know what I’m talking about. UhHuh, UhHuh, UhHuh. … Did you do your homework? Then stand up. Let me see. Have you done it? … Not done? Homework not done. Why not? Yoh! (Lesson 4M, Turn 4).

- Are there no learners who are interested? Are there? … [*Counting the learners who have not done their homework*] 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20. Yhu! Out of 34. I'm going to talk to Mr. X [*deputy principal*] and then I'll no more give you homework because you are not interested. I'm just wasting my time. I'm just wasting my time. (Lesson 11M, Turn 3).

When I asked Ms M to comment further on this in the interview she again apportioned the blame two-ways:

> They themselves need to be responsible, knowing that they have to do homework, and also the parents also … they must meet us halfway – assist them. Even if the learner says there's no homework, they must open the book – they will find homework – it's there. They must help. (Lines 76-85)

Helping learners become more responsible, more self-agentic, is an aspect of self-regulation which, as Zimmerman (2001) explained, "depends on the degree to which [learners] are "metacognitively, motivationally and behaviourally active participants in their own learning process" (p. 5), a combination in short supply it would seem as far as many of Ms M's Grade 4s were concerned. Whether their ability to be 'active participants in their own learning' was partly a function of limited proficiency in the LoLT is not something my data could resolve. Certainly, however, as I discuss in the next section, Ms M was not of the view that the LoLT question *per se* was the central issue.

8.4.2.4 Ms M's use of code-switching

Despite her assurance that I had not been seeing anything "different from normal" (Lines 25-26), I could not help but wonder if – when I was present – Ms M held back on her use of isiXhosa. I observed her using it only rarely, seldom in her whole class teaching; slightly more often in some of her one-on-one interactions with individual learners during seat-work. This was at odds with her claim in the pre-observation interview that she found she had to make *frequent* use of isiXhosa. When asked if her School had a policy on code-switching, she replied, "UhUh. The policy I would say is not very clear. … when it comes to language, it's not clear at all" (Lines 312-314).

She indicated that there was no 'embargo' as such on use of the children's L1. Her use of isiXhosa was, she said, particularly in relation to newer arrivals at the school. "I use it when I see that they don't understand … there are learners who are coming from schools where they were learning everything in isiXhosa. Then I know for them it's a challenge even to read the instruction. "What does the question require me to do?" … for them it's just difficult" (Lines 30-33). Numbers, she said, posed no problem. Words were the problem. "It's easy for them if maybe there's 23+17, then maybe they can work that one out, but when the instruction maybe can be written in words: 'Add these two numbers', maybe to them it's something else, not the same thing as 23+17 just in numbers. So when there are words, it's really difficult for them" (Lines 33-37).

She did however have a question mark over whether or not more frequent use of isiXhosa would help: "I don't think there was going to be much difference. ... I don't know. I don't know" (Lines 327; 324). She mentioned the problem of teaching in isiXhosa, but then assessment being in English, but, more than this, she said she struggled to distinguish between whether language was a main source of difficulty or whether it was simply a question of below-grade-appropriate levels of mathematical proficiency:

> You know what, Sally-Ann, in language things there is a contradiction, because – you know what – the very same learner – you can say something in isiXhosa – they won't understand, then you have to use English to explain isiXhosa. ... So I don't know which is which. That's how it is. Then if you say it in isiXhosa, they are clueless; then you have to use English to explain it. That's how it is. Then [laughs] I really don't know. (Lines 347-353)

And then later:

> Maybe I'm expecting too much from them whereas they are not at that level of my expectations. Maybe I should be in their level. (Lines 475-477)

8.4.2.5 Ms M's views on what constrained her Grade 4s' verbal participation

It would seem from the foregoing that – in Ms M's view – the difficulties she experienced in getting her Grade 4s to more actively engage with her in the observed lessons went beyond simply the fact that – officially – they were learning their mathematics through an L2. One of the key concerns she expressed was learners who were trailing in her expectations for Grade 4:

> ... the basics of mathematics – they don't have. And they are now in Grade 4. At least I'm trying to catch up with the Grade 4 work, but I think I have to go back maybe to Grade 3 where their level is maybe like grade 2 – some of them. (Lines 137-139)

This lag, in turn, she saw as having a knock-on effect on their conceptual grasp of mathematics. I cited her comment in relation to this in Section 8.4.2.1 ("The concept is not there. The language is not there" (Lines 140-141)). Whilst Ms M here implicated language; as touched upon in the Interview 1 narrative, she invoked also something akin to Chall and Jacob's (2003) 'fourth grade slump' phenomenon. She indicated that many of her Grade 4s were struggling to adjust to the expanded IP curriculum and to having subject specialist teachers in place of just the single FP Grade 1, 2 or 3 teacher they were accustomed to.

Weak grasp of mathematical concepts cannot but fail to limit learners' capacity to engage (either mentally or verbally). Independently of this, though, I did also then venture to raise with Ms M a question that has cropped up on a number of occasions in discussions around cultural norms with other Black teachers: that of some cultural reticence around children speaking before being spoken to. As I included discussion of this in Section 2.2 in the Literature Review chapter, I will not pursue this point further, beyond reiterating Ms M's acknowledgement that this could be a contributory factor in her own teaching also (Line 383). She did then also add the point that "sometimes it's chaotic if they do that [speak before being spoken to]. Then I say, "Okay. You wait for me" (Line 390-391).

Regarding some of the answers that children gave to Ms M, I mentioned in Sections 2.4.1 and 6.5 the impression I got that they were sometimes 'playing school', putting their hands up, offering wild guesses, but not genuinely engaging with the 'text' of a particular lesson(s). In the course of the second interview I raised with Ms M the fact that on many occasions I had witnessed her insisting that children raise their hands before answering a question, but then not nominating those who had their hands raised. Why was this, I wondered. Here is how Ms M explained it:

> Sometimes I know they can even raise their hand but they don't even know the answer. And sometimes they don't raise their hand but they know the answer. So I just ask whoever. Even if their hand is up or not. Because the hand can be up, but the answer is not there. The hand cannot be up, but the answer is there! So I just ask whoever. (Lines 357-361)

Having been vouchsafed this intriguing piece of 'reverse psychology', I then asked Ms M if she thought shyness (or fear of ridicule from peers) might have prevented some children from raising their hands, she was again quite definitive in her response:

> No – they are not shy. They just don't want to put their hands up. They are not shy at all. Maybe - I don't know - they are tired of putting their hands up. But I know they are not shy at all. I know they are not shy. ... Also they'll raise their hands because maybe they know sometimes I'll focus on those that don't put up their hands, they'll raise so that, "Ms M mustn't ask me." (Lines 374-380)

I then suggested that it seemed to me on a number of occasions that children were just engaging in a 'guessing game', to which Ms M's phlegmatic response was, "Ja. And it happens a lot, I'm telling you. It happens a lot. That's why sometimes I'll tell them if you do something they must try and put this – what is this? – try and put it down. Think about it" (Lines 398-400).

A major reason cited in the literature for getting children to engage in classroom talk is because of the view that this promotes their mathematical reasoning. I therefore mentioned to Ms M that I had noticed her letting her Grade 4s 'just run' with their guesses (as in the lesson transcript example included in Section 2.4.1 of the Literature Review chapter). She acknowledged this was so, "UhHm" (Line 429). I then asked her what her motive was in "letting them run with those guesses" (Line 430). Her explanation here suggests a desire on her part to draw her learners into showing that they had the courage of their (mathematical) convictions:

> Because I want – because if you know it's right – then even if the other person has said it and I didn't say, "Yes," If you know five is the correct answer, you still say, "Five." Not because "Heh! I was going to say five. That one has already said it. It means I must change. It's not five." Because if you are confident it is five, then no matter who said five, you still stick to your five, because you know this is the correct response. (Lines 432-437)

I was interested to know whether, beyond a child knowing 'this is the correct response', Ms M wanted anything else (such as a mathematical justification); but she explained that learners struggled to explain their reasoning. Part of the struggle she attributed to language inhibition (English):

> They won't give any reason. That's the main problem. To give reason, "Why this one?" It's difficult, even with the Grade 5s. … Hayi! It's always difficult to give reasons, even for simple things. … Then, I think they are shy to engage in language or what: "Because people will think I am wrong." Or "It's better for me to give this very short answer so that I'm off the hook," or whatever. Because I do try to make them engage in English – not to use this very short thing, but then, that's it. (Lines 442-563)

Given the mainly one- two- word answers tallied earlier (Table 8.4) it is unlikely that the learners would in fact be able to give much more than "this very short thing". My impression was that their L2 proficiency levels barred them from engaging in exploratory reasoning in response to Ms M's various, 'Why?" probing questions. What Ms M appeared to be looking for was learners producing the kind of legitimate CALP-type text that comprised formalised statements of mathematical fact rather than evidence of understanding or of reasoning:

There are four **quarters** in one (not 'four');

A quarter is bigger than an eighth (not 'the more pieces that I divide a whole into, the smaller the pieces will get');

Four quarters of twenty rand is twenty **rand** (not 'twenty').

Had Ms M been less intent on 'honouring' her school's 'straight for English' policy, use of her learners' L1 may have enabled the children to engage in more BICS-type reasoning of the exploratory, sense-making sort advocated by Barnes (2008, 2010).

8.5 Ms M's STORY: SOME CONCLUDING COMMENTS

What I have shown in this chapter is that the pattern of talk in Ms M's observed Grade 4 lessons was overwhelmingly that of Ms M doing almost all of the linguistic and conceptual navigating. There was little or no self-initiated input from the learners. Their *formal* verbal output was extremely limited. My emphasis here of the word 'formal' is because in the course of the observed lessons I noted a considerable amount of off-task verbal activity (chatter) amongst the children, all of it in isiXhosa. Their formal verbal output mainly took the form of one- two- work answers in direct response to Ms M's questioning, much of it given in chorus. Almost all of their formal verbal output, which was required primarily to be in English, took the form of one- two- word answers in direct response to Ms M's questioning, much of it given in chorus.

Analysis of the observed verbal exchanges showed a preponderance of the so-called IRE pattern. The apparent level of cognitive challenge in Ms M's initiations was such that factual responses, rather than responses requiring deeper reflection and/or justification, generally sufficed. On those occasions where Ms M pushed learners for reasons for their answers, she was invariably forced to retreat. Children's verbal offerings thus remained at a surface 'right'/ 'wrong' level. This, in turn, further limited opportunities for more extended verbal engagement, and so, further opportunities at practising using either the L2 or the grade-appropriate mathematical discourse.

Ms M identified language as key to learners' ability to engage mathematically. She expressed uncertainty, however, about the extent to which language as such was a root cause of her learners' struggles with their mathematical sense-making. While acknowledging many of the children's limited proficiency in their L2 (English) was a source of difficulty, she indicated that even were she to have engaged with them in their L1 (isiXhosa), the fact of their not yet having achieved the levels of conceptual understanding expected of Grade 4s, would still compromise their ability to access and productively use the language of mathematics.

Ms M's own evaluations of her learners' mathematical capabilities as well as the external assessment that came via the 2014 Mathematics ANAs speak of disturbingly low levels of mathematical proficiency for most of the 2014 Grade 4 children. Sixteen of Ms M's sixty five learners scored more than 50%. Twenty four children scored less than 30%. The class average was 37.9%, almost identical to the *national* average (37%) and slightly above the provincial average (34%).

As I noted in Section 8.2 SANCP also carried out its own annual assessments of learners at its participating schools. These were designed to gauge whether or not there had been improvements in learners' numeracy performance. SANCP's assessments provided an altogether more positive picture of Ms M's learners' evolving mathematical proficiency. As Graven (2015b) explains, the Project used two learner performance assessment instruments:

- a four operations assessment instrument based on that developed by Brombacher and Associates; and,
- a modified version of an instrument developed by Askew, Brown, Rhodes, Johnson and Wiliam which assesses learners' procedural fluency, conceptual understanding, strategic competence and adaptive reasoning.

Table 8.12, below captures some composite results for Ms M's 2011 and 2014 Grade 4 learners on both these assessments.

Table 8.12: Ms M's Grade 4 learners' mathematical performance averages on SANCP assessments (2011 +2014)

	Brombacher & Associates Assessment Instrument (adapted) *(Administered annually in April/ May)*	**Askew, Brown, Rhodes, Johnson & Wiliam Assessment Instrument** (adapted) *(Administered annually in August)*
2011	40%	29%
2014	56%	43%
Change	**+ 16**	**+14**

(SANCP's data base)

These assessments indicate pleasing improvement across Ms M's 2011 and 2014 Grade 4 learner cohorts. Encouragingly, in terms of SANCP's overall Grade 4 learner performance data across 2011 to 2014 learner cohorts, Ms M's learners showed one of the strongest improvements across the period of her school's participation in the project's development work (M. Graven, personal communication, April 5, 2017). While the language and mathematics link was never an explicit focus in the various SANCP intervention initiatives, the fact of the interventions having wrought positive outcomes, suggests that the addition of more language-oriented initiatives could be similarly successful.

CHAPTER 9: Ms P's USE OF CLASSROOMTALK

> *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. … They are supposed to be taught in English … so I'm supposed to speak English, but I can't do otherwise.*
>
> (Ms P, 2014)

9.1 INTRODUCTION

My purpose for this introductory section is to introduce Ms P more formally and fully: first briefly recapping, and then augmenting, some of the information provided about her in earlier chapters.

Ms P teaches at a non-fee-paying Quintile 3 public school. She joined the school straight from training college. At the time of my case study investigation, she had taught there for twenty years and was scheduled to retire at the end of the following year. During this time she had embarked upon, but had not completed, a Further Diploma in Education (Primary School Mathematics). She had struggled, she said, to balance her full work load with part-time study. She did, however, later add an Advanced Certificate: Education in Information Communication Technology to her initial 3-year primary teachers' diploma, thereby aligning her qualifications with the Department of Education's M+4 (matriculation, plus 4 years) "recommended minimum qualification for a professional teacher" (DoE, 2005, p. 15).

When Ms P first joined the school she was, for the first six years, assigned to teaching Grade 1s. All of her subsequent teaching was at the IP level: teaching mainly mathematics (Grades 5 and 6) and English (Grades 4, 5 and 6). 2014 marked for her the start of a focus *exclusively* on Grade 4. She was put in charge of the teaching of mathematics and English to her school's two Grade 4 classes (comprising 32 and 34 children respectively). "This year I was taken to Grade 4 to teach Grade 4 maths and Grade 4 English. And that was the first time to teach those little ones the maths" [Interview 1P, Lines 12-14]. Later in the interview I asked her to tell me more about herself as a mathematics teacher.

> **S-AR:** If you were to talk about what drew you to maths, did the school choose you for maths, or did you offer your services as a maths teacher?
>
> **Ms P:** I didn't offer. I didn't offer. The school chose me.
>
> (Interview 1P, Lines 75-77)

While this response may suggest Ms P does not hold a particularly strong sense of *self*-selection regarding becoming a mathematics teacher, it does indicate her *school's* confidence in her suitability for the role.

Ms P's school follows the CAPS recommendation that throughout FP learners are taught their initial literacy and numeracy through mother tongue (isiXhosa in this instance) with the first additional language (in this instance, English) being taught alongside as a subject. The school has then (in principle) adopted an early exit model of bilingualism whereby Grade 4 marks the official point of transition across to English as its main LoLT. As this chapter's epigraph makes clear, however, Ms P felt compelled to continue making extensive use of isiXhosa with her Grade 4s.

Although South Africa's LiEP advocates a "language policy most supportive of general conceptual growth" (DoE, 1997, p. 2), in many of her references to the LoLT question Ms P frequently emphasised the word '*supposed*' with regard to her teaching in English. This suggests some sense of unease about not fully doing so. In this, and notwithstanding the *multilingual tenets* of South Africa's LiEP, she is not alone. I earlier, for example, noted Probyn's comment on South African teachers' sense of having to '*smuggle* the vernacular' into their classrooms (2009; 2015). This, in turn, suggests that many teachers have yet to be adequately apprised of the LiEP's "underlying principle … [of] maintain[ing] home language(s) while providing access to and … acquisition of additional language(s)" (DoE, 1997, p. 1). What this means is that, even though she may not think it, Ms P's practice is *entirely consistent* with policy.

As shown in Table 1.1 (Introductory chapter) the 2014 Grade 4 Mathematics ANA average for Ms P's learners was 27.3% (below both the provincial and national average). Most children scored less than 49%. There were, however, seven learners who achieved scores of 50%+, two of them in the 70%+ category. Though Ms P's school had joined the SANCP somewhat later than did Ms M's school[76], she, like Ms M, was a member of the NICLE PD programme. This, she said, had contributed positively to her mathematics teaching repertoire: "I'm new, but I gain a lot. I try those strategies that I get from them in my class, and they love them. They love them. … They love them" [Interview 1P, Lines 117-120].

76 In 2013, Ms P's school principal approached the Chair to ask if she, Ms P, and one other member of her teaching staff might join NICLE. As such, Ms P's school entered the Project mid-way through its five-year run.

Because of Ms P's school joining SANCP later than the other participating schools, she and her colleagues only participated in the Project's final cycle of monitoring and impact assessment. This, as noted, was based on an oral administration of an assessment instrument adapted from Askew, Rhodes, Brown, Wiliam and Johnson (1997). The outcomes in Table 9.1 below provide an indication of Ms M's 2014 Grade 4 learners' proficiency levels in three of Kilpatrick, Swafford and Findell's five strands of mathematical proficiency (National Research Council, 2001).

Table 9.1: Ms P's Grade 4 learners' average % scores on SANCP's mathematical proficiency assessments (2014)

	Conceptual Understanding	Strategic Competence	Adaptive Reasoning	Overall average
Ms P's learners	52	34	64	50
Project cohort	51	25	29	35

Data derived from SANCP Database

The fact of their average scores being better on each of the strands relative to the Project cohort's average is the more interesting in light of the extreme poverty under which many of Ms P's learners live (something I touch on again in Section 9.4.2.3). These scores have inevitably led me to speculate on whether Ms P's additive bilingualism practices may have impacted positively on her Grade 4s' potential for mathematical meaning-making.

By contrast, and taking for granted the influence of language medium on assessment outcomes, their 2014 ANA results bear testimony to how delicate a balancing act is needed to ensure adequate exposure to the broader LoLT (particularly when this is the language also of such *formal* assessment).

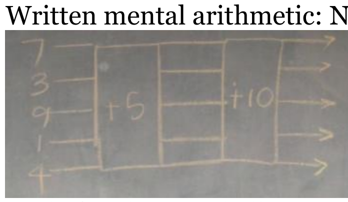
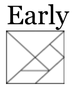
As I share in the postscript to this chapter, this balancing act is almost certainly *more* delicate than many people imagine. As part of its NICLE programme SANCP regularly sought feedback from teachers regarding their experiences with the mathematics ANA's. This feedback fed into two publications authored by the two South African Numeracy Chairs (see Graven & Venkatakrishnan (2013) and Graven & Venkat (2014)). In addition a report summarizing the teacher feedback was sent to the DBE's Assessment Director, Dr Marc Chetty (M. Graven, e-mail communication, November 14, 2017). My postscript derives out of the 2014 NICLE discussions. It pertains to – for want of a better word – a small 'experiment' whereby some of Ms P's Grade 4s tackled an isiXhosa version of a past Mathematics ANA paper.

