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Understanding connections in the school mathematics curriculum

Willy Mwakapenda
willy.mwakapenda@nwu.ac.za

I identify and discuss ways in which different types of connections are described in the South African mathematics National Curriculum Statement and its related documents, particularly at the Further Education and Training (FET) level. I argue that connections are central to the way the discipline of mathematics, its learning outcomes, and assessment standards are conceptualised. The notions of representation *and* integration *are found to be key aspects in understanding connections in mathematics. Using these two notions, I then analyse connections in the National Curriculum Statement and its related documents. Finally, theoretical and practical implications of connections in the curriculum are identified.*

Keywords: connection; new curriculum; school mathematics; South Africa

Introduction

The new South African curriculum provides opportunities for educators and researchers to see mathematics in ways that present mathematics as a discipline that has connections: it has links within itself and other disciplines. It also allows for the development of teaching strategies that help educators and teacher educators see teaching in new perspectives. The vision in the new curriculum also helps us to conceptualise assessment in ways that recognize that all learners can do, and succeed in, mathematics. In this article, I argue that the new curriculum presents an opportunity for understanding curriculum itself. I address the broad question: What is our current understanding of the Further Education and Training (FET) mathematics curriculum that is presently being implemented in South Africa? There have been recent attempts to understand the context (Cross, Mungadi & Rouhani, 2002) and practice (Graven, 2004; Naidoo & Parker, 2005) of curriculum and its implementation in South Africa. Although the concept of connections lies at the heart of key deliberations concerned with new mathematics curricula (see, for example, Forgasz, Jones, Leder, Lynch, Maguire & Pearn, 1996), none of these discussions have made connections an object of exploration and understanding. This article contributes to filling this gap in our understanding of the FET mathematics curriculum. In the article, I identify and analyse the range and nature of connections evident in this curriculum. The issues and questions posed with respect to connections are intended to open up possibilities for thinking about connections that allow for and acknowledge complexities in curriculum and practice.

In the sections that follow, an analysis of the way connections are displayed in the curriculum is presented. The analysis commences by examining connections in definitions of mathematics given the centrality of connections in the way mathematics is conceived. It then describes connections in the way the learning outcomes and assessment standards are presented. The article concludes with a presentation of an emerging picture of connections in the curriculum.

Centrality of connections in the definition of mathematics

Connections are an underlying principle of the mathematics. According to the National Curriculum Statement (NCS), mathematics as a discipline is viewed as follows:

> Mathematics enables creative and logical reasoning about problems in the physical and social world and in the context of mathematics itself. It is a distinctly human activity practised by all cultures. Knowledge in the mathematical sciences is constructed through the establishment of descriptive, numerical and symbolic relationships. Mathematics is based on observing patterns; with rigorous logical thinking, this leads to theories of abstract relations. Mathematical problem solving enables us to understand the world and make use of that understanding in our daily lives. Mathematics is developed and contested over time through both language and symbols by social interaction and is thus open to change (Department of Education (DoE), 2003:9)

Relationships, hence connections, are at the heart of the definition of mathematics. These connections are concerned with what mathematics is: where it comes from — human activity, a construction, a development and contestation that is time- and socially-dependent — and what it does: problem-solve and understand the world and daily living. Mathematics is not about reasoning for its own sake. It is concerned with reasoning, symbolizing and thinking — processes that are connected to activities and problems of the social, physical and mathematical worlds involving human practices in all cultures.

From the foregoing, it is clear that there is a conceptual and social dimension in the essence and use of mathematics. In mathematics both social and conceptual connections are important. Mathematics is a highly conceptual domain, a field of knowledge consisting of concepts that are structured in specialised ways. This entails that the processes of knowing and understanding mathematics are also specialized. The ability to do mathematics well, to represent and communicate mathematics effectively, hinges on individuals having achieved a conceptual understanding of mathematical concepts and procedures and relations between concepts and procedures (Kilpatrick, Swafford & Findell, 2001). In particular, the "powerful conceptual tools" that are made available by mathematics enable learners to "analyse situations and arguments; make and justify critical decisions; and take transformative action" (DoE, 2007:7).