I captured some 17 hours of videotaped observation in Ms P's Grade 4 mathematics lessons over a two-week period, as per the schedule in Table 9.2 below.

Table 9.2: Schedule of observed lessons (Ms P)

	LESSON OBSERVATION SCHEDULE						
	Day	Lesson	Time(mins)	Class	FOCUS	Audio record	Video record
	1	Arrived at school (07h50) to learn Ms P was off sick					
WEEK ONE	2	1	23	4B	Prayer, hymn and greetings Mental arithmetic (7x Table) Written mental arithmetic task (7x Table) Four-digit addition 2448+2374=$\boxed{?}$	✓	✓
		2	18	4A	Written arithmetic task (7x Table) Four-digit addition 2448+2374=$\boxed{?}$	✓	✓
		3	85	4B	Answers to written arithmetic task (7x Table) checked Using two strategies for four-digit addition (standard column procedure/ partitioning with expanded notation) Early finishers: NICLE Homework Book Homework: Four digit addition (e.g. 3029+4399=$\boxed{?}$)	✓	✓
	3	-	(5)	4B	Prayer, hymn and greetings	✓	✓
		4	15	4A	Mental arithmetic: groups of 4 learners take turns to throw dice, add, then double (e.g. 5+5=10x2=$\boxed{20}$)	✓	✓
		5	10 5	4B	Mental arithmetic: groups of 4 learners take turns to throw dice, add then double (e.g. 6+2=8x2=$\boxed{16}$); add/ subtract 3 (e.g. 2+3=5-3=$\boxed{2}$) Previous day's homework addition task checked Using numbers from addition task as *subtraction* tasks (e.g. 2534-1382=$\boxed{?}$). Individual learners called to demonstrate calculations (standard column procedure/ partitioning with expanded notation) Independent work on other examples in exercise books Early finishers: NICLE Homework Book	✓	✓
	4	-	(5)	4B	Prayer, hymn and greetings	✓	✓
		6	55	4A	Mental arithmetic: adding, multiplying, subtracting strings (e.g. 10x2=20+15=35-3=32+2=$\boxed{34}$) Written mental arithmetic task ('Number ladder': *Start at 9, double it, add 2..... What is your number?*) Jointly tackled on chalkboard, the in exercise books, then individual learners called up to demonstrate calculation steps Four-digit subtraction (e.g. 3188-1425) to do in exercise books. Individual learners called up to demonstrate calculations. Homework: New 'Number ladder', plus completing class-work	✓	✓
		7	60	4B	Mental arithmetic: adding, multiplying, subtracting strings (e.g. 10x2=20+2=22-5=17+10=27-13=14÷2=$\boxed{7}$) Mental arithmetic task ('Number ladder') tackled in exercise books, then individual learners called up to demonstrate calculation steps. Four-digit subtraction (e.g. 3188-1425=$\boxed{?}$) in exercise books. Individual learners called up to demonstrate calculations. Homework: New 'Number ladder', plus completing class-work.	✓	✓
	5	-	(5)	4B	Greetings	✓	✓
		8	55	4A	Mental arithmetic: Checking orally 'start at 9 Number Ladder' Oral checking of 'left' and 'right' sides of the body Viewing (and drawing) of objects from front, sides, top	✓	✓
		9	60	4B	Oral checking of 'left' and 'right' sides of the body Viewing (and drawing) of objects from front, sides, top	✓	✓

LESSON OBSERVATION SCHEDULE

	Day	Lesson	Time (mins)	Class	FOCUS	Audio record	Video record
WEEK TWO	**6**	-	(5)	4B	Prayer, hymn and greetings	✓	✓
		10	85	4A	Brief revision of views: front/ side/ top Mental arithmetic: (6xTable) Written mental arithmetic task off chalkboard Textbook activity: Viewing, drawing, and labelling of shapes (front, sides, top) in exercise books	✓	✓
		11	30	4B	Mental arithmetic: (6xTable) Written mental arithmetic task off chalkboard Textbook activity: Viewing, drawing, and labelling of shapes (front, sides, top) in exercise books Joint checking of written mental arithmetic task	✓	✓
	7	-	(5)	4B	Prayer, hymn and greetings	✓	✓
		12	55	4A	Mental arithmetic: Numeric pattern Written mental arithmetic: Numeric patterns.  Early finishers: Labelling and colouring in parts of a tangram	✓	✓
		13	55	4B	Mental arithmetic: Numeric pattern Written mental arithmetic: Numeric patterns Early finishers: Labelling and colouring in parts of a tangram 	✓	✓
	8	**14**	55	4A	Numeric patterns	✓	✓
		15	40	4B	Numeric patterns Early finishers: Colouring in a tangram	✓	✓
	9	**16**	75	4A	Greetings Numeric patterns Multiplication using different strategies	✓	✓
		17	30	4B	Numeric pattern Multiplication using different strategies	✓	✓
	10	-	50	4A	Greetings Test period	✓	✓
		-	50	4B	Greetings Test period	✓	✓

9.2 Ms P's GRADE 4 MATHEMATICS CLASSROOM

Ms P was fortunate in having a dedicated classroom for her Grade 4 mathematics and English teaching. My first impression of this classroom was of a highly print rich and well-ordered pedagogical 'Aladdin's Cave'.

Photo 9.1: Indications of Ms P's print-rich Grade 4 classroom

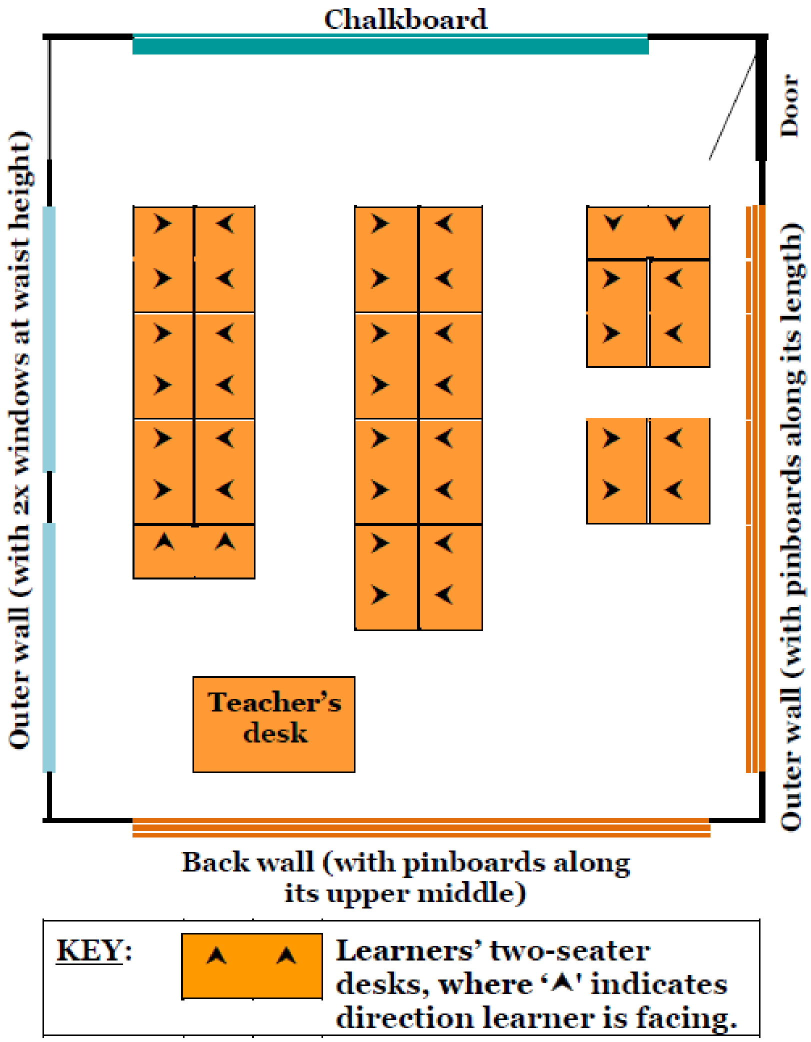


Figure 9.1: **Ms P's Grade 4 classroom layout**

Ms P's layout, she said, was to facilitate group work: "I don't want to move the desks, or make them face the other side. I just give them the group work – this group, this group, - just like that – for group work." The only time she temporarily altered the desk arrangement was – as on the final day of observation - when tests were written. Whereas some teachers have expressed reservations about this 'OBE-compliant' orientation to group work, seeing it as conducing to off-task chatter (see, for example, Robertson, 2012), Ms P indicated that she forestalled this by keeping on the move: "If you walk around, you'll see that this one is not working, this one is not working, but if you sit, and then it's time to chat with each other." Ms P's constant circulating was a marked feature of her teaching throughout the observation period. Regarding on-task talk, there were occasions – as in any classroom - when Ms P instructed learners not to talk: *"Akukhomntu uzothetha apha, akukho namnye ozathetha"*

[No one is going to talk here. Not a single person is going to talk.] [Lesson 1P, Turn 5]. At other times she encouraged them to talk to their neighbours; and, at others, to address the whole class (particularly when individual children were up at the chalkboard demonstrating for their classmates how they had tackled a particular sum). At these times, Ms P would instruct them: "*Thetha sive kalok bhuti, xelela iklasi.*" [Speak so that we can hear, boy. Tell the class.] [Lesson 3P, Turn 30].

As the above two examples indicate, and as noted previously, Ms P made extensive use of isiXhosa with her Grade 4s. I use *italics* to signify Ms P's actual isiXhosa utterances and then provide [in red] an English translation. My phrasing choice: 'an English translation', rather than simply 'the English translation', is deliberate. I am vulnerable in this respect because, as outlined in the Methodology Chapter (Section 3.5), I was reliant on others for the transcription capture (and subsequent translation) from my audio/ video recordings of those places where Ms P talked in isiXhosa. I am aware that a different transcriber and/or translator might wish to challenge some of the isiXhosa talk data. In a 'post script' to this chapter I touch on the fact of isiXhosa's orthography (*written* representation of its sounds and words) and lexis not yet being standardised. This results in isiXhosa speakers not always agreeing as to what the standard form of a particular word ought to be. Standardisation of a language takes a long time.

In the next section I discuss patterns of observed classroom talk in Ms P's mathematics lessons, including further evidence of her significant reliance on isiXhosa.

9.3 SOME OBSERVED VERBAL PATTERNS IN Ms P's LESSONS

I was able to capture only a small amount of talk between learners (most of which was in isiXhosa) and of Ms P's one-on-one talk with learners (much of which was in isiXhosa also). The patterns discussed in this section therefore are mainly from when Ms P addressed the whole class. As I did with the Ms M chapter, I applied Sinclair and Coulthard's exchange analysis (1992) to some of Ms P's whole-class teaching, and then did an analysis also of patterns emerging from her use of questions. Before doing these forms of analysis, however, I want first to underscore the fact of extensive use of isiXhosa being perhaps *the* major verbal pattern of Ms P's observed lessons. In the following section therefore I focus on a verbatim transcript of one of her lessons.

9.3.1 isiXHOSA AS THE DOMINANT MEDIUM

The transcript I chose for this section is of the second of Ms P's observed Grade 4 mathematics lessons. I selected it simply because it is the shortest (comprising a mere 37 turns). In my field notebook I noted that this shortness, according to Ms P, was a consequence of some confusion that morning around classes' arrival and departure times. This, she said, was because the Principal was away that day and certain of her colleagues were 'taking chances' (Field notes, 2014-08-12).

The amount of isiXhosa used here is, I estimate, more or less representative of the isiXhosa: English ratio throughout Ms P's observed lessons. Amongst my field notes for this day I wrote of my sense of being overwhelmed by the amount of isiXhosa usage: 'My ability to access what's going on is going to be a big challenge. How much can I get help?' I noted here also that at the end of this day's observed lessons I mentioned to Ms P that it had struck me that isiXhosa had been the dominant medium. I wrote in my notes: 'She replied that it was the only way they could cope' (Field notes, 2014-08-12).

Ms P: DAY 1 [Lesson 2]		**Utterance**		
Turn		**English only [Translations from isiXhosa in red]**		**Original isiXhosa utterances**
1	T	*[A new class enters]* Where have you been? You are supposed to be here already. Come in.		*Nihleliphi? Akumele ukuba senilapha? Ngenani*
2	T	People, I won't wait for you next time. Your period is supposed to be till up to half past. What am I going to do now? You know you should be here when you have been sitting in your class.		*Bethunani, Kalok nihleli eklasini yenu*
3	T	Why were you sitting in your class? What were you doing? At half past, you are leaving here.		*Nihlelele ntoni eklasini? Nenza ntoni pha? Nge cala niyahamba apha.*
4	Ls	*[Children settle.]*		
5	T	*Ms P instructs them to get out their exercise books and copy and do the following mental maths written up on the chalkboard.]* No one is going to talk here. Not a single person is going to talk. What is the matter with you?	**7x4= 7x8= 7x3= 7x5= 7x10= 7x6= 7x0= 7x9= 7x2=**	*Akukhomntu uzothetha apha, akukho namnye ozathetha. Yintoni wena?*
6	T	Half past, I'm taking the work.		*ndiyawuthatha lomsebenzi*
7	T	Who has not finished their work? Why are people not writing? Please write people.		*Ngubani ongeka gqibi? Kutheni ningabhali? Bethunani bhalani.*
8	Ls	*[I observe some learners count using their fingers. As learners finish they take their work to Ms P for*		

Ms P: DAY 1 [Lesson 2]		Utterance	
Turn		**English only [Translations from isiXhosa in red]**	**Original isiXhosa utterances**
		marking. She continues circulating, checking on progress.]	
9	T	*[Addressing a child.]* What is this number?	*Ngubani elinani*
10	L	21	
11	T	How do you write 21?	*Ubhalwa njani u21?*
12	T	You sit with a partner and you do this. *[Ms P indicates to those finished the mental maths, the four-digit addition sum written on the chalkboard:* **2448+2374***. She distributes A3 sheets of paper to pairs of learners.]* Any way you like. Don't copy from another person. I will see if you copied the person next to you. Any way you like. You can add zeros. You can do any way you like.	*Uhlala nomlingane wenze lomsebennzi. Nangeliphina uhlobo ofuna ngalo. Ungajongi konye. Ndizobona xa ujonge komnye. Nangeliphina uhlobo ofuna ngalo, ungafaka nomaqanda.*
13	T	*[Ms P returns to checking on individual learners.]* Come here, my child.	*Yiza apha mntanam*
14	T	Who has not finished? Write in the middle, so that I can see.	*Ngubani ongagqibanga? Bhala esiphakathini, ndizokwazi ukubona.*
15	T	Don't copy from another person, do your own strategy.	*Ungakopi komnye,*
16	T	Yeah, this one. Make your own strategy. Don't copy from next door, your neighbour. You must have a partner. Quickly. Quickly. Quickly.	*Ewe eliholobo. Yenza ngohlobo lwakho. Ungakopi komnye, kumeza. Funeka ube nomlingane*
17	T	Who are you working with? Who are you sitting with?	*Wenza nabani? Uhleli nabani?*
18	T	Who doesn't have a partner? Busani. Stand up and come sit here.	*Ngubani ongenaye umlingane? Busani phakama uzohlala apha.*
19	T	You must write big, understand? Write your name and your partner's name.	*Bhala kakhulu neh? Bhala igama lakho nelomlingane wakho*
20	T	*[Ms Ps strokes child's head and smiles down at her.]* Hee! Heh, Baby! You go, Girl!	*Hee! He mntana wam! Hay, sana.*
21	T	You must write in the middle. Write in the middle of the paper. Write the big numbers please.	*Bhala esiphakathini. Bhala esiphakathini. Bhala amanani amakhulu*
22	T	No No No! Lunga, are you done? Who are you sitting with?	*Hay hay hay! Lunga ugqibile? Uhleli nabani?*
23	T	Go to the others, people. Can you see them?	*Iyani kwabanye bethuna, niyababona?*
24	T	Are you still on that one? Time is running out.	*Nisekuleyana, liyaphela ixehs abethuna*
25	T	Guys, you are supposed to leave now. What is the next period?	
26	Ls	Xhosa,	
27	T	You write your name and your partner's and then you copy that, understand?	*neh?*
28	T	No! What is it? Since when can't you write?	*Hay! Yintoni? Uqalenini ungakwazi ubhala*
29	T	What is 7x8? What is the answer? No! Don't count	*Ngubani u7x8, ithini impendulo,*

Ms P: DAY 1 [Lesson 2]		Utterance	
Turn		**English only [Translations from isiXhosa in red]**	**Original isiXhosa utterances**
		for him. Count for yourself.	*sumbalela. Zibalele*
30	T	What is this number? *[Ms P is working with one child on the addition task. Asking the child to show her what she's done. She congratulates the child.]* And then? Yes! Hee! Yes! You are a lady. *[Two learners sitting alongside the girl clap their hands for their classmate.]*	*Ngubanu elinani? Ewe hee! Uli lady*
31	T	Okay guys, okay, Write your name.	*bhala igama lakho*
32	T	So, when you come back, you are going to count for me and show the class how you did it. *[As she speaks Ms P collects in the A3 sheets from learners.]*	
33	T	Your name, Boy, your name. Thank you.	*bhuti,*
34	T	When you come back, you must finish off, understand. You must finish it off.	*Xanibuya, funeka nizogqibezela siyevana? Funeka nizogqibezela.*
35	T	Yhuu, this is the first time I'm seeing this. People have copied each other's work.	*Yhuu abantu bakope kwabanye*
36	T	Okay. Those who didn't finish must come back during break-time, neh?	
37	Ls	Yes.	
[Learners file out to next lesson.]			

Though my recording devices prevented me from capturing much of learners' actual peer-to-peer talk, the body language I observed suggested full engagement in discussing the choice of an addition strategy (Turn 12 onwards). Their talk appeared to be entirely task-focused. My impression also was that the children's communications with one another were exclusively in isiXhosa. Turns 10 and 26 are the only instances of my hearing Ms P's learners' use of English to communicate. In an interview post- the observation period, one of my questions to Ms P confirmed my impression that peer talk was mainly in isiXhosa. When I asked her what language the children used when working together on mathematics tasks, her reply was: "Among themselves they speak Xhosa. I won't lie!" (Interview 3P, Line 178). When I then asked whether or not she saw this as a problem, she responded: "No. Because they do understand each other, and that one who can't speak English contributes when they speak Xhosa in their group" (Interview 3P, Line 182-183). This then, she felt, contributed to a strengthening of their mathematical understanding (Interview 3P, Line 186).