Kinds of connections privileged in the curriculum

The National Curriculum Statement recognizes that there are "opportunities for making connections" across various mathematical content involved within and across learning outcomes. According to the DoE (2003:54), these opportunities "should be sought in requiring the solution to standard as well as non-routine unseen problems". However, the following statement regarding the "purpose" of mathematics suggests that some kinds of connections are more highly valued than others:

> An important purpose of Mathematics in the Further Education and Training band is the establishment of *proper* connections between Mathematics as a discipline and the application of Mathematics in real-world contexts (DoE, 2003:10, emphasis added).

What is meant by "proper connections" in the foregoing statement? Does this suggest there are certain kinds of connections between mathematics and its applications that may be "improper"? If so, according to whom are these connections considered to be proper? Who authenticates these connections? It is suggested here that the classification of connections cannot be determined without considering who is making sense of those connections. In this respect, Presmeg (2006:172) has argued that "for the purposes of connecting knowledge in the teaching and learning of mathematics, it is essential to take the meaning-maker into account".

In the national Curriculum Statement the privileging of connections, that are more mathematically focused, is a further cause for concern. For example, as shown in Table 1, the NCS (DoE, 2003) specifies competence descriptions in connection with the kind of learner that this curriculum is expected to produce.

Table 1 Competence descriptions for learner achievement

By the end of Grade 10 the learner with meritorious achievement can:	make connections among basic mathematical concepts (DoE, 2003, p.74)
By the end of Grade 11 the learner with meritorious achievement can:	make connections between important mathematical ideas from this and lower grades (p.75)
By the end of Grade 12 the learner with satisfactory achievement can:	make connections across important mathematical ideas and provide arguments for inferences (p.77)
By the end of Grade 12 the learner with outstanding achievement can:	synthesise across different outcomes and make connections with other subjects (p.73)

In Table 1 there is a potential privileging of mathematical content — mathematical concepts, ideas, and mathematical argumentation — in the type of connections that learners with satisfactory/meritorious achievement are envisaged to be producing. We also see that there is an expectation that Grade 12 learners with an outstanding achievement will be able to "synthesise across different outcomes and make connections with other subjects". However, we note here that making "mathematical" connections does not seem to be a key feature of the competences anticipated for learners with adequate, partial, or inadequate achievement. Is this an indication that the kind of connections being anticipated and emphasized at this level are of such a conceptual nature that they cannot be demonstrated by under-achieving learners? It might also be that the kind of connections being valued here are those that are more "proper" or "correct". Connections or relationships that may be attempted but which may be regarded as "not correct and not explained" (DoE, 2006:64) may be unrecognised.

Connections in the learning outcomes and assessment standards

The National Curriculum Statement makes connections among the key elements (knowledge, skills, and values) of the learning outcomes and experiences to be gained by learners. According to the NCS, "it is important not to think of Learning Outcomes as independent of each other" given, for example, that it is "impossible to study measurement without having an understanding of numbers and operations involving numbers". Every Learning Outcome is associated with a number of Assessment Standards which "describe the minimum level at which learners should demonstrate their achievement of the Learning Outcome(s) and the ways of demonstrating their achievement". The assessment standards are intended to be specific to a grade and show "how conceptual progression will occur in a learning area" (DoE, 2006:16).

Learning Outcome 5 is a typical example of learning outcomes in which connections across the disciplines and contexts are emphasized. According to Learning Outcome 5, the learner is expected to

> deal with data in significant, social, political, economic and environmental contexts with opportunities to explore relevant issues (e.g. HIV/Aids, crime, abuse, environmental issues) (DoE, 2006).