A scroll through Ms P's talk in Lesson 2 above indicates that most of her talk related to pedagogical management (for example, getting learners to stay on task; indicating where and how big they should write), rather than mathematical content as such. Reviewing the video data, however, it is clear that in her one-on-one exchanges with learners her mediation focused in on task content, and by extension, therefore, mathematics content. So, for example, in Turn 29 we see her saying to a child: *Ngubani u7x8, ithini impendulo, sumbalela. Zibalele.* [What is 7x8? What is the answer? No! Don't count for him. Count for yourself.] In this sense this lesson was not typical of Ms P's observed classroom talk. As the exchange analysis of Lesson 16 (next section) indicates, there was a strong pedagogical emphasis in terms of both intent *and* content here. I return in Section 9.4.2.2 to Ms P's extensive use of isiXhosa and her expressed ambivalence about how helpful this was in the longer term.

9.3.2 EXCHANGE STRUCTURES IN Ms P's OBSERVED LESSONS

Two of Ms P's lessons were selected for detailed analysis using Sinclair and Coulthard's exchange structure model. As indicated in Part 5's introductory section, I chose two lessons for each teacher for this analysis – one at the start and one towards the end of their respective observation periods. The 'timing' rationale for choosing a lesson close to the beginning and then one towards the end of my periods of observation was that I might thereby more easily detect changes in teaching manner that might be put down to 'observer effect'. In the event, I did not become aware of any such changes, and, as reported earlier, Ms P assured me, "I was doing my work as usual" (Interview 2P, Line 355).

Ms P's Lessons 3 and 16 were chosen. They comprised 222 and 106 exchanges respectively, and, given that Lesson 3's analysis was twice as long as that of Lesson 16, I decided that I would include in this thesis text the full analysis for Lesson 16 only, together with the following breakdown of Lesson 3's exchange structure analysis categories (Table 9.3, below). A copy of Lesson 3's full exchange analysis is included my Research Archive.

Table 9.3: Breakdown of exchange types (Lesson 3P)

	Exchange type	Quantity	Sub-type	Sub-total
LESSON 3p	Boundary markers	6		6
	Informing exchanges	72	Management objective [M]	20
			Pedagogical objective [P]	42
			Disciplining objective [D]	8
			Social objective [S]	2
	Directing exchanges	60	Management objective [M]	25
			Pedagogical objective [P]	33
			Disciplining objective [D]	1
			Social [S]	1
	Eliciting exchanges	84	Management question [M]	19
			Discipline question [D]	2
			Pedagogy question [P]	37
			Open (referential) question [O]	-
			Closed (display) question [C]	25
			Social question [S]	1
	TOTALS	**222**		**222**

Table 9.4, below, is the full exchange analysis for Lesson 16P. As just noted, the analysis contained much fewer exchanges than did Lesson 3. To further shorten it, and as I note also midway in the Table, I made the further decision to omit all Ms P's exchanges with *individual* learners, barring lesson turns 52-61 (Exchanges 40-46, below). The latter provide insight into the nature of Ms P's one-on-one discussions with various learners. Lesson turns 63-125 (also one-on-one exchanges) are therefore not included. Exchange 69 onwards reflects only whole class interactions. Indeed, as I noted in my opening comment to section 8.3.1, Sinclair and Coulthard's exchange analysis system works best for teacher-fronted teaching. It does not easily lend itself to one-on-one verbal interactions either between peers or between a teacher and individual learners. A record of the omitted one-on-one interactions is available in the Research Archive (Lesson 16P transcript).

Because all Initiation and Feedback Moves came from Ms P, and all of Response Moves from the learners, I have not used 'T' or 'L' labels to mark individual utterances.

Table 9.4: Analysis of exchange structures (Lesson 16P)

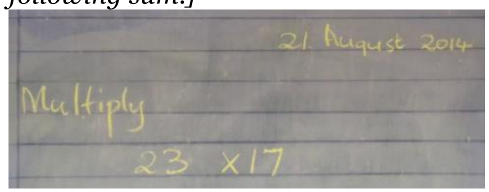
KEY:

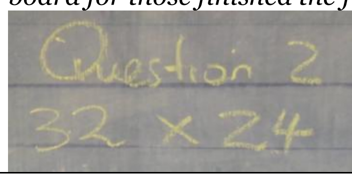
EN	=	Exchange Number	**P**	=	Pedagogy related
Red	=	English translation from isiXhosa	**S**	=	Social comment/ question
M	=	Management related	**NV**	=	Non-verbal response
D	=	Discipline related	^	=	Rising tone to cue learners in to providing an answer
C	=	Closed (display) question	~	=	Pause/ Uncompleted comment
O	=	Open (referential) question			

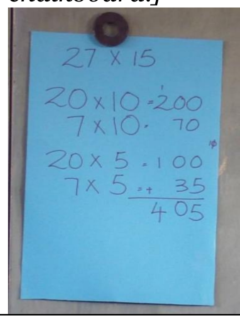
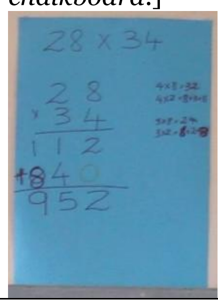
Lesson 16P		**MOVE**		**MOVE**		**MOVE**	
EN	**Exchange Type**	**[I] Initiation**	Act	**[R] Response**	Act	**[F] Feedback**	Act
1	**Boundary (1)**	Good morning, Teachers, How are you, Teachers?	Marker	We are fine, thank you. How are you?	Reply (individual)	We are fine, thank you, Teachers.	Reply (group)
2	Directing	Okay, sit down.	Directive [M]	*Learners sit* [NV]	React (group)		
3	Eliciting	Did you do your homework?	Elicitation [M]	Yes Miss.	Reply (in chorus)		
4	Directing	Okay, take out your maths book, so we can have a look.	Directive [M]	*Children take out books* [NV]	React (group)		
5	Directing	Let's swap our books. Give your neighbour your book. Give your neighbour your book.	Directive [M]	*Children swop books* [NV]	React (group)		
6	Directing	No! You know I don't want you there.	Directive [D]	*Child moves* [NV]	React (individual)		
7	Directing	*Ms P, by handing him a piece of chalk, nominates child to complete first line of task on chalkboard.* [NV]	Directive [P]	*Child enters answer:* 10x10 = $\boxed{100}$+ 50= *[NV]*	React (individual)		
8	Eliciting	Are you going to write 150 there?	Elicitation [P]	*Child adds in* $\boxed{150}$. [NV]	React (individual)	Thank you. Very good, Girl. Very good!	Accept/ Evaluate
9	Directing	*[Ms P nominates next child.]* Hurry, Boy.	Directive [M]	*Child points at* 10x20=, *then hesitates.* [NV]	React (individual)		
10	Directing	Look, People, I want you to mark in pencil and small markings.	Directive [M]				
11	Eliciting	20x10 is?	Elicitation [C]	*Learner tries*	React		

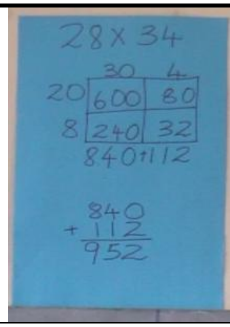
Lesson 16P		MOVE		MOVE		MOVE	
EN	**Exchange Type**	**[I] Initiation**	Act	**[R] Response**	Act	**[F] Feedback**	Act
				working out on his fingers. [NV]	(individual)		
12	Directing	Count 20 10 times.	Directive [P]	*Child unsure.* [NV]	React (individual)		
13	Eliciting	Who can help him? *[Ms P hands chalk to another learner.]*	Elicitation [P]	*Child speaks out loud the calculation process, as she writes:* 10x20=$\boxed{200}$+	React (individual)	Yes, Girl.	Accept/ Evaluate
14	Directing	Raise up your voice.	Directive [M]	Ten times twenty is two hundred.	React (individual)		
15	Directing	Sit down, Boy.	Directive [M]	*Child returns to his seat* [NV]	React (individual)		
16	Directing	We are here now. 200 +50	Directive [P]	*Child still unsure.* [NV]	React (individual)	Yes Mthobeli. Very good, Girl. Very good. *Ms P sends learner back to her seat.*	Evaluate
17	Directing	*[Ms P hands chalk to another learner.]*	Directive [P]	*Learner adds* $\boxed{250}$ *in the correct place.* [NV]	React (individual)		
18	Directing	*[Ms P hands chalk to another learner.]* Okay, Girl.	Directive [P]	*Child fills in* 30x10=$\boxed{300}$+50 =$\boxed{350}$ [NV]	React (individual)		
19	Eliciting	Where did you get that 350? What did you do?	Elicitation [O]	*Learner points at each of the numbers in the sequence she tackled them.* [NV]	React (individual)	Okay.	Accept
20	Directing	*[Ms P nominates child to complete next line.]* Lunga.	Directive [P]	*Learner fills in:* 40x10=$\boxed{400}$+50	React (individual)		

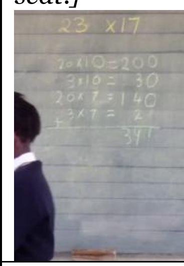
Lesson 16P		MOVE		MOVE		MOVE	
EN	**Exchange Type**	**[I] Initiation**	Act	**[R] Response**	Act	**[F] Feedback**	Act
				=$\boxed{450}$			
21	Directing	*[Ms P nominates a child to complete next line.]* [NV]	Directive [P]	50x10=$\boxed{500}$+50 =$\boxed{550}$	React (individual)		
22	Eliciting	How did you get the answer?	Elicitation [O]				
23	Informing	I want to know.	Informative [P]	*Learner points at the sequence he followed to get the correct answer.* [NV]	React (individual)	You don't just write an answer. You say, "500 +50 ...". Don't rob us. Don't rob us, Man.	Evaluate
24	Directing	*[Ms P nominates child to complete last line.]* [NV]	Directive [P]	*Learner comes up but appears uncertain.* [NV]	React (individual)		
25	Directing	Come on, People.	Directive [M]				
26	Informing	Some people here don't want to come in front. They don't want to write on the chalk board.	Informative [M]				
27	Directing	Come here, Girl. Come here.	Directive [P]	*Learner comes up and fills in the sequence correctly:* 60x10=$\boxed{600}$+50 =$\boxed{650}$. [NV]	React (individual)		
28	Eliciting	What's the answer?	Elicitation [C]	It's 600. And 600+50 =	Reply (individual)		
29	Eliciting	What's the answer?	Elicitation [C]	It's 650.	Reply (individual)	Okay. Okay.	Accept
30	Informing	These children are naughty.	Aside				
31	**Boundary (2)**	Okay.	Marker				
32	Directing	Write today's date.	Directive [M]	Children open their books. [NV]	React (group)		
33	Informing	You do corrections when you are wrong.	Informative [P]				
34	Informing	If you are wrong, you should do the corrections.	Informative [P]				
35	Directing	If you are wrong, you do the corrections	Directive [P]				

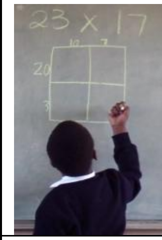
Lesson 16P		MOVE		MOVE		MOVE	
EN	**Exchange Type**	**[I] Initiation**	Act	**[R] Response**	Act	**[F] Feedback**	Act
		now.					
36	Directing	Do not rubber it. Do not rubber it.	Directive [M]				
37	Directing	Write next to the wrong one. You write the correct one here. Write the correct one here. *[Ms P indicates on the chalk board where they should write.]*	Directive [P]				
38	Informing	Because you are slow. You are very slow.	Informative [M]				
39	Directing	*[Ms P writes date (21 August 2014), the heading 'Multiply' and underneath the following sum.]*  You do any method you know, understand. You do any method you know.	Directive [P]				
40	Informing	We did multiplication, and we did 3 methods.	Informative [P]				
41	Eliciting	Do you still remember them? Do you still remember them?	Elicitation [P]	Yes Miss.	Reply (in chorus)	Okay.	Accept
42	Directing	Let's do it.	Directive [P]	Yes Miss.	Reply (in chorus)		
43	Directing	No, People! You've been given work to do. Now you stand up!	Directive [M]	*Children addressed settle* [NV]	React (group)	*Ms P circulates, addressing individual learners.]*	
44	Eliciting	What did you do here? Is it corrections?	Elicitation [M]	*Child nods* [NV]	React (individual)	Okay.	Accept
45	Eliciting	Why did you write it on the side?	Elicitation [M]	*Child looks down at what she's written* [NV]	React (individual)		
46	Informing	You saw mine is in the middle.	Informative [M]				
47	Directing	Pule, go sit there.	Directive [M]	*Child obeys* [NV]	React (individual)		
48	Directing	Let's hurry, People.	Directive [P]				

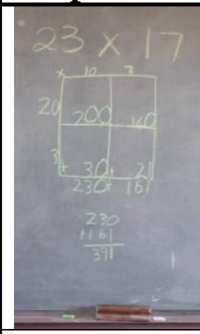
Lesson 16P		MOVE		MOVE		MOVE	
EN	**Exchange Type**	**[I] Initiation**	Act	**[R] Response**	Act	**[F] Feedback**	Act
49	Informing	You didn't give me my pencil yesterday.	Informative [M]	Sorry, Teacher, I gave you.	Response (individual)	Oh, okay.	Accept
50	Directing	Hide your work, Baby.	Directive [P]	Child shields her work with her hand. [NV]			
51	Informing	No one must see your method.	Informative [P]				
52	Directing	No, no, no. *[Ms P quells chatter. She circulates, observing children at work, asking an occasional question.]*	Directive [M]	*Learners are working at their maths. Some start bringing their books to Ms P for marking.* [NV]			
53	Directing	*[Ms P writes another question on the chalk board for those finished the first one.]* 	Directive [P]	*Children continue queuing to have their work marked.* [NV]			
54	Eliciting	*Ms P returns to one-on-one monitoring. Noticing a learner's error, asks:* Don't you say 23x17?	Elicitation [P]				
55	Directing	Start with tens. Then you say 7x3 and 7x2.	Directive [P]				
56	Eliciting	Have you forgotten the strategy now?	Elicitation [P]			*Praises those who are correct (e.g.* Very good, Girl.)	Evaluate
57	Informing	Some have forgotten.	Informative [P]				
58	Directing	People, can't we do this?	Directive [P]				
59	Directing	Okay let's try this one. *[Ms P points to one of three A4 manila sheets above the chalkboard.]*	Directive [P]				
60	Informing	Most of you tried to do this one but they forgot it.	Informative [P]				
61	Directing	Let's do this one.	Directive [P]				
62	Eliciting	Let's try this one, this strategy.	Elicitation [P]				

Lesson 16P		MOVE		MOVE		MOVE	
EN	**Exchange Type**	**[I] Initiation**	Act	**[R] Response**	Act	**[F] Feedback**	Act
63	Eliciting	Do we see? *[Ms P cleans a space on chalkboard. Takes down the A4 sheet and puts it up on the chalkboard.]* 	Elicitation [P]				
64	Eliciting	Let's try this one.	Elicitation [P]				
65	Informing	You forget this one. [*Ms P points to the second A4 manila sheet above the chalkboard.*] 	Informative [P]				
66	Directing	Don't do this one.	Directive [P]				
67	Directing	You do this one. *[Indicates the A4 manila sheet on chalkboard.]*	Directive [P]				
68	Directing	Or do this one. [*Ms P points to a third A4 manila sheet stuck up above the chalkboard.*]	Directive [P]				
69	Directing	Other people do this one.	Directive [P]				

Lesson 16P		MOVE		MOVE		MOVE	
EN	**Exchange Type**	**[I] Initiation**	Act	**[R] Response**	Act	**[F] Feedback**	Act
							
70	**Boundary (3)**	Okay, People.	Marker				
71	Eliciting	Let's ask anyone to come in front and do this one, please.	Elicitation [P]	*No one volunteers initially* [NR]			
72	Directing	Anyone come.	Directive [P]	Child comes to front. [NV]	React (individual)		
73	Directing	*[Many children are still standing in line, waiting for their work to be marked.]* You sit down.	Directive [M]	Learners return to their seats. [NV]	React (group)		
74	Directing	*[Ms P indicates in isiXhosa where child should write on the chalkboard.]*	Directive [P]	Child writes 20x10=200[NV]	Response (individual)		
75	Directing	There are lines on the board, hear me.	Directive [M]	Child rubs out and re-write 20x10=200[NV]	React (individual)		
76	Directing	Eyes on the board, Guys. Eyes on the board.	Directive [M]	*Most children appear to comply* [NV]	React (group)		
77	Directing	Girl, you must write under the lines. Listen!	Directive [M]				
78	Informing	It starts here. It starts here.	Informative [P]				
79	Eliciting	Where should you write this 3?	Elicitation [P]	*Child points* [NV]			
80	Eliciting	Is it okay under tens?	Elicitation [P]	*Child re-positions the 3* [NV]		Yes.	Accept
81	Directing	Even here, you must write under the units.	Directive [M]				
82	Directing	*Stop what you doing. Listen* and close your book.	Directive [P]	*Most children appear to comply* [NV]	React (group)		

Lesson 16P		MOVE		MOVE		MOVE	
EN	**Exchange Type**	**[I] Initiation**	Act	**[R] Response**	Act	**[F] Feedback**	Act
83	Informing	See. That zero is a unit. Units *must be under units.*	Informative [P]	*Child writes in the correct place* [NV]	React (individual)	Very good, very good!	Evaluate
84	Informing	You're not writing on the lines.	Informative [M]	Child makes to pick up chalk duster. [NV] *[Child continues writing out the solution, speaking out the numbers as she does. When she gets to adding the columns, she counts on her fingers. She completes the calculation and returns to her seat.]* 	React (individual)	[Ms P stops her.] But keep on. Don't erase.	React
85	Directing	Okay! You do the other one, neh.	Directive [P]				
86	Informing	The time is over now. The time is over now.	Informative [M]	*Silence* [NR]			
87	Eliciting	Have you seen the time?	Elicitation [M]	*Silence* [NR]			
88	Directing	Do the second one, Boy. Come here.	Directive [P]	*Next child comes up to chalkboard.* [NV]			
89	Eliciting	Are you going to do this one, or the second one? *[Ms P indicates the A4 manila sheets with the different multiplication strategies.*	Elicitation [P]				
90	Informing	I want the other strategy.	Informative [P]				
91	Eliciting	Who can do the other strategy? Yes, Boy.	Elicitation [P]	*[Child writes out the multiplication sum, draws the grid, together*	React (individual)	No, no, no. We times there. We multiply. Not add. We say	Evaluate

Lesson 16P		MOVE		MOVE		MOVE	
EN	Exchange Type	[I] Initiation	Act	[R] Response	Act	[F] Feedback	Act
				with the relevant figures for calculation, and voices his next move.] zero + zero = zero 		zero x zero. We don't say zero 0+ zero.	
92	Directing	Write big in the middle.	Directive [M]				
93	Eliciting	Do you understand, Boy?	Elicitation [P]	*[Child continues filling in the grid, but makes a slip for the 4th quadrant.]* 3x7=14. Child looks uncertain [NV]	React (individual) React (individual)	*The other children react.* Ms P: Huh? 3x7?	Evaluate
94	Eliciting	Let's count in 3's.	Elicitation [P]	*[Child counts off 7s on his fingers.]* 7; 14; 21. *[Writes 12 into the 4th quadrant.]*	React (individual)	*The other children react.*	
95	Directing	*Ms P asks him to re-write it correctly.*	Directive [P]	*He writes 21, then moves on to do the addition.* [NV]		Very good. Very good. [*Other children clap.*]	Evaluate

Lesson 16P		MOVE		MOVE		MOVE	
EN	**Exchange Type**	**[I] Initiation**	Act	**[R] Response**	Act	**[F] Feedback**	Act
							
96	**Boundary (4)**	If you are wrong, this one, or that one, that's your homework.	Marker				
97	Eliciting	Hear me?	Elicitation [P]	Yes, Miss.	React (group)		
98	Informing	That's your homework. You are going to do it right. It's either you do this one *[points to the first strategy]*, or do this one *[points to the second strategy]*.	Informative [P]	*Silence* [NR]			
99	Eliciting	Understand?	Elicitation [P]	*Silence* [NR]			
100	Eliciting	Let's tidy the desks and go.	Elicitation [M]	Children clear the desktops. [NV]	React (group)		
101	Informing	I want the corrections.	Informative [P]	*Silence* [NR]			
102	Eliciting	Hear me?	Elicitation [P]	Yes, Miss.	React (group)		
103	Informing	I want this one and this one - both of them.	Informative [P]	*Silence* [NR]			
104	Informing	You are making noise with these chairs.	Informative [M]	*Children lift chairs into place* [NV]	React (group)		
105	Eliciting	Are they that heavy?	Elicitation [M]	*Silence* [NR]			
106	Directing	Just pull up the chair. Just go.	Directive [M]	*[The children file out.]* [NV]	React (group)		

What the following breakdown of exchange types for Ms P's Lesson 16 reveals is a strong emphasis on initiating moves with pedagogical intent (Table 9.5). Of the 106 exchanges, 62 are to do with pedagogy, and, including her 2 open and 3 closed questions which were also of a pedagogical nature, the total becomes 67. Put differently, almost two-thirds of Ms P's initiating moves are pedagogically oriented.

Table 9.5: Breakdown of exchange types (Lesson 16P)

	Exchange type	Quantity	Sub-type	Sub-total
LESSON 16p	Boundary markers	4		4
	Aside	1		1
	Informing exchanges	21	Management objective [M]	7
			Pedagogical objective [P]	14
			Disciplining objective [D]	-
			Social objective [S]	-
	Directing exchanges	51	Management objective [M]	20
			Pedagogical objective [P]	30
			Disciplining objective [D]	1
	Eliciting exchanges	29	Management question [M]	6
			Discipline question [D]	-
			Pedagogy question [P]	18
			Open (referential) question [O]	2
			Closed (display) question [C]	3
			Social question [S]	0
	TOTALS	**106**		**106**

The next Table provides an aggregated breakdown of Lessons' 3 and 16's exchange types.

Table 9.6: Aggregated breakdown of exchange types (Lessons 3P and 16P)

	Exchange type	Quantity	Sub-type	Sub-total	[%]
LESSONS 3 AND 16	Boundary markers	6+4		6+4 (10)	
	Asides	0+1		1	
	Informing exchanges	72+21	Management objective [M]	20+7 (27)	29
			Pedagogical objective [P]	42+14 **(56)**	
			Disciplining objective [D]	8+0 (8)	
			Social objective [S]	2+0 (2)	
	Directing exchanges	60+51	Management objective [M]	25+20 (45)	34
			Pedagogical objective [P]	33+30 **(63)**	
			Disciplining objective [D]	1+1 (2)	
			Social [S]	1+0 (1)	
	Eliciting exchanges	84+29	Management question [M]	19+6 (25)	35
			Discipline question [D]	2+0 (2)	
			Pedagogy question [P]	37+18 **(55)**	
			Open (referential) question [O]	0+2 (2)	
			Closed (display) question [C]	25+3 (28)	
			Social question [S]	1+0 (1)	
	TOTALS	**328**		**328**	

And finally, Table 9.7 provides a tally of Ms P's discipline-oriented, managerial and pedagogical utterances for lessons 3P and 13P.

Table 9.7: Categorisation of exchange types (Lessons 3P + 16P)

CATEGORY	Tally		TOTALS	%
	Lesson 3P	Lesson 16P		
Discipline-oriented comments/ questions	11	1	**12**	**4**
Managerial comments/ questions	64	33	**97**	**31**
Pedagogical comments/questions	137	67	**204**	**65**
TOTALS	212	101	**313**[77]	

What emerges from each of these Tables is a profile of a teacher in which discipline issues are minimal, and in which a pedagogically-oriented focus is paramount. Ms P appears to have been highly effective at keeping her learners fully 'on task'.

9.3.3 Ms P's LEARNERS' OBSERVED VERBAL OUTPUT

In relation to Ms P's whole class interactions, learners' verbal responses were limited. For the most part Ms P appeared to have to be guided by gesture (mainly pointing) and some other forms of body language from the children. Chorusing was not a strong feature of this or other observed lessons. As was shown, for example, it is only in Lesson 16's exchanges 3 and 41 in which the children chorus an answer. Learner talk comprised mainly speaking of (or possibly, more accurately 'reading off') the numbers involved when individual children were called up to demonstrate their calculations for their classmates (as is, for example, shown in Exchange Number 13, where the child voiced "ten times twenty is two hundred, plus ~" as she wrote it out on the chalkboard [10x20=$\boxed{200}$+]).

Reference here to the difference between 'receptive' and 'productive' language skills is useful. Listening, being a receptive skill, involves the ability to decode incoming aural text (in this case Ms P's verbal instructions). Speaking, as a productive skill, involves being able to verbally convey a message that others will comprehend. In the Literature Review chapter I cited Nunan's description (2015) of listening as "the gasoline in the engine of second language acquisition" (p. 33). In language learning, development of the receptive skills generally precedes that of the productive skills. Hence, in the early stages of language acquisition (be it of the mother tongue; of a second language; or in this instance the language of mathematics), listening with understanding is generally less of an initial challenge than having to *produce*

77 [10 boundary markers, 4 social comments/ questions, and the 1 aside not included.]

contextually appropriate speech. Ms P's learners' actions, gestures, and brief verbal responses provide evidence that their receptive skills were functioning moderately well. The briefness of their productive (verbal) responses indicates that – relative to the L2 learning continuum (Table 2.3 of the Literature Review chapter) - they were most probably between the 'early production' and 'speech emergence' stage of development.

Getting her learners to come up and demonstrate on the chalkboard how they arrived at particular solutions to the various mathematical tasks she had assigned them was a particular feature of Ms P's teaching. On several occasions during these moments she would instruct a learner not simply to demonstrate, but also to 'thetha' (isiXhosa for 'talk'). So, in Lesson 13P, for example, she said to a child: "*Sisi, uthethe sive sisi.*" [Girl. Raise up your voice.] (Turn 20). Later in this same lesson, to another learner up at the chalkboard, Ms P put the question: "*Wenze njani ndifuna uqonda apha kwenzeke ntoni.*" [How did you get the answer? I want to know.] When the child then simply gestured by pointing to the steps he had taken, she insisted: "*Akuthathi ngobeka uthi 500+50. Susiqhatha fondini susi robber susi rober fondini.*" [You don't just write an answer. You say, "500 +50 …". Don't rob us. Don't rob us, Man] (Lesson 13P, Turns 33-35).

In an earlier lesson (3P) I had observed a child mildly over-stepping Ms P's 'thetha' brief, acting as if he were the teacher rather than simply the learner! He had, at Ms P's request come up to the chalkboard to calculate 2448+2374.

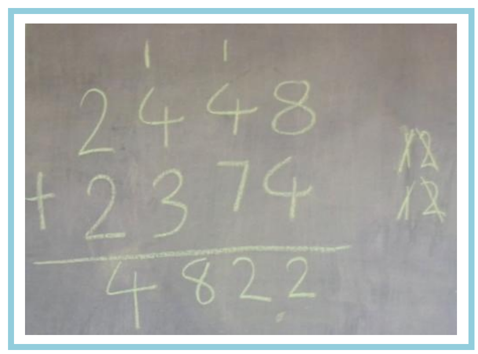


Photo 9.2: Child's chalkboard solution

Ms P had invited him to use any strategy he liked. He chose the standard column algorithm. *"Thetha sive kalok bhuti, xelela iklasi,"* Ms P instructed. [Speak so that we can hear, boy. Tell the class.] Instead, the boy put the question to the class: "Four plus eight is ^?" "12!" they chorused.

Ms P then interjected: "*Andithi babuze, ndithi baxelele. Awuqali ngencinci kuaqala?* [I am not saying ask the class. I said tell the class. …] *Thetha sive kalok*. [Speak so that we can hear.] Thereafter the boy simply attended to his working out, reporting as he went along: "Five plus seven is ~"; "Five plus three is eight", and so on (Lesson 3P, Turns 22-29).

I noted in the Literature Review chapter (Sections 2.5.1 and 2.5.2) that a key element of both the 'Thinking Together' and 'Talk Moves' programmes was establishing a mutually respectful and supportive atmosphere in the classroom where children are free to talk (or, in Ms P's terms, 'thetha') without any fear that classmates might laugh at their effort. Ms P's view was: "It is useful. That is practice. [...] Practising to voice the feeling maybe sometimes, you know" (Interview 3P, Lines 126-128). I earlier cited Ms P's comment that her learners were at times "scared" because some children "like to laugh at each other" (Interview 2P, Line 291). In the third interview Ms P again referred to this as an explanation for why her learners did not 'thetha' as much as she would have hoped for.

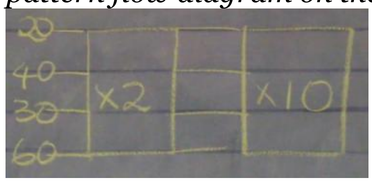
> That's a problem, they don't talk. They used to laugh to each other when someone makes a mistake. You know. They laugh. Then the other one will be withdrawn because of that. They don't want to make mistakes. They are scared of making mistakes. (Interview 3P, Lines 101-103)

I found Ms P's use of the verb 'used [to]" interesting. Certainly, notwithstanding her comments here, the sense I got was not so much that her learners were scared to talk, as that they were insecure as to how best to express their reasoning through English. They were not at a stage of L2 proficiency that conduced to easy stringing together of words into sentences, but they certainly 'got by' with more telegraphic-style 'articulation' of their various calculation steps. Some achieved this non-verbally by simply pointing at the sequence they followed in arriving at their answers; others would speak out loud along the lines of, for example, "four minus two [*counts on her fingers*] is two (lesson 5P, Turn 79); and *"[pointing to the steps on a numeric pattern Ms P has written up on the board]* five plus ten is fifteen ~ plus twenty is thirty five" (Lesson 13P, Turn 47).

As Ms P indicated in a subsequent interview, she wanted learners, "to tell the others", because, as she put it, "I believe that they learn from each other" (Interview 2P, Line 265). She then went on to explain her motives in some detail:

> If sometimes something they don't take it seriously from me, when the other one is doing it, "Oh! Ubani [*isiXhosa for 'somebody'*] is doing it like this!" You know? [...] That's why I say, "Say something. Don't just do it for yourself. Do it for – with them." You know? [...] 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." (Interview 2P, Lines 267-274)

I noted earlier that Ms P had organised her classroom layout to facilitate group work. Despite my not capturing any significant amount of learners' peer-to-peer talk, I was, in Lesson 14P, 'party to' a mathematical disagreement between two boys seated near where my video recorder was positioned. The following transcript starts with Ms P instructing learners to work in pairs on what she labelled a 'numeric pattern flow diagram'.

Ms P: DAY 8 [Lesson 14]		**Utterance**	
Turn		**English only [Translations from isiXhosa in red]**	**Original isiXhosa utterances**
12	T	*[Ms P distributes recycled A3 desk calendar sheets.]* Okay with your partner do these for me, understand? *[Ms P draws the following numeric pattern flow diagram on the chalkboard.]* 	*Nhe*
13	T	You are making noise.	*Niyangxola.*
14	T	Quickly with your partner, write in big. I want the big numbers. Yes, with a crayon. I want big numbers.	*Ubhale kakhulu nhe, ewe ngecrayon*
[Turns 15-22 not related to the following event.]			
23	L(1)	*[A pair of learners is having a disagreement about how to proceed.]* No. It should be multiply times 10. Give the paper to me. I will write. This is wrong.	*Heeee times 10 hee ha a sapha ndibhale ngokwam. Irongo lento*
24	L(2)	This isn't wrong.	*Irongo phi lento*
25	L(1)	Okay. Write your thing, boy, and show to Ms P. You will then know this is wrong.	*Okay bhala bhala sani qgiba umbize zabona irongo lento*
26	L(2)	*[Inaudible explanation from learner2.]*	
27	L(1)	*[Insists his partner show it to Ms P.]* Take it, boy. *[L(2) takes A3 sheet to Ms P.]*	*Isa fondini isa*
28	T	Who are you working with? He must also come. *[L(1) joins them. Ms P discusses with the two boys their calculating. They return to their seats.]*	*Usebenza nabani? Iza nalomntu usebenza naye*
29	L(1)	I *told* you that this is wrong.	*Bendikuxelele bendithe irongo.*

It is unfortunate that my recording equipment was unequal to the task of capturing the boys' entire discussion. It was striking to have witnessed the two of them clearly engaged in some form of exploratory talk (albeit that they were perhaps a little short of the 'mutual respect' alluded to above); and also, that they made exclusive use of their L1 in doing so.

9.3.4 Ms P's QUESTIONING PATTERNS

As Tables 9.6 indicated, a significant part of Ms P's teaching the two lessons used for exchange structure analysis comprised eliciting exchanges (often in question form). In the following Table I pull out data from these two lessons to provide examples of the form Ms P's elicitations took. The red indicates Ms P's use of her learners' L1.

Table 9.8: Examples of Ms P's elicitations (Lesson 3P and 16P)

QUESTION CATEGORY	Total	%	Examples
Management	25	22	Andile, did you give them the books? (3P, EN62) Did you write it? Where did you write it? Where did you write it? (3P, EN88) What did you do here? Is it corrections? (16P, EN52) Have you seen the time? (16P, EN86)
Discipline	2	2	Who is making a noise? (3P, EN64) Why are people talking when there is a book in front of them? (3P, EN64)
Pedagogy	55	48	Where are the zeros? Where are they? Where is the answer? What is this answer? (3P, EN101) What is going on here, Lindiwe? What is going on? Do you see the way you have put the numbers? (3P, EN103) Do you understand, People? (3P, EN112) Can people who don't understand, lift up their hands so I can help? (3P, EN126) Who can help him? (16P, EN13) Do you still remember them? Do you still remember them? *[3 strategies for 2-digit multiplication]* (16P, EN40) Don't you say 23x17? *[on noticing a learner's error]* (16P, EN53) Have you forgotten the strategy now? (16P, EN55) Are you going to do this one, or the second one? *[indicating the different multiplication strategies]* (16P, EN88)
Open (referential)	2	2	Where did you get that 350? What did you do? (16P, EN19) How did you get the answer? (16P, EN22)
Closed (display)	29	25	What is this 7 or 20 for? What is it for? (3P, EN27) Don't you start with the unit first? (3P, EN33) Who can tell me what these are? Who can remember what these are? Who can remember? *[wanting learners to identify 'columns' and then 'rows']* (3P, EN48) Is one plus three eight? (3P, EN100) 20x10 is? (16P, EN11) What's the answer? (16P, EN29)
Social	1	1	Did you go? *[to the doctor]* (3P, EN12)
	114		

Two things stand out in the above examples of Ms P's questions. Firstly (as already noted), her extensive use of isiXhosa; secondly, that her questions seem to genuinely elicit, rather than shut down, participation from her learners. Even in her 'display' questions her emphasis appears not so much to be on getting a learner to provide a single right answer as pushing learners to give more thought to their mathematical procedure/s. I now take Ms P's seventh lesson (a lesson roughly midway through the observation period) for further analysis of her patterns of questioning. As I did for the Ms M chapter, I draw on Bellon et al's framework for categorizing the purposes of teachers' questions (see Figure 8.3) for this further analysis. As before, red indicates where Ms P used isiXhosa. The lesson began with 'mental maths'.

Ms P got learners to orally work with her to solve a number ladder, starting with the number '10' (as shown alongside); and she then got them to repeat the same steps in their exercise books, starting this time at the number '9'.

Number ladder	
Start at 10	
Double it	**=**
Add 2	**=**
Subtract 5	**=**
Add 10	**=**
Subtract 13	**=**
Halve it	**=**
What is your number?	**=**

Table 9.9: Analysis of Ms P's questions according to category and purpose (Lesson 7P) (after Bellon et al., 1992)

	PURPOSE OF QUESTION	**Total**	**%**	
Instruct	**To focus thinking** What is that number? (Turn 2) What do we do? What do we do? (Turn 18) What must we do with that one? (Turn 66) Can you do this strategy? (Turn 169)	**28**	**33**	**38**
	To extend thinking Who can tell me what is the other word for subtract? (Turn 9) We say if we add, we plus, isn't it? (Turn 58) What are we going to do, Girl? Where do we start? (Turn 61)	**4**	**5**	
Formative Assessment	**To evaluate comprehension** Do we see? (Turn 30) Are you with me? (Turn 54) How did you get that? We must show others how you did it. (Turn 71) What is happening here? Come forward Boy. (Turn 145)	**19**	**23**	**23**
	To make instructional decisions	**-**	**-**	
	To diagnose readiness	**-**	**-**	
Encourage	**To promote active learning**	**6**	**7**	**23**
	To encourage involvement Achieved mainly through nominating individual learners: Yes, Boy? Yes, Girl? Yes, Lindiwe? (12 such turns)	**12**	**14**	
	To motivate learners Very good, very good. Did I put the *[reward]* stamp on your book? (Turn 167)	**1**	**1**	
Manage	**To maintain attention** Twenty past, you must be finished, understand? (Turn 40)	**1**	**1**	**17**
	To control behaviour Stop that, you hear me? (Turn 4) Where are you coming from, Child? *[to a latecomer]* (Turn 45) Hear me, Mr D? (Turn 108)	**6**	**7**	
	To maintain order It will waste your time if you copy *[the question]*, understand? *[Learners should just write the answers]* (Turn 43) Who haven't come for marking? (Turn 113)	**7**	**8**	
	TOTAL	**84**		

Ms P asked 84 questions in Lesson 7P. The biggest category of question related to instruction, focusing thinking mainly, but with some extension-of-thinking-type questions, two of which – interestingly – relate to her seeking her learners' assurance that they were *au fait* with mathematical terminology (something I discuss in the next section). Ms P did not ask a lot of 'demand-type' questions. Instead her questions were of a more 'invitation-to-participate' sort; eliciting, rather than demanding, responses. So, for example, she asked, "Who can tell me what is the other word for subtract? She did not ask "What is the other word for subtract?" Her phrasing gave her questions less of an imperative tone, inviting a learner to volunteer an answer, rather than calling on learners plural in ways that might then have conduced to their providing answers in chanted unison. As I noted previously, chorused responses were not, in fact, a strong feature of Ms P's observed lessons.