The associated Assessment Standard 8.5.1 indicates that this outcome will be established if learners pose questions relating "Human Rights, social, economic, environmental, political issues" to their environment. It is expected that learners "should be critical and aware of the use, and especially abuse, of data representation and statistics" in the analysis and interpretation of data. Engagement of learners in data handling not only provides entry into the mathematical concepts involved but also allows the possibility for learners to understand and learn about the social and everyday contexts unfamiliar to them. This is accomplished through mathematical modeling. According to DoE (2003:10), mathematical modeling

> provides learners with the means to analyse and describe their world mathematically, and so allows learners to deepen their understanding of Mathematics while adding to their mathematical tools for solving real-world problems". This understanding is also accomplished by "posing

questions" related to particular contexts (DoE, 2006:18).

There are also connections between the critical outcomes and assessment standards. One of the critical outcomes expects learners to "demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation". The associated Assessment Standard 8.2.1 indicates that this outcome will be established if learners are able to "investigate and extend numeric and geometric patterns looking for relationships or rules, including patterns found in natural and cultural contexts" (DoE, 2006:20).

It is evident from the above analysis that there are connections that emerge from learners' engagement in solving problems and investigating contextualized situations that involve the real world. What is at issue here is the extent to which learners will be able to *pose* problems given that they are more attuned to traditional classroom cultures which present them with already formulated problems.

Representations as an aspect of connections

A key aspect of all learning outcomes for the NCS concerns learners' abilities to make "representations". For example, within the domain of geometry, while ensuring that learners are mathematically literate, they are required to work towards being able to "describe, represent and analyse shape and space in two and three dimensions using various approaches in geometry ... and trigonometry in an interrelated or connected manner" (DoE, 2003:10).

Representations in Learning Outcomes 1 and 2

In Learning Outcome 1, learners are required to "recognise, describe, represent and work confidently with numbers and their relationships to estimate, calculate and check solutions" when solving problems. Within this outcome, learners are expected to "expand the capacity to represent numbers in a variety of ways and move flexibly between representations" (DoE, 2003:12). In Learning outcome 2, learners are required to be able to "investigate, analyse, describe and represent a wide range of functions and solve related problems". Within the FET band, learners "*should* ... use symbolic forms to represent and analyse mathematical situations and structures" (DoE, 2003:13). The foregoing statement captures the power of the algebraic component associated with this learning outcome. It signifies a connection between symbolic forms and the analysis of mathematical situations and structures. According to the DoE (2003:12, emphasis added),

> A fundamental aspect of this outcome is that it provides learners with versatile and *powerful* tools for understanding their world while giving them access to the strength and beauty of mathematical structure. The language of algebra will be used as a tool to study the nature of the relationship between specific variables in a situation. The *power* of algebra is that it provides learners with models to describe and analyse such situations.

The concept and language of algebra is critical here. Learners need to have access to algebra in order to acquire mathematical knowledge and its structures needed for them to understand their world and decipher "unknown information" about situations. It does not seem that learners have a choice. They must develop symbolic knowledge. There is little indication from the above that, apart from the use of mathematics and algebra, there are other means available for learners to understand and analyse their worlds and situations. However, what is being suggested in this article is that learners need to be allowed to make other meaningful connections that may be different from those suggested by the NCS. This is important as it recognises the fact that curriculum knowledge is not the only resource which learners can use in order to make sense of the world they live in.

The power of the concepts of algebra and function is also evident in the constitution of these concepts as central to one of the learning outcomes (LO2). There is therefore a requirement that teachers structure learning programmes in ways that provide for appropriate learning experiences and situations that develop these key concepts and enable learners to "experience the power of algebra as a tool to solve problems" (DoE, 2003:13). There is a requirement to represent mathematical models of situations in different ways: "in words, as a table of values, as a graph, or as a computational procedure (formula or expression)" (2003:12). Learners need to work fluently and flexibly with conversion between numerical, graphical, verbal and symbolic representations. From the above description, there are two kinds of connections that are evident. First, there is a strong connection between algebra and functions as domains of mathematical knowledge. Algebra serves as a tool for working proficiently in functions. Secondly, proficiency in both algebra and functions enables learners to work efficiently in four representations of mathematical activity, namely, numerical, graphical, verbal, and symbolic. The connections among these four representations are made possible through proficiency in both algebra and functions.