9.3.5 Ms P's MEDIATING OF MATHEMATICAL VOCABULARY ITEMS

Notwithstanding my noting in earlier sections, the point that the language of mathematics is more than simply mathematical vocabulary, vocabulary clearly is a key part of this language. I was struck by Ms P's handling of vocabulary. One of the first things I noticed when I first arrived in her classroom was the laminated vocabulary lists stuck down on each learners' desk. I asked Ms P about these in our second interview. She explained that this was an idea she had got from a teacher development workshop at Rhodes University, a workshop she herself had not been able to attend as she had another commitment:

> **Ms P:** … but I asked one of the teachers to give me one so that I could photocopy and then I photocopied them and then I plakked [*Afrikaans for 'stuck'*]. And then I ask them to read it every day.
>
> **S-AR:** And have you found it makes a difference?
>
> **Ms P:** It does. It does. Because they know most of the words here – those guys who can't read.
>
> (Interview 2P, Lines 464-468)

Nation, a leading researcher in the area of vocabulary acquisition, made the point that it is not possible for learners to be explicitly taught all the words they need to know. "Vocabulary learning," he argued, "depends on the number of meetings with each word and the quality of attention at each meeting" (Nation, 2015, p. 137).

There are three examples in Lesson 7 of Ms P confirming (and reiterating) her learners' understanding *in English*, but also in IsiXhosa, of certain mathematical words. In Turns 9 to

13, for example, Ms P (Turn 9) checked, in an ‘incidental’, but (importantly) context-embedded way, that her learners understood the word ‘subtract’. In terms then of Nation’s comment cited above, then, Ms P’s handling of this mathematical vocabulary ‘check’ was both incidental *and* deliberate. The fact that it was context-embedded helped make it more meaningful than had she simply given her learners a list of mathematical words and definitions outside of a particular mathematical task (which in this case, was the solving of the ‘number ladder’).

Ms P: DAY 4 [Lesson 7]		**Utterance**
Turn		
9	T	Subtract 5. Who can tell me what is the other word for ‘’subtract? What is the other word for ‘subtract’?
10	L	Minus
11	T	‘Minus’ or ^?
12	L	Take away
13	T	‘Take away’. Take away 5 from 22.
[...]		
29	T	And then from 27, we subtract, we subtract 13. We take away 13. Yes?

The first child offered the more mathematically technical term ‘minus’. In seeking perhaps to mesh BICS with CALP, Ms P nudged her learners further, leading a second child to then offer the more everyday equivalent, ‘take away’. Later Ms P did the same with the word ‘add’, providing the synonym ‘plus’ as a further option.

Ms P: DAY 4 [Lesson 7]		**Utterance**	
Turn		**English only [Translations from isiXhosa in red]**	**Original isiXhosa utterances**
57	T	20, isn’t it. Okay. To that 20, we add 2.	*nhe*
58	Ls	22	
59	T	We say if we add, we plus, isn’t it? Add 2. 22	*Nhe*
60	T	22 subtract 5. 22 subtract 5. Yes, Lindiwe?	
61	L	17, Miss.	
62	T	He says it’s 17. Let’s look if he is correct. It’s 22 subtract 5. What are we going to do, girl? Where do we start? Show us.	*Uthu 17 ba unyanisile na? siqala sithini sisi? Siqala phi siqala ngaphi? Mbobala*

And then later, Ms P re-emphasised the meaning of ‘double’, and, as with other occasions, where she offers a range of strategy options, she provided them with the choice of either ‘doubling’ or ‘multiplying’.

Ms P: DAY 4 [Lesson 7]		Utterance	
Turn		**English only [Translations from isiXhosa in red]**	**Original isiXhosa utterances**
96	T	[...] Remember, when we double, we say 10. When we double something, double 10, hey.	
97	T	20, and double 2.	
100	L	4	
101	T	Double 2. When you double, you say the number twice 2x9. You can multiply, or use addition. We got 9+9. What do you get? 8+8. What do you get? That is how you double. That's 'double' neh. Understand?	*Udouble 2 naba uba dabulishi boy2 udouble uthi timse 2 kanye plus elanani we got u9+9 ufumane bani 8+8 ufumane bani that's double nhe?*

In the next section I focus on Ms P's own perceptions of the sorts of things that enabled or constrained her learners' mathematical sense making. Included here is brief further discussion of the consideration she gave to developing their mathematical (and other) vocabulary.

9.4 Ms P's PERCEPTIONS ABOUT HER LEARNERS' MATHEMATICS LEARNING (Interview data)

In the following subsections I present data obtained from the three interviews I had with Ms P: the first ahead of the lesson observation period; the second the day before the end of the observation period; and the third, an *ad hoc* one, which took place when I went to deliver to her copies of the interview and lesson observation transcripts. Full transcripts of these interviews are available in my Research Archive. As with Ms M's interviews, I provide here a "narrative rendering" (Sfard & Prusak, 2005, p. 17) of my interview data for Ms P in an effort to foreground her voice. The same provisos outlined in my telling of Ms M's 'story' pertain here; namely that I acknowledge the fact that the following subsections represent '*my* story of Ms P's story' rather than *her* story (after Sfard & Prusak, 2005, p. 20). It is also not a full recount. Largely omitted from the full (interview) story are those things that have already been covered in previous sections.

9.4.1 INTERVIEW 1: Ms P

This initial interview took place twelve weeks ahead of my period of observation in Ms P's Grade 4 mathematics classroom. We began the interview with my gathering some biographical information from Ms P, much of which has been shared in earlier sections, including the fact of teaching mathematics at the Grade 4 level being a relatively new experience for her. Consistent with the experiences of many other South African teachers, as reported by, for example, Graven (2014b), Ms P explained that she had encountered gaps in her Grade 4s' foundational mathematical understanding. This had obliged her to back-track to earlier grade-level work: "I won't lie. It's not easy because I start from Grade 3 work because most of the work they haven't done in grade ~ in the foundation phase. So that work takes time. I start from the Grade 3 work, and start from Grade 4 afterwards" (Interview 1P, Lines 14-16).

It was in asking whether she was able to 'cross-pollinate' between mathematics and English, that Ms P indicated that, although she did indeed do this, she felt that her learners' English proficiency contributed to her difficulties (notwithstanding that, in terms of CAPS, they would have begun on learning English as a subject from Grade 1).

> Those kids it's not easy for them. The English is not easy for them because in their foundation phase they were doing everything in Xhosa – first additional language, uh – mother tongue. But now in Grade 4 is that transition. Eh! It is not easy. ... It is not. (Interview 1P, Lines 49-53)

She was quick to emphasise however that English was not the only challenge her children faced. "Most of the learners," she explained, "have a problem, have problems. Some of these problems are social problems. Most of our kids are sick. They're on treatment. So they don't cope most of them. ... If you are teaching in class you will see that he is not here. The mind is far away" (Interview 1P, Lines 66-72).

Later in the interview I guided talk back to the language question.

> **S-AR:** Do you want to talk a bit more about the language problem that you say you encounter? And the kinds of things that are really difficult for you?
>
> **Ms P:** It's the vocabulary.
>
> (Interview 1P, Lines 105-108)

In response to this, she explained that she had tried various ways of strengthening the children's mathematical vocabulary. "What I did was I chose the words from the mathematics language and then described them on a chart. If I say 'altogether', they must know that it's a 'plus' – you use a plus sign. If you say 'left', they don't know which operation this should use. So it's vocabulary that is the problem" (Interview 1P, Lines 108-111). She later expanded on how, even though officially the LoLT for Grade 4 mathematics was English, she continued her L1 support for her learners.

> Ja. It is *supposed* to be English, but because of that transition - they were doing Xhosa in *everything* – everything on the foundation phase, but I do have to translate it in Xhosa, if I see them they stuck. For example, the problem solving, they will reach the situation, then they don't know what to do because of that vocabulary that is limited to them. So if it is said, "How much did they get altogether?", they don't know what 'altogether' means, so I must translate it in Xhosa. (Interview 1P, Lines 152-157)

In line with Cummins's construct of 'common underlying proficiency' (2005), Ms P indicated that she felt the children *were* able to transfer across into English the mathematical concepts they had learned in isiXhosa. What remained a problem, however, was their not being able initially to recognise, and hence *realise* (after Bernstein, 2000) what was required of them, particularly in test situations:

> Oh, they are scared for tests. … They know something, but when they hear the word 'test' I don't know what happens in their minds. (Interview 1P, Lines 120-124)

She explained that when writing their Mathematics ANAs, for example, she, as their class teacher, was not permitted to scaffold even by reading out test questions (as was the case for Grade 1 and 2 learners):

> They do have the understanding of what is going on but the *question* is their problem. (Interview 1P, Lines 161-163)

9.4.2 INTERVIEWS 2 and 3: Ms P

The second and third interviews with Ms P took place respectively on the afternoon before my final day of lesson observation, and then eight weeks thereafter when – as part of the member-checking process - I met with Ms P to give her copies of my lesson observation and interview transcripts. Despite the third interview not being formally scheduled, I was fortunate that throughout the research process I had my tape recorder on hand which meant I was able to record our discussion for subsequent transcription.

I have chosen to weave together into a single section insights emerging from the second and third interviews, my rationale here being that they covered similar ground. To achieve the weave I have organised the interview data into three subsections as follows:

- Management of classroom teaching
- Language of learning and teaching
- Social problems

9.4.2.1 Ms P's management of classroom teaching

I noted in Section 9.2 that Ms P's arrangement of the children's desks was designed to facilitate peer-to-peer discussion. I noted also that she was not worried that it might also facilitate off-task chatter as she kept a close check on their engagement with the tasks she assigned them. When not doing whole-class teaching, she moved around constantly, checking on individual children's progress. I asked her what informed her decisions when deciding who to give attention to and when to move on: "When you see that he's moving or she's moving [i.e. making headway], then I go to other one. I don't want to disturb the others" (Interview 2P, Lines 40-41).

Ms P explained she needed to achieve a lot within the actual school day:

> There's no time for maybe after school, because of the transport problem. … That child who has a problem - the transport is there to fetch him. It's been a long time of talking to parents that after school the child who has a problem, "Please talk to the transport." UhUh – they don't. So that's the only time [i.e. during school hours] we try to put them to work. (Interview 2P, Lines 41-46)

We briefly discussed some other administrative issues, including the writing of the ANAs and record keeping, before returning to things relating to the way Ms P managed her classroom teaching. One thing I had repeatedly observed was children, with Ms P's tacit approval, working out things by counting on fingers and tapping foreheads. I noticed too that even she at times modelled such gestures.

Lesson 1P, Turn 61 **Lesson 5P, Turn 70** **Lesson 6P, Turn 188**

Photo 9.3: Examples of Ms P and her learners' use of physical gesture as an aid to calculation

"Even," I said, "when they've got really simple sums I noticed some of them – it was like 6 minus 4 - then they can't just say 2, they still [I gestured counting on fingers]" (Interview 2P, Lines 127-129). I asked Ms P if she thought such body gesturing was helpful. She seemed to regard it as a developmental thing.

> I think it's a good thing, so that you can be – they can do it on their own. Because they come from the foundation phase – can't do the mental maths. … Even the tables – they start here. … Ma'am, it's not easy. The tables! I took time on tables. (Interview 2P, Lines 105-110)

The practice of TPR (Total physical response) is a practice used by second language teachers to aid comprehension. First mooted by Asher (1969), it involves encouraging learners to act out meaning at the same time that they attempt to verbalise it. Teachers, in turn, do the same so as to make what *they* say to learners (their input) more comprehensible. It is a particularly common practice in Foundation Phase teaching, and possibly something Ms P has brought across from her time teaching this phase. Ms P expressed the view that the learners did not do this because they were "lazy to learn", but because "most of the kids, they have social problems, so their minds – I really don't know what is happening with their heads. They are really difficult" (Interview 2P, Lines 132-135). (I focus on this social aspect in the next section.)

In the same way that Ms M linked TPR to aiding learners to do mental mathematics, she noted also the importance of automatizing her learners' tables as an aid to mathematical fluency.

> I do feel they should know the tables, because in multiplication they use tables, in division they do use the tables. And when they know tables, it's easy to calculate. … I disagree with the new things [*she included here discussion of the teaching of reading and what she perceived as a decline in children's reading proficiencies*]. (Interview 2P, Lines 112-114)

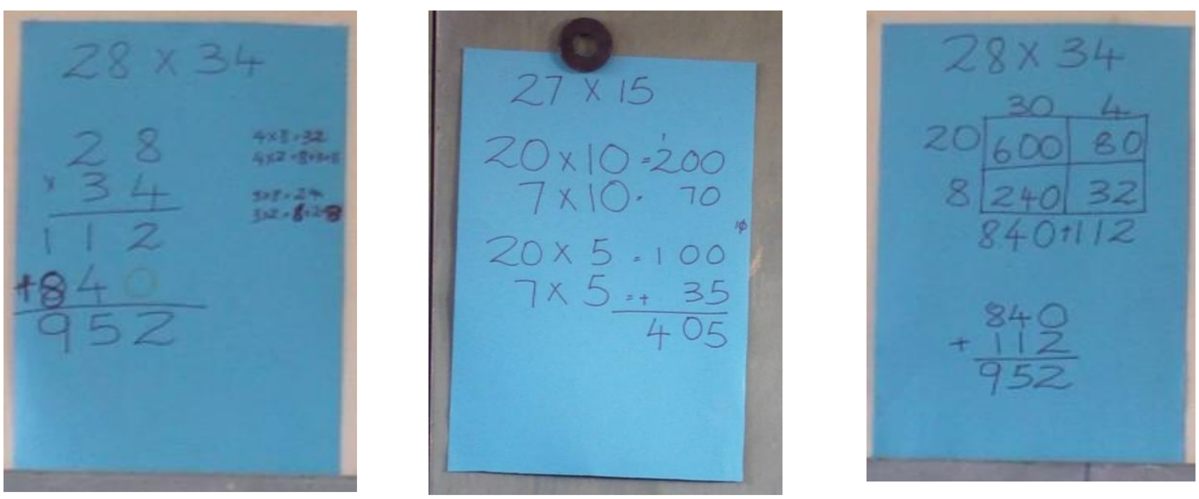
She suggested that the greater 'freedom' of the new curriculum meant: "The teachers throw away their good things, and now they follow this. … That's my problem" (Interview 2P, Lines 121-124).

I then asked her about her practice of allowing learners to choose the strategy they wanted to use in working out arithmetic solutions. I enquired why she encouraged this, to which she replied:

> 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.
> (Interview 2P, 149-151)

This multi-strategy approach, Ms P said, she had picked up from the NICLE sessions. Prior to this, she had taught just the one strategy. She explained that previously she had only been aware of, for example, the standard algorithm for 2 digit by 2 digit multiplication, and that many learners struggled with this: "It's not easy for them" (Interview 2P, Line 158). But the other two strategies (see Photo 9.4, below) she had picked up through NICLE she said had made a big difference: "These 2 – Wow! [...] when I came with this one at [NICLE] – Wow! ... It helps a lot." (Interview 2P, Lines 156-170)

In the introductory section for this chapter I described Ms P's classroom as a veritable "Aladdin's Cave" in terms of its print richness. Amongst the many posters on display in her classroom were the following. They were sited up above the chalkboard, and she would bring them down and place them on the chalkboard whenever she wasn't to remind her learners of the different strategies they could use.



The 'old' way **The 'two 'new' ways**

Photo 9.4: Ms P's posters illustrating different multiplication strategies

As I noted in the discussion around Bernstein's recognition and realisation rules (Section 6.4) I made a connection between Ms P's encouraging this choice of strategy and helping learners towards greater autonomy and self-regulated behaviour. Mindful too of, for example, Hattie's (2007) work on the role of feedback in helping learners take more control over their own progress, and Dweck's work on 'fixed' and 'growth' mindsets relative to children's motivation to achieve in class (see, for example, Dweck, 2007; 2008, 2010), I next asked Ms P about her different oral feedback strategies.

> Now, I've noticed you when you're teaching them, you're very sweet with them, and you say, "Well done!" - I can't remember your exact words, but you say "Well done. That's so good. Good. Well done." And then another time you won't say anything, but I can see you're ticking them 'right'. (Interview 2P, Lines 175-179)

Ms P explained that she would sometimes hold back on 'public' praise, going rather for acknowledging high achievers with reward stickers in their exercise books. Asked her rationale for this, she replied:

> I don't want to hurt those who don't get. ... I sometimes think of them. Yes – I know the kid is – you encourage them by praising them always, but there are those who don't have any praising. I don't want to hurt them always. (Interview 2P, Lines 186-190)

I have seen many teachers who struggle to do differentiated teaching. This was not the case with Ms P. This, combined with the fact that her learners were clearly well inducted into her preferred classroom rules and routines is what, I believe, conduced to lessons almost completely free of discipline problems. Learners were seldom 'off-task'. There was a fairly wide range of mathematical performance in the class (as indicted in the introductory section of this chapter). When asked the basis on which children were assigned to either Class 4A or 4B, Ms P explained that her school did not practise streaming: "From the foundation phase ... we put them in line and then we say go to [*names herself*], to [*names other Grade 4 teacher*] ... They are balanced when I see them, because there are those who have potential and those who are very low" (Interview 2P, Lines 8-12). I mentioned in the second interview that I had observed that she always had another task ready for early finishers.

> **S-AR:** Is it difficult for you to do this differentiation?
>
> **Ms P:** It's not. Because they get bored and, you know, Mandla [*one of the clearly bright children in her class*] is naughty. ... I must. I must, because he is going to be bored, and do something wrong. ... So that's why I keep him busy.
>
> (Interview 2P, Lines 400-410)

I then remarked on how neatly all Ms P's learners exercise books were: "Even the weak children," I remarked, "their books are neat. How did you get that to come right?" Invoking God, Ms P said:

> I talk to them about the neat work. Because at - um – even about the class – you know? I started by talking about the class. I said we are praying here. We are talking to God. God doesn't stay in a dirty place. So even in our books, you know, you must keep your book as your class you do. (Interview 2P, Lines 209-212)

Notwithstanding Graven's argument that "consistent work must be prioritised above neatness" (2016, p. 11), Ms P's indication that she perceived neatness as an aspect of discipline carries weight: "the discipline, the discipline – you must be continuously talking about it when they come to class for the first time" (Interview 2P, Lines 223-224). The 'discipline' to which Ms P was here referring to may be the more important given the stressful uncertainties of the living circumstances she said many of her learners endured beyond the classroom: "You tell them what you like and what you don't like" (Interview 2P, Lines 224-225). One of the things Ms P did not like was untidy work. Wong Fillmore made the point (1985) that 'automatizing' more mundane structural regularities and classroom routines helps free children of 'What next?' type anxieties. This, she argued, allowed (especially L2) learners to channel their attention more whole-heartedly (-headedly) into the academic tasks at hand. Ms P's emphasis on neatness is also evident in the following photograph is of Ms P's classroom *between* a morning's set of observed Grade 4 lessons. It speaks of her having borne in on her learners her expectations regarding 'neatness'. This pristine state was the learners' doing.