Representations in Learning Outcome 3

In Learning Outcome 3, learners are required to "describe, represent, analyse and explain properties of shapes in 2-dimensional and 3-dimensional space with justification" (DoE, 2003:13). The study of space, shape and measurement enables learners to: "link algebraic and geometric concepts through analytic geometry" and to "analyse natural forms, cultural products and processes as representations of shape and space" (2003:14). According to the DoE, the proposed content for Learning Outcome 3 "really only becomes meaningful and alive when used to address issues of importance to the learner and to society" (2003:60). The key connection that is evident in this learning outcome (LO3) concerns links between algebraic and geometric concepts. In other words, for learners to work proficiently in their study of space, shape, and measurement, they need to use both algebraic and geometric knowledge.

Representations in Learning Outcome 4

With respect to Learning outcome 4, it is important to engage learners in collecting, organising, analysing, and interpreting data to establish statistical and probability models to solve related problems. These activities enable learners to "become critically aware of the deliberate abuse in the way data can be represented to support a particular viewpoint" (DoE, 2003:14). The underlying connection evident in this learning outcome (LO4) concerns links among four key processes in working and making decisions involving statistical data. These processes are: collection, organization, analysis, and interpretation of data. Learners' fluency in these processes can enable them to work more proficiently in statistical thinking and reasoning with statistical and probabilistic models.

Representations and learner achievement

The ability to produce and work with representations is a key competence particularly for learners that the National Curriculum Statement categorizes as "outstanding achievers". Table 2 shows the kind of achievement expected of learners at the FET level.

Table 2 Representations and learner achievement

By the end of Grade 10 the learner with outstanding achievement can:	make use of appropriate mathematical symbols and representations (graphs, sketches, tables, equations) to communicate ideas (DoE, 2003, p.72)
By the end of Grade 11 the learner with outstanding achievement can:	use appropriate mathematical symbols and representations (graphs, sketches, tables, equations) to communicate ideas clearly and creatively, linking across Learning Outcomes (p.73)
By the end of Grade 12 the learner with outstanding achievement can:	communicate solutions effectively, thoroughly and concisely, making use of appropriate symbols, equations, graphs and diagrams (p.73)

As can be seen in Table 2, there is an emphasis on learners being able to "use appropriate mathematical symbols and representations" and to communicate mathematical ideas and solutions effectively using symbols and representations. However, it appears that this kind of competence (making "proper" representations) does not seem to be anticipated for learners with adequate, partial, or inadequate achievement. The competence that is clearly demanded across Grades 10 to 12 is the ability to work proficiently with representations that involve making deliberate connections between the graphical, algebraic, symbolic, and numerical domains of mathematical activity.

Integration as an aspect of making connections

The DoE recognizes integration of concepts and processes within mathematics by acknowledging that "Learners need to be able to see the interrelatedness of the Mathematics they are learning" (DoE, 2006:49). According to the DoE (2003:3),

> Integration is achieved within and across subjects and fields of learning. The integration of knowledge and skills across subjects and terrains of practice is crucial for achieving applied competence as defined in the National Qualifications Framework. Applied competence aims at integrating three discrete competences — namely, practical, foundational and reflective competences. In adopting integration and applied competence, the National Curriculum Statement Grades 10–12 (General) seeks to promote an integrated learning of theory, practice and reflection.

It is observed that "integration within a learning area is automatic in the sense that you cannot work with measurement without integrating with number" (2003:76). This suggests that integration within learning areas is an inevitable activity. What is key here is that in order for integration to take place, learners need to gain access to and make connections between, various concepts and fields of knowledge.

Adler, Pournara and Graven (2000:3) have identified three levels of integration: "integration of the various components of mathematics; between mathematics and everyday real world knowledge; and where appropriate, across learning areas". They have argued that while integration is desirable, the extent of the demands placed upon teachers makes integration less feasible. However, as shown later, the Department of Education claims that integration across learning areas is more feasible at the lower grades than at the higher because of the difficulty of finding sufficiently generative contexts at the higher levels. According to DoE (2006:27), contexts are "situations or conditions in which content is taught, learnt and assessed". These are derived from "different sources" such as: the nature of the Learning Area being taught, the socio-economic environment of learners, national and other events, interests, nature and needs of learners, and the integration of appropriate Assessment Standards from other Learning Outcomes and other Learning Areas. While proposing that contexts are a useful way in which to "integrate" learning areas, the DoE (2006) have noted the following:

> Up to Grade 6, it is customary to select a couple of contexts, for example four per year, and deal with all the Mathematics content under each one of those contexts. We could, for example, decide to choose *Our School* as context for the first term and relate all the Mathematics to the school. Then for the second term you could decide to choose *Building a bridge* as your context... However, note that the further we progress from grade to grade, i.e. from primary school to secondary school, it becomes increasingly difficult to define one context that is relevant for all core knowledge and concepts.

It appears that ways of proceeding with integration determine what kinds of integration are possible. In the case of mathematics, the DoE (2003:27-28) states that

> It is more sensible to identify the different core knowledge and concepts (these then become the headings for the different Lesson Plans), and then choose a context for each activity to make the learning material more enriching and more meaningful to the learner.

There seems to be a claim here that integration becomes “more sensible” if mathematics is the starting point. What does “more sensible” mean here? Arguing from the perspective of “transfer”, Parker (2006:62-63) has pointed out that “the idea of transferability of everyday knowledge into mathematics is absent” in the National Curriculum Statement. The focus in the NCS appears to be “on the establishment of proper connections between mathematics as a discipline and the application of mathematics in the real world”. Does that mean that connections that involve moving from the everyday into mathematics are not “proper”? We see again here that making connections that involve moving from mathematics into the everyday has a more privileged status than the making of connections that employ moves from the everyday world into mathematics.

Connections: a summary

The above analysis has presented and discussed ways in which connections are described in the South African mathematics National Curriculum Statement and its related documents. This discussion has captured the following: (1) the centrality of connections in definitions of mathematics; (2) the privileging of “proper” connections in mathematics; (3) the prevalence of connections across learning outcomes and assessment standards; and (4) representation and integration as key components of the curriculum statement and learning outcomes. It is important to reflect again on the nature of connections that have been identified across learning outcomes (LOs). This is because of the key role that learning outcomes play in the formulation and implementation of curriculum policy. An analysis of Learning outcome 2 (LO2) has identified a key connection that involves strong links between algebra and functions. Algebra serves as a tool for working proficiently in functions. Proficiency in both algebra and functions enables learners to work efficiently in the numerical, graphical, verbal, and symbolic representations of mathematical activity. The connections among these four representations are made possible through proficiency in both algebra and functions. The key connection identified in learning outcome (LO3) concerns links between algebraic and geometric concepts. For learners to understand and work more productively in their study of geometrical knowledge (i.e. space, shape, and measurement), they need to draw on their knowledge of *both* algebra and geometry. With respect to Learning outcome 3, the analysis has shown that a key connection concerns links among four processes involved in working and making decisions involving statistical data. These processes concern the collection, organization, analysis, and interpretation of data. Proficiency in these processes is critical if learners are to work more productively with statistical concepts which demand statistical thinking and reasoning, with statistical and probabilistic models. We can see here that the underlying connection in learning outcome (LO4) is somewhat different from the kinds of connections identified in LO2 and LO3. Learning outcome 4 concerns connections that are about processes while connections identified in Learning outcomes 2 and 3 concern connections that are more about the field of mathematical knowledge: algebra, functions and geometry, in this case.