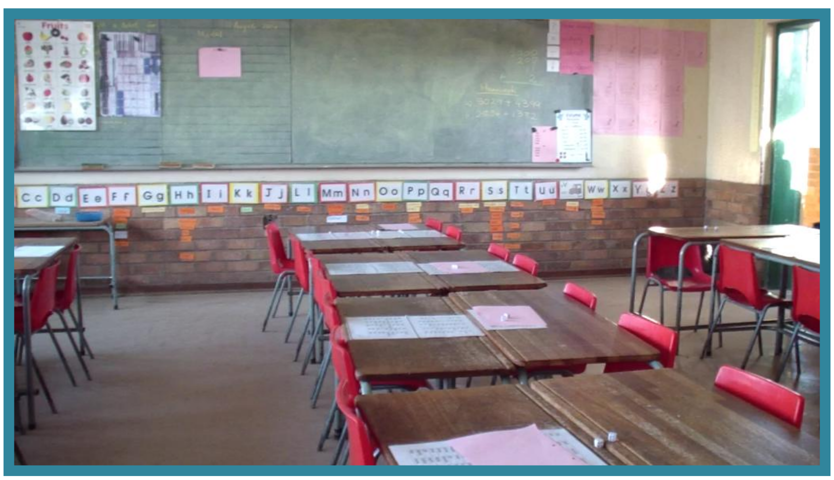


Photo 9.5: Indications of Ms P's Grade 4 classroom 'orderliness'

9.4.2.2 Ms P's thoughts on the Language of Learning and Teaching question

I have already explored much of Ms P's bilingual practices, particularly her sense of a need for ongoing and extensive use of isiXhosa. Given that she so clearly saw isiXhosa as central to her Grade 4s' mathematical meaning making, I asked her: "Do you think it's a good idea for them to learn in English at all?” (Interview 3P, Line 17). Her response was interesting, and very clearly in favour of retaining (but strengthening) children’s opportunities for developing proficiency in English. Her first point was that policy meant that from Grade 4 English became the dominant medium, but even when I put to her the question: “if the policy could be changed, what would your feeling be about the *learning* in mother tongue as opposed to having to do this big switch?” (Interview 3P, Lines 19-21), her reply was:

> Mm-Hm. No. I don’t want that. I don’t want English to be dropped. … I think if it can be changed from the Foundation Phase – they teach some things in English – it can be better. Because – it will be difficult for them to *do* the upper standards – the classes. It will be very difficult. Because the books are written in English. It’s only Xhosa that is written in Xhosa. (Interview 3P, Lines 23-29)

I then put another ‘if’ question before her: “What if the upper grades could also have isiXhosa as LoLT?” She was adamant:

> Uh-Uh. Uh-Uh. I don’t like that. I don’t want to lie, Ma’am. Even us. It’s not easy for us to speak English. Yes. It’s not our language, but if I go somewhere, I come across the foreign person, maybe from Zimbabwe, they know nothing about Xhosa. How am I going to communicate with them? You know? We prepare these kids to be able to communicate with the other people. I’m against that home language be changed to – the home language be taught to – upper classes. […] I’m against that. (Interview 3P, Lines 32-40)

I then asked whether there might be any advantage in splitting the language of learning and teaching from learning in English so that children could, for example learn their mathematics (and other content subjects) in mother tongue and at the same time learn English as a subject. “Do you think,” I asked her, “it would help [your Grade 4s] learn their maths better if it was done all in mother tongue?” MS P threw the ball back into my court.

> **Ms P:** Okay. I’ll ask you a question.
>
> **S-AR:** Okay.
>
> **Ms P:** If that is done, what will happen when they come to the tertiary?
>
> (Interview 3P, Lines 47-49)

9.4.2.3 Ms P's concerns for the impact of social problems on children's opportunities to learn

I have alluded in several places to Ms P's sense that social problems were a major impediment to her children's opportunities to learn, plus her sense that circumstances were getting progressively worse.

> As the time goes, kids from the previous years were not like this. I don't know what is happening now. Yoh! ... They forget easily. You do the activity in the class, they enjoy, and you see they follow – you give them class work, it's like, "I don't know". (Interview 2P, Lines 134-139)

She mentioned that non-completion of homework tasks was a problem that used to worry her:

> Yoh! I used to get cross too. But because I understand the social problems - you know. The neighbour would come and say, "Yoh! These didn't sleep. They were drunk. They were fighting." And where was the child by that time? So, how can they do their homework? (Interview 2P, Lines 474-478)

She again remarked on the drinking problem in the third interview:

> Our kids' parents are drinking a lot. Even if you ask the parent to come at 9 o' clock, already they're drunk. So the kid when he or she is in the class, she's not thinking of what you are teaching. She is thinking, "What am I going to eat at home? (Interview 3P, Lines 97-101)

And in both interviews, as with the first, Ms P mentioned that significant ill-health dogged many of her learners.

> There is a lot of that. HIV/AIDS. But the other parents don't want to talk. And we are not supposed to ask them. But we see that this kid is not well. And we live with them at the township. We know that the parent is sick. Maybe the child is also sick. (Interview 3P, Lines 221-224)

Ms M's comment (cited in Section 9.4.1) perhaps bears repeating here:

> Most of our kids are sick. They're on treatment. So they don't cope most of them. ... If you are teaching in class you will see that he is not here. The mind is far away. (Interview 1P, Lines 67-72)

Home circumstances then, are extremely stressful for many of Ms P's learners. Her classroom represents possibly the most stable and safe place many of them have access to. Even outside of their home circumstances, as is well-documented, circumstances in many of South Africa's townships are squalid in the extreme, *including* some of the surroundings to Ms P's school. In fact complaints have appeared in the local press about a shebeen (informal drinking tavern) right across the road from the school.

Socio-politically too South Africa is experiencing turbulence. On the very day I arrived to hand over my observation and interview transcripts to Ms P for checking there was a xenophobic incident. As I neared the school, I saw children streaming out through its gates, some hopping, some skipping, most chatting amongst themselves. Some recognised me, waved and smiled. Literally moments later, however, as I was pulling in through the gates, my car was surrounded by children, squealing, and racing back into the school grounds. Wondering what could possibly have happened, I glanced back and saw a massed phalanx of people moving up the lane towards and then alongside the school fence. When I got into the school foyer, I asked the receptionist what was going on. She said 'the people' were after people from Somalia and Pakistan. I gathered they suspected that 'a Pakistani man' had been involved in some recent murders in the township areas. A number of partially dismembered corpses had been found in the veld in the preceding weeks.

My purpose in sharing this vignette is not to sensationalise, but simply to illuminate, the kinds of abnormal stresses impacting on the lives of the children attending Ms P's school, and – indeed – those attending Ms M's school (which is in the same vicinity). These stresses inevitably impact then on Ms M's and Ms P's opportunities to teach mathematics in ways that are closer to optimal.

9.5 Ms P's STORY: SOME CONCLUDING COMMENTS

In the introductory chapter I cited Ms P's justification for why she made a great deal of use of her Grade 4s L1. She 'confessed' to code-switching "a lot" (Interview 3P, Line 16). Ms P's slight air of defensiveness about code-switching is, through no fault of her own, problematic. As the research by Webb and Webb (2008), and subsequent research by Webb (2010), so forcefully illustrated, 'English only' approaches significantly limit L2 learners' opportunities for 'exploratory dialogue'.

Ms P's justification did not relate to this centrally important element in mathematical sense-making however. It related to her perception that her Grade 4s had had insufficient preparation in their Foundation Phase for the transition to English as LoLT. As I noted earlier (Section 5.5), she indicated that while one or two of her Grade 4s could follow in English, many could not: "Those kids – if you are talking – speaking - English – yoh! – it's like you are not talking.' (Interview 3P, Lines 13-14). This said, my sense was that one of the reasons why she manages to have such on-task behaviour was that the learners' L2 *receptive* understanding was in advance of their L2 *productive* proficiency. The tenor of the exchanges throughout the period of observation came across as supportive of children's needs to continue their mathematics learning in and through their L1.

In this chapter and the preceding one (Ms M's use of classroom talk) I have highlighted some of the patterns I observed in both teachers' observed Grade 4 mathematics lessons. In the concluding part of the thesis I pull together some of the main conclusions, contributions, and implications of the overall study.

POSTSCRIPT: 'LOST IN TRANSLATION'[78]

I noted in the introductory section of this chapter that, despite Ms P's un-ease relative to her frequent use of isiXhosa in teaching her Grade 4s, she was – consistent with South Africa's LiEP (1997) – in fact practising an additive form of bilingualism. I noted also that Ms P's Principal too attended SANCP's NICLE sessions.

Time at one of NICLE's 2014 was given to working with participating teachers on preparing for the upcoming ANAs. The idea was that, with SANCP's help, participating schools would write mock ANAs in preparation for the real thing. The teachers were invited to share some of their ANA views and experiences. Time was also spent unpacking past mathematics ANA papers, amongst which was the 2012 Grade 4 paper.

In the course of discussing this particular paper Ms P's Principal drew the group's attention to the following assessment item, the isiXhosa wording for which, she argued, was particularly problematic.

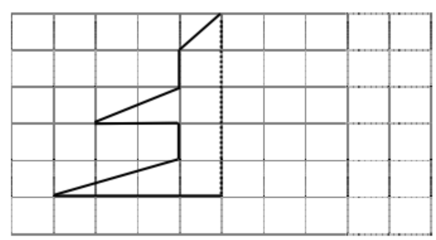
English version: Draw the right-hand side of the sketch to make the sketch symmetrical about the dotted line. **IsiXhosa version:** Gqibezela obu bume bolingano-macala (besimetri).	

Figure 9.2: **Assessment item (2012 Grade 4 Mathematics ANA paper)**

Ms P's principal expressed the view that few learners would understand the word 'bolingano-macala'. She remarked that she, as a native isiXhosa speaker, had not encountered this word. She was, she indicated, at a loss to know what had possessed those responsible for the isiXhosa versioning to use such a word. A constructive and lively discussion ensued, with NICLE members in full agreement with the Principal.

Two things happened as a result of this incident. Though neither relate directly to classroom talk as such, both, in my view, are – tangentially - extremely important.

78 (after Sofia Coppola's award-winning 2003 film of this name)

The first thing that happened was, intrigued by the possibility that assessment in mother tongue may not necessarily serve learners well, I, through the SANCP Chair, approached Ms P and her Principal with the suggestion that we might investigate this further. A past 2012 Grade 4 Mathematics ANA paper was available on the internet in both English and isiXhosa. I suggested some learners could sit for the isiXhosa version of the paper; others the English version. They agreed that this was a good idea. As the following interview transcript extract indicates, however, the relative merits of assessment in L1 as opposed to L2 turned out to be anything but clear-cut.

> **S-AR:** I was interested at our last NICLE group when Mellony and I came to talk to you about one class doing the practice ANAs in English, the other in Xhosa. And I was thinking that's going to be a problem if what your Principal says about some of the words is true.
>
> **Ms P:** UhHm. UhHm. And then I did this with them.
>
> **S-AR:** Oh, have they done it already?
>
> **Ms P:** I think they had difficulty with the Xhosa one.
>
> **S-AR:** Really?
>
> **Ms P:** Yes. They have difficulty with the Xhosa one because they were asking, "What does this word mean?" Whereas it is Xhosa! But with the English, they just read the instructions.
>
> **S-AR:** Even though they had Grade 1, 2, 3 in Xhosa? What did they write their ANAs in in Grade 3?
>
> **Ms P:** They write in Xhosa. But there are difficult words. As the Principal said last time, there is no such word in Xhosa.
>
> (Interview 2P, Lines 72-86)

I did subsequently ask Ms P (in our third interview) whether she felt her learners' difficulty with the isiXhosa version of the paper was solely down to the translation complication.

> **S-AR:** I'm wondering if language is the problem or if it's just that children really struggle with maths ~
>
> **Ms P:** You would think that these kids have a problem in English. They also have a problem in their mother tongue. There are kids in Grade 4 who can't read their mother tongue. It's us. It's come from us the teachers.
>
> (Interview 3P, Lines 67-71)

By ‘us the teachers’ Ms P was alluding to her view that teachers had abandoned the ‘old’ more systematic and disciplined approach to teaching reading[79].

Moving to the second thing that happened out of the NICLE discussions on the English: isiXhosa translation ‘bolingano-macala’ and the implications it might have for equitable assessment, I then sought comment from a colleague in my University’s African Language Studies division, Dr Pamela Maseko.

Dr Maseko provided me with the following careful analysis.

> 1. "ulingano-macala" is a term that seems to have been coined to convey meaning of symmetrical. It literally means equality of the sides (ulingano = equality, amacala - sides). Bo- in bolingano is a concordial agreement deriving from ubume. Whether that is accurate mathematically (whether the isiXhosa term represents the mathematical concept of symmetrical) is another debate.
>
> 2. The terms "ulingano" and "ubume" are in the lexicon of the language, and are common in everyday speech discourse, however the coinage from the two words (i.e. (ulingano-bume) is a new coinage, and therefore unfamiliar, even more so to 8/9 year olds. My belief is that it is wrong to coin new words for assessments. The students would not have used these in the general learning.
>
> 3. I do not agree that the "translators" should be just translating words, (and not meaning). This is even more problematic in specialized language/discipline specific language.
>
> 4. The worst is that the translation itself is incorrect - the back translation of isiXhosa would read: "Finish off this structure of equality of sides".
>
> 5. In the research I am doing I am looking at all instances of mistranslations (they are numerous!!! - inaccuracy relates to cognitive aspect, grammar, culture and domain) and I am posing a question that, given these mistranslations, whether the assessment results from these ANAs are in fact a true reflection of the learners' capabilities in the given learning areas. The ideal would be to design an assessment that is specific in isiXhosa, get the teachers who are in the classrooms involved in the development. Translation should be conditional.

(e-mail communication, September 25, 2014)

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79 I recently shared this mock ANA ‘experiment’ my colleague Sarah Murray. She is someone steeped in foundation phase literacy development as well as second language teaching and learning. Sarah expressed an almost identical view to that of Ms P. She said that the learners’ difficulty with the isiXhosa version of the Mathematics ANA did not in all probability derive simply from translation issues. Mentioning the PIRLS findings, as well as findings cited by Spaull, Sarah spoke of the “appallingly low levels of reading proficiency in mother tongue” achieved by a majority of African learners; and, like Ms P, put this down to poor teaching methods. (S. Murray, personal communication, November 21, 2017).

As Dr Maseko's e-mail comment, above, highlights there are numerous complexities affecting South Africa's LoLT issue. (See Robertson & Graven, 2014, for further discussion of this communication.)

In relation to the fact of isiXhosa, until relatively recently, being an essentially oral rather than written language, Kaschula and Maseko (2014) noted a "lack of guidance when it comes to word formation patterns and their actual use" (p. 11), giving rise then to disagreements on aspects of vocabulary and syntax. As Graven (personal communication, November 14, 2017) commented, while this may not necessarily be a problem within the local context of one classroom, it does pose problems for common regional, or national, assessments. Kaschula and Maseko (2014) call on people working on both ends of the education spectrum (both within basic education and within tertiary education) to contribute towards the 'intellectualisation' of African languages as well as to the promotion of multilingualism. They emphasise the importance of ensuring that our teachers "understand the notion of mother-tongue and mother-tongue-based-bilingual-education" (Kaschula & Maseko, 2014, p. 11). "We need," they write, "to see the languages of the nation as '… part of its natural resources … on the same level as its petroleum, minerals and other natural resources' (Wolff 2006)" (Kaschula & Maseko, 2014, p. 13).

Part 6: Conclusion to the study

CHAPTER 10: CONCLUDING REMARKS AND REFLECTIONS

10.1 REITERATION OF THE STUDY'S GOALS

10.2 SUMMARY OF SOME KEY 'FINDINGS' FROM THE STUDY

10.3 REALISATION (after Bernstein, 2000) **OF THE STUDY'S RESEARCH QUESTIONS**

10.4 REFLECTIONS ON THE OVERALL QUALITY OF THE STUDY

10.5 SOME IMPLICATIONS DERIVING FROM THE STUDY

CHAPTER 10: CONCLUDING REMARKS AND REFLECTIONS

> *Teaching the language(s) of schooling does not only support language learners, but also has the potential to improve the quality of education more generally. All children encounter the knowledge taught in schools through language, and all children need to use language to participate and learn. Meaningful focus on language can support that learning.*
>
> (Schleppegrell, 2015, p. 15)

10.1 RE-ITERATION OF THE STUDY'S GOALS

This study examined the role of oral language in mediating Grade 4 learners' mathematics learning in contexts where English (the learners' second language) is the official medium through which teaching and learning takes place. Its aim was primarily a conceptual one: an attempt to pull together from a range of sources, ideas that might contribute towards highlighting possibilities for synergy across the language/mathematics interface.

The empirical aspect of the study rested on data from two Grade 4 L2 mathematics classrooms. I used these data to help illuminate aspects of theory relating to the centrality of language to learning. The theories I selected for this study came from a range of different sources, all of which focused on elements of affordance and constraint relative to the challenge L2 learners face in *acquiring* a second language while simultaneously learning how to *use* language as a tool for mathematical meaning making. Halliday (1993) noted "when children learn language … they are learning the foundations of learning itself. The distinctive characteristic of human learning is that it is a process of making meaning - a *semiotic process*" [italics added] (p. 93).

Formal assessments of young South African learners' making of mathematical meaning cited in the study indicate that a majority of children do not cope well with, let alone meet, the curricular expectations appropriate to their grade, and, as Graven (2015b) observed, "implementing a national curriculum, without taking into account the extreme inequality of the contexts in which implementation occurs, will not address inequality …" (p. 1). Language, particularly the fact that a majority of South African learners' learning through a second language, has repeatedly been implicated as a key factor contributing to inequalities, and – indeed – inequities within the Country's schooling system.

This study focused on the role of classroom talk in mediating mathematical meaning making. Literature on talk as a social, cultural and cognitive tool for making meaning was reviewed, with particular attention given to literature relating to developing learners' capacity to use talk to make meaning in and through a second language in their classrooms. Because classrooms can never be 'neutral' spaces, my study needed to take account of some of the ways in which political, social, economic and cultural factors impact on the mathematics teaching and learning taking place in them. To this end, the theoretical frame I constructed for the study comprised selections from the work of three theoretical luminaries all of whom paid considerable attention to the place of language *in* learning and to the influence also of particular sociocultural contexts and practices *on* learning.

My use of Vygotsky's, Bernstein's and Halliday's ideas created for me an invaluable multi-focal lens through which to focus on aspects of the classroom talk observed in my two research site mathematics classrooms. My study has shown the enormously complex way in which the language issue played out in these two classrooms. Despite the cumulative insights to be gained from the enormous body of professional literature around the issue of language and learning (and of mathematics learning in particular), there is little sign yet of a unitary best way forward. Assessment data cited in the study show that we are a long way off resolving the dilemma around whether to use learners' potentially strongest form of linguistic capital (their home language) to help them gain access to mathematical concepts, or whether to use English (the language widely *perceived* to carry the greatest potential for successful mathematical performance in our present context).