The analysis presented above has also identified that the ability to make connections is key in the nature of competences that are expected of FET learners. Grades 10–12 learners are expected to work competently with representations that involve making deliberate connections between the graphical, algebraic, symbolic, and numerical domains of mathematical activity. We have also seen from the analysis that learners are not only expected to make connections between concepts in mathematics. They are also required to integrate their knowledge of mathematics with their knowledge of other learning areas. This means that there are new kinds of competences that are expected of learners. They need to gain access to and make connections between various concepts within a specific discipline (e.g. mathematics and between concepts from different disciplines (e.g. between mathematics and Arts and Culture).

The analysis has also indicated that there are certain types of connections that appear to be privileged, hence more highly valued, in the National Curriculum Statement. By claiming that an important purpose of mathematics in the FET band "is the establishment of *proper* connections between mathematics as a discipline and the application of mathematics in real-world contexts" (DoE, 2003:10, emphasis added), the NCS suggests that there are certain types of connections between mathematics and its applications that may be "improper". Without an interrogation of what it means for connections to be "proper" and who authenticates these connections, such claims are problematic.

It is argued here that the connections identified and discussed above do seem to be inevitable. This is because, as discussed above, relationships, hence connections, are at the heart of the nature of mathematics. The connections discussed in this article are concerned with what mathematics is: where it comes from, and what kinds of experiences are enabled by mathematics in the processes of problem-solving and understanding the social world. However, as discussed later, there are complexities that are associated with the kinds of connections identified in this article.

Connections: The emergence of a complex picture

The analysis presented above points to considering "conversation" as a possible way of getting to understand connections. It allows us to reflect on how our understanding of these connections link to classroom practice, and how our experiences of classroom practice could lead to deepening our understanding of the complexity of connections.

Conversation: A way of understanding connections

In this article I have identified and discussed ways in which connections are described in the NCS. The range of connections described in the NCS gives spaces for the curriculum to develop and emerge as a "conversation". Two key forms that this conversation is taking are: conversations within mathematics and conversations between mathematics and/for the intended educator/ learner audience. These conversations are important given the nature of the broader curriculum that is informing teaching and learning in South African schools in the current society.

How do we need to understand these connections? There are a number of issues and questions that need to be posed in order to understand these connections. The first concerns the kind of theories that need to be invoked in attempting to understand and make sense of the nature of connections that are apparent in the NCS curriculum for mathematics. We need to ask the question about the kind of assumptions about curriculum that need to inform our analysis of connections in the curriculum. It is suggested here that there is an opportunity, in such an analysis, for taking a perspective of "curriculum as conversation", as elaborated elsewhere (see for example, Reeder, 2005)?

Connections and classroom practice

The second is an issue about the implications that these connections have for practice. There is a complexity that is inherent in all curricula here. This concerns the point that there are bound to be contradictions and biases in the statements of outcomes and intentions of any curriculum. Translating into practice a curriculum with its inherent contradictions and biases is therefore a complex phenomenon. The complexity of translating curriculum expectations into practice is particularly important in relation to the requirement that teaching needs to integrate across learning areas. It needs to be acknowledged that working in integrated ways in the school curriculum makes available new visions and realities for schooling. However, turning this vision into reality is a complex activity for educators and researchers that are likely to meet with challenges both within and beyond specific curriculum disciplines. There is a need to understand the identities of educators and learners (their beliefs about pedagogy and schooling) in order to support the enactment of this vision. The critical challenge here concerns the mathematics and, in general, the knowledge that is needed for teaching and learning. For example, at present, we do not know much about what happens when the mathematics needed in order to enable learners to understand a science concept that requires mathematics is not well understood. The training that is currently being provided to enable educators to implement the curriculum needs to be acknowledged. However, there is an important gap that has not been recognized both in education policy and in teacher education practice that concerns the preparation of learners to work in a reformed curriculum that demands making connections within mathematics and between mathematics and other disciplines. Many approaches to implementing reform (Pithouse,

2001) concentrate on preparing teachers to implement such reforms. The "training" of teachers for the South African NCS/FET mathematics curriculum is a sound example. There have been many inadequacies with this way of proceeding in implementing curriculum reform. Some of this inadequacy has to do with the conceptions of curriculum that are informing (or need to inform) curriculum implementation. There is a need to conceptualise approaches that acknowledge that just as new curriculum proposals place heavy demands on teachers, they also place demands on learners. The conceptual as well as practical questions linked to this position add to the complexity of implementing new curricula. Does it mean that when institutions prepare teachers for the new curriculum they are also preparing learners to anticipate and plan for the respective demands being placed upon them? Is there a place for "training" learners for the new curriculum? Are there any approaches to curriculum implementation that consciously prepare learners to respond to the demands of the new curriculum? The dominant literature on teacher education focuses on educating teachers and preparing them to implement the requirements of a new curriculum. Given the demands that the new curriculum presents for learners, it is important that ways are explored that also attend to preparing learners to face the demands of the new curriculum.

Specific complexity of connections

The fact that there is an emphasis on connections in the National Curriculum Statement in mathematics education in South Africa is consistent with developments in mathematics education globally. In the context of mathematics education in the USA, the National Council of Teachers of Mathematics (NCTM) has a curriculum standard dedicated to connections. In the NCTM curriculum standards for Grades 9–12 (a phase similar to the South African FET), it is proposed that:

> The mathematics curriculum should include investigation of the connections and interplay among various mathematical topics and their applications so that all students can:
>
> - recognize equivalent *representations* of the same concept;
> - relate procedures in one representation to procedures in an equivalent representation;
> - use and value the *connections* among mathematical topics;
> - use and value the connections between mathematics and other disciplines (NCTM, 1989:148, emphasis added).

In the above statement, there is an emphasis on recognizing and valuing of connections and representations by *all* students. The requirement for students to be engaged in "investigation of mathematical connections" so that students can "use a mathematical idea to further their understanding of other mathematical ideas" (NCTM, 1989:84) underlines a key element of mathematical activity that has a potential to make connections within mathematics possible. In the context of mathematics education in South Africa, we need to deepen our understanding of not only what these connections are but also what purposes these connections are intended to serve.

Entry point for making connections

There is also a further critical issue in understanding connections in mathematics which concerns the matter of what needs to be an appropriate and practical starting point for recognizing and understanding connections. In her discussion of the "connections" standard in the context of mathematics education in the USA, Presmeg (2006:167) has noted two ways of making connections between mathematics and everyday life.

> Start with an everyday practice that is meaningful to the participants, and then see what mathematical notions grow out of the chaining as it is developed. Secondly, one might focus on a mathematical concept that is to be taught, and then search for a starting point in the everyday practices of students that can lead to this concept in several links of the chaining process.

In relation to the South African curriculum and curriculum textbooks, we need to ask the question: what appears to be the starting point for making connections? Does the making of connections start with mathematical content/concept or with everyday/non-mathematical contexts? What kinds of learning are made possible by these different starting points? What kinds of starting points do teachers recognize and/or prefer in their teaching? What kinds of opportunities for learning about mathematics do these make possible? There is also the general question about when and why might it be more appropriate to start from a particular practice (within or outside mathematics) rather than another when making connections.

Extended engagement with the issues and questions identified here would contribute to the deepening of our understanding of the new NCS curriculum. This curriculum is replete with demands upon educators and learners for making connections, producing representations, and working in integrated modes within mathematics and across curriculum disciplines.

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Author

Willy Mwakapenda is Associate Professor in the Department of Mathematics Education at the North-West University. His research foci are school mathematics curriculum policy and implementation, student/teacher thinking and understanding, use of concept mapping to understand learning and identities, and understanding connections within mathematics and across curriculum disciplines.