In the next section I summarise some main conclusions from the study. It is not in the nature of a small-scale case study to make substantive claims about 'findings' as such. I hope, however, readers will find resonance with some of the elements that I saw as having emerged from the study.

10.2 SUMMARY OF SOME MAIN CONCLUSIONS TO BE DRAWN FROM THE STUDY

My analysis of the talk taking place in the research site classrooms found:

- Talk on the part of learners was limited, particularly in terms of learners' use of English in articulating their mathematical thinking. Learner responses to teachers' questions were essentially of a one- or two- word order, despite instances of open-ended questions calling for learners to explain, for example, 'Why do you say so?' There was little or no evidence of extended talk in pursuit of mathematical sense-making.

- While my recording devices during the periods of observation allowed me to capture only a small amount of peer-to-peer talk and of teachers' one-on-one discussions with learners, my sense was that isiXhosa, not English, predominated in these interactions. One of the research site teachers confirmed this to be so: "Among themselves they speak Xhosa" (Interview 3P, Line 178).
- Learners' limited verbal engagement during the observed mathematics lessons contrasted strongly with my informal observations outside the research site classrooms as I arrived and/or departed each day. Here I took pleasure in observing learners' lively use of their basic interpersonal communication skills (BICS) in and through their home language. This for me bore out Halliday's point, cited earlier, that, while, "every normal child has a fully functional linguistic system .... reconciling one functional orientation with another [playground chatter/ classroom talk, for example]" is the challenge (in Bernstein, 2003/1973, p. xv). There was little evidence in the classroom of learners utilizing the "fully functional" BICS they evidenced in their respective school playgrounds. This too then constrained them from engaging in the kind of exploratory mathematical classroom talk that might lead them into more complex mathematical territory where greater cognitive academic language proficiency (CALP) would be required.
- Research cited in the Literature Review chapter (Section 2.3 particularly) provides convincing evidence of the contribution well-structured classroom talk makes to strengthening children's meaning making processes. Vygotsky's and Bernstein's work helped to articulate some of the ways in which socio-historical, socio-cultural and socio-economic factors impact on the learning context. The learning contexts of both research site schools have been, and continue to be, significantly impacted upon by the racial, linguistic and cultural divides exacerbated by South Africa's apartheid history. These inevitably compound the effects on learners of stressful socio-economic circumstances. I noted in Chapter 9 that this was a point that one of the research site teachers, Ms P, particularly emphasised: "Most of the kids, they have social problems, so their minds – I really don't know what is happening with their heads" (Interview 2P, Lines 132-135).
- Work by Cummins (2008; 2010), Gibbons (2003; 2015), and others has demonstrated how important it is that learners gradually master the language of the discipline, in this instance mathematics. Cummins's writing emphasises the importance of using

children's BICS to build upon and help in the transition towards greater cognitive CALP. Gibbons's writing emphasised ways for helping learners, particularly L2 learners, traverse what systemic functional linguists call the 'mode continuum' from everyday discourse to the specialist discourse of particular academic registers. Both sets of writing echo in several ways Halliday's construct of a 'cline of instantiation' (2004). My analysis of exchange structure data indicates that both research site teachers' learners' instantiations of mathematical talk are a long way off the full potential of the mathematical cline, even at grade-appropriate level. This bears on the important point made by Bernstein (1964) that "as a child progresses through a school it becomes critical for him *[sic]* to possess, or at least be oriented toward, an elaborated code if he is to succeed" (1964, p. 67). Speaking of the dual hurdle of learning mathematics in and through a second language, Ms M observed: "All these learners here at school are Xhosa-speaking learners and maths is done in English. And maths also has its own language. Then I think that is a main problem" (Interview 1M, Lines 73-75).

- Though not directly related to a child's language proficiency, both research site teachers indicated that their Grade 4 teaching was compromised because their learners lacked the requisite foundational numeracy skills and concepts. Both indicated that they believed the children's Foundation Phase experiences had inadequately prepared them for the step up to Intermediate Phase curricular expectations. Ms M noted, "I know that at least this, and this and this should have been covered in the foundation phase, but I find that it's not there" (Interview 1P, Lines 169-170). Ms P similarly noted: "It's not easy because … most of the work they haven't done in … the foundation phase. So that work takes time" (Interview 1P, Lines 14-15). The teachers' observations in this regard align with findings from other studies (see, for example, Adler & Pillay, 2017; Graven, 2015b).
- Both research site teachers implicated the rapid and uneven pace of South Africa's curriculum reform attempts in their learners' under-preparedness for Grade 4 mathematics. Both suggested that teachers' professional expertise and experience had been to greater or lesser extents undermined by the changes, and that Ministerial and Provincial initiatives to prepare teachers for such changes had been inadequate. In this context I cite another teacher with whom I worked, who likened the training offered by District Officials to being "microwaved" (Robertson, 2012, p.

243). To the best of my knowledge little has yet been done by District Offices (even in 'microwave' terms) to support teachers as regards strategies for handling the challenge of teaching mathematics in and through a second language. Amongst the "essential mathematical skills" that South Africa's new Curriculum and Assessment Policy Statement identifies for Grade 4 Mathematics is that learners develop the oracy-based skills of being able to "to listen, [to] communicate, ... [and to] reason logically" (DBE, 2011, pp. 8-9). Figures cited in the introductory chapter show that the challenge of doing so in and through a second language pertains to nearly 80% of South Africa's Grade 4 learners.

- My final 'finding' is external to the study as such, and is, at this stage, purely speculative. While it is beyond the scope of the present study, it does suggest opportunities for further investigation down the line. This 'final finding' derives not from my study data, but through my access, via the study, to some of SANCP's data base. Without venturing too far into comparative territory, it was interesting to reflect on the extent to which the research site teachers' language of learning and teaching choices might have contributed to marginally different assessment outcomes. As noted, one teacher (Ms M) used mainly L2 (English) in her mathematics teaching. Her learners did better (albeit not well) on the national Mathematics ANAs than did the other teachers' learners. This suggests that preparation for national assessment *in* English may be better served *via* learning through English as LoLT. On the other hand, the other teacher (Ms P), as the observation data showed, made extensive use of her learners' L1 (isiXhosa). Her learners scored marginally better than did Ms M's learners on SANCP's assessment instrument which focused on conceptual understanding, strategic competence and adaptive reasoning.

  I observed Ms M making determined efforts towards getting her learners to produce 'legitimate text' consonant with ANA paper text (even though her insistence on 'legitimate text' seemed sometimes to sabotage her learners' mathematically-correct intuitions). By contrast, in terms of SANCP's assessment instrument, based as it was on Kilpatrick et al's strands of mathematical proficiency, it is possible that Ms P's additive bilingualism contributed in some positive ways to her learners' mathematical meaning making capacities in the conceptual understanding, strategic competence and adaptive reasoning strands (and this despite the stressful and less than ideal home circumstances she had described many of these children as living in).

10.3 REALISATION (after Bernstein, 2000) OF THE STUDY'S RESEARCH QUESTIONS

The first research question for this study was: Why is classroom talk seen to be so important relative to children's learning of mathematics, and what synergies between this and language/literacy development might there be?

In the wake of a recognition that purely cognitively oriented views of learning do not adequately explain learning processes, the importance of what Mercer and his colleagues termed 'interthinking' through exploratory classroom talk has received increasing attention. Studies illuminating why this more dialogic form of pedagogy is important were included in my Literature Review chapter. So too were studies providing evidence of the improved learning outcomes derived from more dialogical teaching practices. Literature around the challenge for children who – for whatever reason – are not able to learn in and through their home language was also included in the Literature Review chapter. This went alongside discussion around theories of second language acquisition and the forms of pedagogy most likely to support acquisition not only of a second language but also of *literacy* in that language.

In the natural order of language development, oracy skills (listening and speaking) necessarily precede and underpin skills traditionally associated with literacy (reading and writing). All four skills go hand-in-hand in supporting learners' capacity to access and engage with other forms of 'powerful knowledge' (Young & Muller, 2013) (in this instance, mathematical knowledge). However, as I have shown reviewing the literature, accessing and engaging with (in this instance) mathematical knowledge in and through a second language requires careful attention to the potential consequences of choices made around how L1/L2 usage in a classroom is balanced. Figure 1.2 of Chapter 1 (reproduced again below as Figure 10.1) is my graphic synthesis of a range of choices available to South Africa's schools. The model of choice in most instances is Model B. Model A is Ms M's school's choice; Model B (officially) Ms P's school choice. The only learners in South Africa who 'fall' outside of these models are those who have either English or Afrikaans as their home language. As the language statistics provided in the introductory chapter indicated, they comprise less than one-fifth of the learners in the Country.

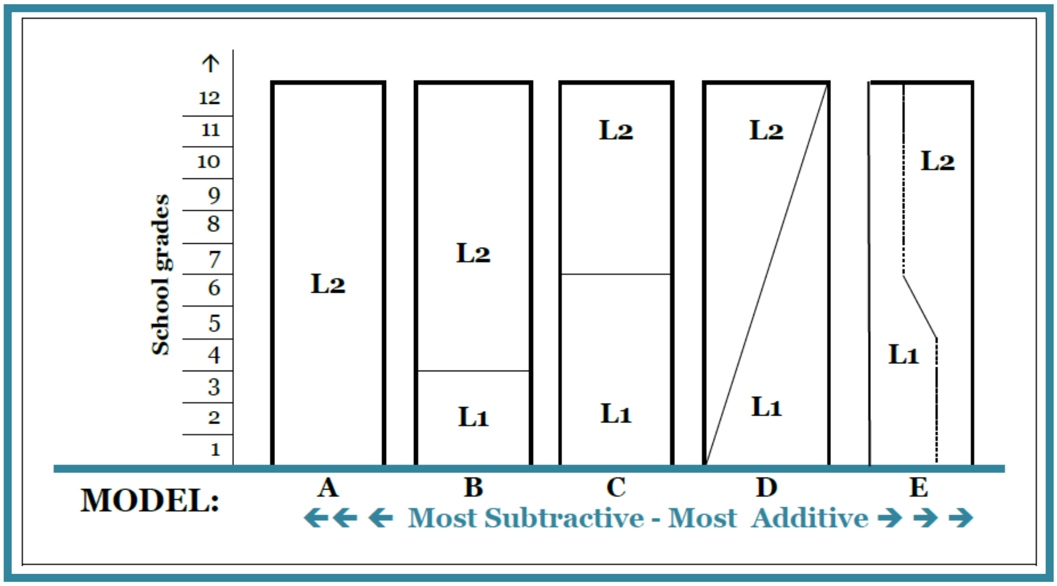

Figure 10.1: **Some models of bilingualism**

Included in the Literature Review chapter are a number of Figures and Tables where I have combined different research work across decades, across authors, and across contexts to produce a synthesis of key ideas. These, I hope, mathematics teacher educators, practitioners, and other researchers interested in further exploring the interface between language and mathematics learning, may draw on as tools in their own thinking about some of the things happening in mathematics classrooms. Table 2.3, where I have pulled together views and findings around the stages and signs of second language acquisition, is an example of such synthesis. Similarly my adaptation from a range of sources of the language thinking matrix (Table 2.9) may be another useful tool for showing how, irrespective of the stage of second language acquisition learners' may be at, learning tasks can be designed in ways that extend the level of cognitive demand beyond simple recognition and recall.

Pedagogically, research repeatedly points (all other things being equal) to mother tongue, coupled with carefully structured incremental access to a second, and even third, language, as first prize. Such, however, is the hegemonic aura of English in post-apartheid South Africa that – overwhelmingly - parents exercised their democratic rights and opted for a subtractive language of learning and teaching route for their children. As noted, English is the language seen to offer the greatest potential for social and economic advancement. The link between English as language of learning and teaching and advancement is, however, more often than not, a chimera. The rub lies in the 'all other things being equal' clause, which is what, early on, led some, for example, Desai, to wonder whether South Africa's Language in Education Policy perhaps “errs on the side of allowing too much choice” (1999, p. 46). Genuinely dialogical, exploratory classroom talk cannot happen without an adequate level of proficiency in the language of learning and teaching. The Literature Review chapter clearly articulated the tensions and dilemmas mathematics teachers face when their learners’ L1 is different from the classroom language of learning and teaching. It is hugely challenging to a teacher to support learners’ ongoing L2 acquisition while at the same time attending to their acquisition of mathematical understanding so as to meet curriculum outcomes.

My second set of research questions was: How might drawing on three different sources of theoretical insight enhance our understandings of the crucial links between language and learning? In particular, what might they add to this case study exploration of teachers’ use of classroom talk in support of their Grade 4 learners’ learning of mathematics?

In Part 4 of the thesis I outlined my *trans*disciplinary intention of working across the disciplines of psychology, as represented by Vygotsky; sociology, as represented by Bernstein; and socio-linguistics, as represented by Halliday. I argued that, given their common emphasis on the centrality of language to the learning process and their common highlighting of the influence exerted by socio-cultural and historical factors on learning outcomes, the work of these three theorists cohered particularly well. To hold together my transdisciplinary theoretical frame, I introduced the metaphor of a multifocal lens, converging on the observed classroom talk. The following ‘re-production’ of this lens metaphor (Figure 10.2) contains some subsequent refinement of the original Figure (4.1).

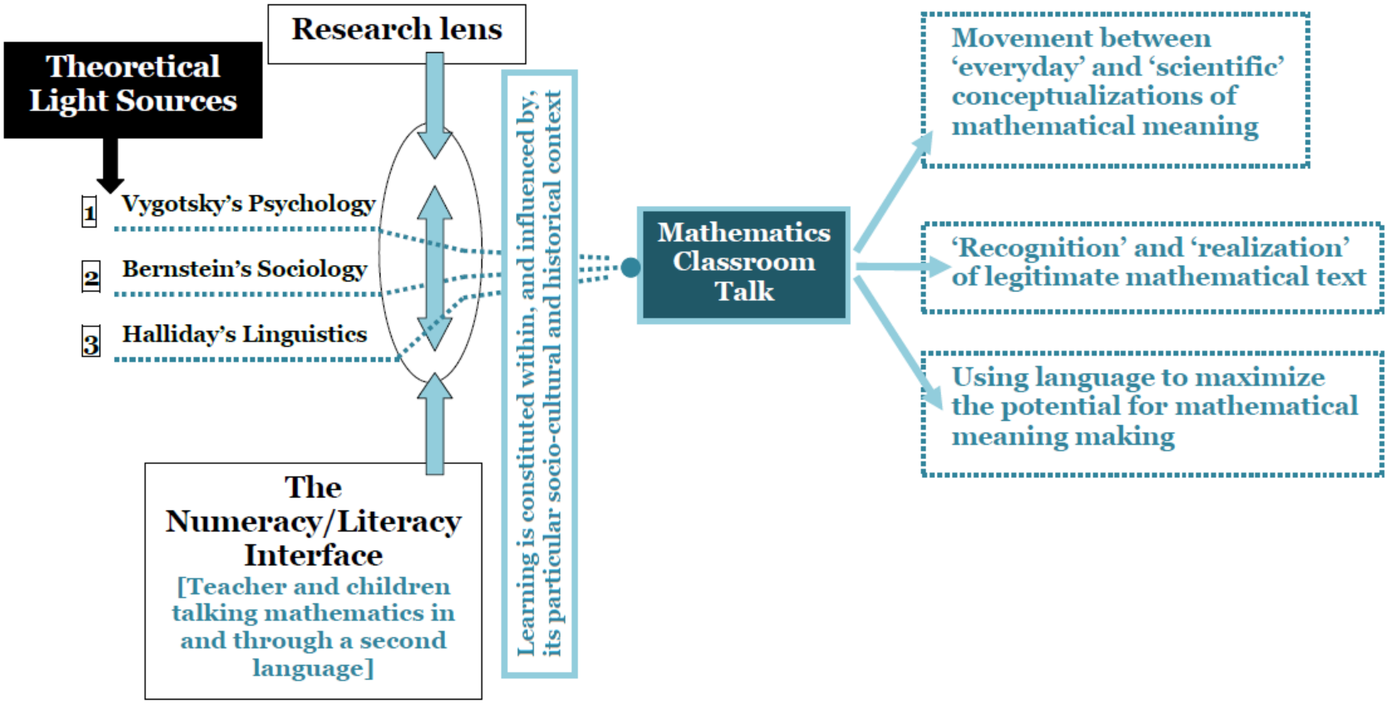

Figure 10.2: **A transdisciplinary convergence on mathematics classroom talk**

In mapping out the respective ideas of Vygotsky, Bernstein and Halliday, and illuminating aspects of their thinking with empirical data from my classroom observation data, not only have I been able to develop richer insight into the ways in which the research site teachers used talk to mediate their Grade 4s' mathematics learning, but I have also been able to exemplify, and pay respect to, the extraordinary contribution these three theoretical luminaries have made to our understandings of teaching and learning.

My third set of research questions was: What is the nature of talk in the observed Grade 4 mathematics lessons? How does such talk appear to mediate the learning of mathematics? In what ways do teachers use their learners' emergent bilingualism as a resource for teaching and learning?

Chapters 8 and 9 focus on these questions. The nature and pattern of the classroom talk in both research site classrooms was, at first glance, little different from that reported in many other studies of classroom talk; namely, essentially teacher dominated (monologic), and often short on opportunity for supporting learners' deeper engagement. In drawing together, however, a rich array of insights from the literature on the place and value of talk for the negotiation - and making - of meaning, I have been able to show in a perhaps more nuanced way possibilities for supporting teachers towards more productive use of talk in their classrooms.

My two research site teachers used talk to mediate their children's learning of mathematics in different ways. Ms M, in keeping true to her school's 'straight for English' policy, seemed primarily concerned to steer her learners towards being able to use what she saw as 'legitimate' L2 text. She pushed her learners to repeat statements of 'mathematical fact' in L2. Even though not all of her learners seemed to have yet conceptually grasped these facts, it is possible they were perhaps rather better prepared than were Ms P's learners for ANA-type assessment tasks. Ms P, on the other hand, seemed primarily concerned not to over-use L2 at the expense of her learners' linguistic access in comprehending her various mathematics classroom tasks. She acknowledged that "most of the time" she spoke isiXhosa in her mathematics lessons. In this she was more closely aligned to South Africa's Language in Education Policy document's principle of additive bilingualism, but, given that formal assessment of her learners' mathematical understanding (both within the school and in relation to external ANA-type external assessments) was in English, this almost certainly compromised the children's preparedness for such assessment. In a sense, therefore, but in different ways, both Ms M's and Ms P's opportunities to use classroom talk in mediating their learners' mathematical learning was significantly compromised, which brings me to my fourth, and final, set of research questions: What informs the participating teachers' classroom talk practices during their Grade 4 mathematics lessons? What do they identify as enabling/ constraining factors in relation to the oral interactions taking place during their mathematics lessons? What implications might these have for teachers working in similar contexts? And what implications might these have for issues of equity?

In reflecting on the extent to which my study has satisfactorily realised a response to this final set of questions I here focus only on the last two questions in the set. The first two were effectively dealt with in Ms M's and Ms P's respective chapters. Both Ms M and Ms P, as noted, are well-intentioned and motivated teachers. Both indicated that their membership of SANCP's NICLE programme had made a positive difference to the quality of their mathematics teaching and thereby the quality of their learners' mathematics learning. The circumstances under which they work are challenging. Grade 4, as noted, is a significant time of transition out of the carefully scaffolded and narrowly defined foundation phase. Added to this is the fact that, like the overwhelming majority of South African learners, Ms M's and Ms P's Grade 4s come from socio-economically challenging circumstances. Furthermore, most significantly of all in terms of the present study, these learners have the unenviable additional hurdle of, to again cite Macdonald's metaphor (1990; 2002), 'swimming up the waterfall' in and through – officially at least – a language that few of them have yet had sufficient opportunity to become proficient in. South Africa's post-apartheid commitment to redress remains a hollow one for as long as such inequities around the Language of learning and teaching issue continue, and the majority of the Country's learners continue to be denied effective access to using their L1s (alongside English) as a tool to use in the process of, in this case, mathematical meaning-making.

10.4 REFLECTIONS ON THE OVERALL QUALITY OF THE STUDY

In the course of carrying out this study I have reflected on how thoroughly I have met my original intentions. Have I tried to do too much? Have I done too little? In this closing reflection on the nature and quality of this piece of work I wish to note my concern for guarding against theoretically a "little bit of this, … little bit of that, … little bit of the other" identified by Halliday (2006) in his reflections on transdisciplinarity. I have traversed broadly across psychology, sociology and socio-linguistic territory. I have ventured some distance into what for me is the more familiar territory of theories of language teaching, particularly of second language. And I have entered – for me – the relatively new mathematics education territory. However, I believe, notwithstanding my eclecticism, that I have managed to do justice to these various territories. In navigating them my aim has been to contribute to the growing body of opinion and evidence around the value of classroom talk as a mechanism for enhancing learners' mathematics meaning making.

While I believe I have adequately articulated some of the core messages around the importance and value of classroom talk, I am aware that in telling the story of Ms M's and Ms P's use of classroom talk, I may have raised more questions than answers. Certainly, their stories have highlighted that getting learners to engage in talking in mathematically productive ways is a challenge, made all the more difficult when the language of the classroom is different from the language of the home. As Ms P remarked in relation to helping her learners make the transfer across to learning mathematics in an L2: "Eh! It is not easy. … It is not" (Interview 1P, Line 53). This challenge notwithstanding, it is my hope that readers of this thesis will find in it insights that they feel resonate in positive respects with aspects of their own professional circumstances.

In this context, and in closing, I want to re-iterate the comment from Maxwell (2013) that I used it in my Methodology chapter. He noted that qualitative research offers the possibility of "generating results and theories that are understandable and experientially credible" (p. 31) to an intended audience. While I have not generated new theories as such, I believe I have put some important theories into a novel combination and illuminated them in useful ways with my empirical data. *If* other members of the education profession, most especially teachers and teacher educators, are able to relate to this case study exploration of Ms M's and Ms P's mathematics classroom talk practices, and identify parallels in their own circumstances; *if* they can draw insights from the analysis of these practices that may then have positive knock-on effects for other classroom circumstances, this, I believe, will have demonstrated this study's contribution to provoking new thinking that has resonance.

10.5 SOME IMPLICATIONS DERIVING FROM THE STUDY

I noted in the introductory chapter Eysenck's argument (2013/1976) that while individual cases may not *prove* anything, they can nonetheless be *instructive*. Taken in this sense, it is my hope that the case explored here will be seen to have both intrinsic and instrumental merit (Stake, 2005): *intrinsic* in the sense that classroom talk is inherently interesting to those concerned with educational practices and outcomes; *instrumental* in that any additional understanding of how classroom talk influences both literacy development and development of mathematical understanding may contribute to the quest for more equitable ways of handling classroom dynamics. In the present case, this pertains to "possibilities and hope" (Vithal, 2000, p. 19) for finding ways of facilitating young, second language learners' opportunities to learn mathematics. As noted in the introductory chapter, finding "sustainable and practical" ways (http://www.ru.ac.za/sanc/) for improving the quality of numeracy outcomes in primary schools is central to my University's SANCP initiative. I close therefore with the following set of suggestions:

- We need to do more sustained and proactive challenging of widely-held perceptions around English as a route into educational - and subsequent economic – opportunity. Because there is no gainsaying the power of English, it is vital that South African learners be given the opportunity to develop proficiency in it. In a teaching/ learning context, however, English as subject is not the same as English as, in this instance, the Language of learning and teaching for mathematics education. English as Language of learning and teaching can, as this study, and countless other studies have shown, constitute a form of symbolic violence (after Bourdieu, 1984) against learners who are not native speakers of English. Reddy et al's report (2016) on South African learners' TIMSS 2015 performance made it clear that children whose home language was different from the Language of learning and teaching scored significantly lower than native speakers of the Language of learning and teaching. As Chapman and Tunmer (2003) noted, "once [a] "cascade" of failures and motivational problems commences, it is difficult to reverse the negative spinoff effects on academic achievement, motivation, and behavior" (p. 17). Chapman and Tunmer (2003) made this comment in relation to links between reading difficulties and learning problems, but the same applies when gaps in foundational numeracy get in the way of children's mathematics progression.

- If English is to remain (as it in all probability will) the main Language of learning and teaching in South African schools, we need to do more to ensure that mathematics teachers receive professional development support (at both pre- and in-service levels) focusing on broadening and deepening their understandings around the linguistic, and hence epistemological, consequences of learning mathematics through an L2. More is needed in terms of supporting teachers to understand code-switching and, drawing on newer literature on translanguaging, further research on the implications of this for mathematics teachers' practices in L2 contexts is needed.
- We need to remain alert to the anomaly that exists in many schools which have a 'straight for English' language policy (as is, for instance, the case for Ms M's school). We call learners at these schools English Home Language learners but we know full well that they are not. Not only is the language used to describe them therefore misleading, but the English Home Language curriculum outcomes are not well-suited to support them in becoming fully proficient in English. The difference between an L1 and L2 speaker is that an L1 speaker brings into the classroom a vast store of intuitive L1 linguistic knowledge. The existing English Home Language curriculum does not cover this knowledge in the explicit way that it is dealt with in the English First Additional Language curriculum. Ms P's circumstances are similar to a lot of other township schools where learners' switch to L2 takes place in Grade 4. Ms M's circumstances by contrast are very similar to that of the

majority of ex-Model C schools where most of the learners now are designated English home language speakers, but they are not.

- We need to more widely publicise the fact that South Africa's Language in Education Policy *is* built upon the principle of additive bilingualism. At the moment predominantly subtractive policies and practices appear to be operative. Additive bilingualism needs to be genuinely accepted as core to any teaching and learning of mathematics taking place in contexts such as those contained in this case study investigation. Were teachers apprised of the *underlying* principles of additive bilingualism, Ms P and others like her would not need then to feel anxious about 'smuggling the vernacular' into their classrooms. They would better understand that considered use of the vernacular is a legitimate element in effective mathematical sense-making in L1/L2 settings.
- And finally, we need to help mathematics teachers towards recognising (and, in deference to Bernstein, then *realising*) that their strategies for supporting learners' developing cognitive academic language proficiency (CALP) in mathematics (in both L1 and L2) should involve a conception of 'academic language' in mathematics that goes beyond a constrained interpretation of 'legitimate' mathematical text as that which is in texts such as curriculum documents, mathematics textbooks, and formal mathematics assessments. Especially important here are strategies which foreground the value of classroom talk in assisting L2 children towards becoming more confident, competent and *explorative* bilingual learners, and thereby, more active agents of their own mathematical meaning-making processes.

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APPENDICES

1. COPY OF LETTER TO PARTICIPATING TEACHERS
2. COPY OF LETTER TO SCHOOL PRINCIPALS
3. COPY OF DEPARTMENT OF EDUCATION PERMISSION LETTER
4. COPY OF LETTER TO LEARNERS' PARENTS / CARE-GIVERS
5. CONTENTS LIST: DATA ARCHIVE

APPENDIX 1

COPY: LETTER TO PARTICIPATING TEACHERS

RHODES UNIVERSITY

Grahamstown • 6140 • South Africa

EDUCATION DEPARTMENT

Tel: (046) 603 8383/4 • Fax: (046) 622 8028

[date (May 2014)]

[Teacher's name]
[School's name + Address]

Dear [Teacher's name]

Re **YOUR AGREEMENT TO ALLOW ME INTO YOUR CLASSROOM**

Thank you very much, [Teacher's name] for your willingness to participate in my doctoral research by allowing me into your classroom to observe your Grade 4 mathematics lessons. Thank you too for your willingness to be interviewed by me in relation to your teaching of Grade 4 mathematics, and for allowing me to make audio/video recordings during lessons and interviews.

I attach herewith a copy of the letter which I have given to your Principal in this regard. As mentioned in this letter, I undertake to preserve the anonymity both of the school and of yourself through the use of pseudonyms. In addition, no learners will be directly identified.

If there is anything about which you are unhappy or uncertain regarding the way I am going about the research, please do tell me, and we can work around it. Please know also that if at any stage you wish to withdraw from participating in the study, that is entirely your prerogative.

Thank you.

My kind regards
SALLY-ANN ROBERTSON

APPENDIX 2

COPY: LETTER TO SCHOOL PRINCIPALS

RHODES UNIVERSITY

Grahamstown • 6140 • South Africa

EDUCATION DEPARTMENT

Tel: (046) 603 8383/4 • Fax: (046) 622 8028

[date (May 2014)]

Principal: xxxxxxx
[School's address]

Dear xxxxxxx

Re **PERMISSION TO CONDUCT RESEARCH AT YOUR SCHOOL**

Thank you for having agreed to allow me to carry out research in your school. As I mentioned, I am currently registered for my PhD degree. My research is located in the field of Mathematics Education, and my particular focus is on exploring links between the teaching and learning of mathematics and language and literacy development.

Further to our brief discussion over the phone last term, thank you for allowing me access to the teacher responsible for teaching Grade 4 Mathematics at your school, and to her Grade 4 mathematics lessons during this year's third term. As I mentioned, I did make contact earlier with [teacher's name] and – pending your permission - she expressed her willingness to participate in interviews with me and to have me observe her classroom. She has my assurance that if at any time she wishes to withdraw from the project that's entirely her prerogative.

I propose using audio- and video-recordings to capture my research data. I will be guided by you regarding what procedures you would like me to follow as regards seeking permission from your School's School Governing Body (SGB), plus from the parents (guardians) of the Grade 4 learners.

When I write up the actual doctoral thesis I shall, of course, preserve the anonymity of both the school and the teacher concerned through the use of pseudonyms. No learners will be identified. Should you and/or [teacher's name] be interested in reading the final product of this research I'll gladly provide a copy of my thesis.

Thank you again, [principal's name], for your generosity in allowing me this access to your school. I really appreciate it.

My sincere regards

SALLY-ANN ROBERTSON

✂--

CONSENT FORM: xxxxxxx

Sally-Ann Robertson is hereby given permission to observe the term 3 Grade 4 Mathematics lessons taught at [school's name].

I note that data from Mrs Robertson's classroom observation, together with the interviews she conducts with the Grade 4 teacher, [teacher's name], will contribute to the thesis which Mrs Robertson is required to submit as part of her work towards a doctoral degree in the field of Mathematics Education.

I have been assured that the Grade 4 teacher will be given opportunities to review the raw data before Mrs Robertson incorporates these into her write-up of the thesis so as to ascertain whether [teacher's name] feels these have been captured accurately and fairly. I have also been assured that the anonymity of my school, my learners, and the teacher concerned will be preserved in Mrs Robertson's final writing-up of the thesis.

Principal's signature: .... **Date:** [(May 2014)]

APPENDIX 3

COPY: DEPARTMENT OF EDUCATION PERMISSION LETTER

Province of the
EASTERN CAPE
EDUCATION

STRATEGIC PLANNING POLICY RESEARCH AND SECRETARIAT SERVICES
Steve Vukile Tshwete Complex • Zone 6 • Zwelitsha • Eastern Cape
Private Bag X0032 • Bhisho • 5605 • REPUBLIC OF SOUTH AFRICA
Tel: +27 (0)40 608 4773/4035/4537 • Fax: +27 (0)40 608 4574 • Website: www.ecdoe.gov.za

Enquiries: B Pamla   Email: babalwa.pamla@edu.ecprov.gov.za   Date: 01 September 2014

Mrs. Sally-Ann Robertson

Education Department - Rhodes University

P.O. Box 94

Grahamstown

6140

Dear Mrs. Robertson

PERMISSION TO UNDERTAKE A DOCTORAL THESIS: THE ROLE OF LANGUAGE IN SUPPORTING CHILDREN'S NUMERACY DEVELOPMENT – EXPLORING GRADE 4 TEACHERS' USE OF CLASSROOM TALK IN MATHEMATICS LESSONS

1. Thank you for your application to conduct research.
2. Your application to conduct the above mentioned research at [redacted] and [redacted] Primary Schools under the jurisdiction of Grahamstown District of the Eastern Cape Department of Education (ECDoE) is hereby approved on condition that:

   a. there will be no financial implications for the Department;

   b. institutions and respondents must not be identifiable in any way from the results of the investigation;

   c. you present a copy of the written approval letter of the Eastern Cape Department of Education (ECDoE) to the Cluster and District Directors before any research is undertaken at any institutions within that particular district;

   d. you will make all the arrangements concerning your research;

   e. the research may not be conducted during official contact time, as educators' programmes should not be interrupted;

building blocks for growth

Page 1 of 2

f. should you wish to extend the period of research after approval has been granted, an application to do this must be directed to Chief Director: Strategic Management Monitoring and Evaluation;

g. the research may not be conducted during the fourth school term, except in cases where a special well motivated request is received;

h. your research will be limited to those schools or institutions for which approval has been granted, should changes be effected written permission must be obtained from the Chief Director: Strategic Management Monitoring and Evaluation;

i. you present the Department with a copy of your final paper/report/dissertation/thesis free of charge in hard copy and electronic format. This must be accompanied by a separate synopsis (maximum 2 – 3 typed pages) of the most important findings and recommendations if it does not already contain a synopsis.

j. you present the findings to the Research Committee and/or Senior Management of the Department when and/or where necessary.

k. you are requested to provide the above to the Chief Director: Strategic Management Monitoring and Evaluation upon completion of your research.

l. you comply with all the requirements as completed in the Terms and Conditions to conduct Research in the ECDoE document duly completed by you.

m. you comply with your ethical undertaking (commitment form).

n. You submit on a six monthly basis, from the date of permission of the research, concise reports to the Chief Director: Strategic Management Monitoring and Evaluation.

3. The Department reserves a right to withdraw the permission should there not be compliance to the approval letter and contract signed in the Terms and Conditions to conduct Research in the ECDoE.

4. The Department will publish the completed Research on its website.

5. The Department wishes you well in your undertaking. You can contact the Chief Director, Mr. GF Mac Master on the numbers indicated in the letterhead or email greg.macmaster@edu.ecprov.gov.za should you need any assistance.

MR. GF MAC MASTER
CHIEF DIRECTOR: STRATEGIC MANAGEMENT MONITORING AND EVALUATION

FOR SUPERINTENDENT-GENERAL: EDUCATION

APPENDIX 4

COPY: LETTER SENT TO LEARNERS' PARENTS/ CARE-GIVERS

ENGLISH VERSION

RHODES UNIVERSITY

Grahamstown • 6140 • South Africa

EDUCATION DEPARTMENT

Tel: (046) 603 8383/4 • Fax: (046) 622 8028 [(May 2014)]

Dear Parent

I am a lecturer at Rhodes University. I am carrying out research for a PhD on how Grade 4 teachers are teaching Mathematics. The purpose of the research is to help improve the teaching of Mathematics in Grade 4 classrooms.

I am carrying out the research in two schools. I have permission to carry out the research from the principals of the schools and the teachers. Rhodes University has also approved my research. I will also request the permission of the Department of Education, Grahamstown District Office.

I am doing research in [teacher's name] Grade 4 class. I will be videoing her teaching Mathematics and also taking photographs of the classroom. The photos and videos will only be used for the purposes of the research. The only people who will have access to them are myself and my supervisor (Professor Mellony Graven).

I request permission to carry out research in your child's class. If you have any questions, you can contact me on 083 406 0264 or you can talk to the class teacher, [teacher's name].

Yours sincerely

Sallу-Ann Robertson
Senior Lecturer

✂--

I have read the above letter and I give permission for you to do the research in my child's class.

Please write your child's name below:

....

Please sign your name below:

....

IsiXHOSA VERSION

RHODES UNIVERSITY
Grahamstown • 6140 • South Africa

EDUCATION DEPARTMENT
Tel: (046) 603 8383/4 • Fax: (046) 622 8028

[(May 2014)]

Bazali aba bekekileyo

Ndingumfundisi-ntsaphowaseRhodes University. Ndenzauphandongendlelaabantwanabebangalesineabafundiswangayoizi Balongootitshalabab o. IsizathusokwenzaoluphandokukufunaukuphuculaukufundiswakweziBalongootBonganilabeba ngalesine.

Ndenzaoluphandokwizikoloezimbini.NdifumeneimvumeyokwenzaokukwiSebelezeMfundolas eRhini, kwiiNqununuzezikolokwakunyeneetitshala.IRhodes University nayoindivumeleukwenzaoluphando.

Ndenzauphandoegumbinilokufundalebangalesinekatitshalau[teacher’s name]. Ndizakubendishicilelautitshalau[teacher’s name] ngexeshaefundisaiziBalo. Ndizakubendithathanemifanekisoegumbinilakhelokufundisa. Lemifanekisokwakunyenolushicilelozizobezisetyenziswakoluphando. Abantuabazakubabekwaziukuzifumanandim, ne-supervisor yam (Profesa Mellony Graven).

Ndicelaimvumekunibazaliyokwenzaoluphandoegumbinilokufundalomntwanawakho. Ukubaninayoimibuzongoluphandoninganditsalelaumnxebakulenombolo 083 406 0264 okanyeningathethanotitshalakaziu[teacher’s name].

Owenuozithobileyo,

Sally-Ann Robertson
Unjingalwazikwezemfundo

✄...

Ndiyifundilelembalelwano,
ndiyavumaokokubaulenzeoluphandoegumbinilokufundalomntwanawam.

NdicelaubhaleiMlomntwanawakhongezantsi:

....

SayinangasezantsiiMlakho:

....

APPENDIX 5

CONTENTS LIST: DATA ARCHIVE

CONTENTS LIST: DATA ARCHIVE

Ms M DATA

Ms P DATA

Page

LESSON TRANSCRIPTS

INTERVIEW TRANSCRIPTS