

## Chapter 4

# Perspectives on Geometry and Measurement in the Australian Curriculum: Mathematics

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The Australian Curriculum: Mathematics presents the measurement and geometry content strands together in order to emphasise their relationship to each other and highlight their practical relevance. In this chapter, we examine the connectivity between the measurement and geometry sub-strands and the interconnectivity with other content strands in the document. We analyse the terminology and language used throughout this content strand; evaluate the framing and structure of the strand, noting the lack of reference to visual and spatial reasoning; and question whether current assessment practices are congruent with the measurement and geometry strand. One of the most positive aspects of this strand was the potential for teachers to develop rich, conceptually-connected learning opportunities. A major area of concern was the lack of reference to visual and spatial reasoning within the content strand. Seen as a critical and integrated aspect of both sub-strands, the lack of attention afforded to such reasoning processes may impact on the way teachers enact the Curriculum. We suggest a significant and sustained professional development program to accompany the implementation of the Curriculum to ensure the connectivity between content strands is made explicit.

### Introduction

In this chapter we describe the framework of the measurement and geometry content strand of the new Australian Curriculum for mathematics and its impact on curriculum implementation in the classroom. We pose a number of questions within this chapter, specifically seeking to determine what kinds of knowledge and skills in measurement and geometry are valued in the document. Furthermore, we explore the mathematical foundations of the Curriculum by highlighting the emphasised concepts and understandings that are privileged in the document and the extent to which the decisions to include these concepts and understandings have strong

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research and theoretical foundations (Reid, 2005). Moreover, we examine the extent to which this Curriculum supports students and teachers in a rapidly changing society and provide suggestions for further curriculum development in this content strand.

As levels of accountability for both teachers and school systems increase, aspects of the curriculum that are not easily testable (and thus measurable), such as open-ended problem solving and practical applications of mathematics, are at risk of being squeezed out of the classroom curriculum. As Dimarco (2009) asserted, teachers struggle to facilitate open-ended problem-solving tasks when the focus on national testing is overly emphasised. In relation to measurement and geometry, it is much easier to test basic skills and understandings (under pencil-and-paper conditions) than it is to assess students' mathematical cognitive problem-solving processes (English & Sriraman, 2010). As a consequence, future curriculum standards could be altered and lowered to allow more students to perform well in standardized testing (Hattie, 2005). In parallel with this shift, the number content strand of the curriculum has been awarded increased attention, both from a teaching and learning and an assessment perspective (Verschaffel, Greer, & De Corte, 2007). Hence, it is imperative that the more practical strands of mathematics, namely measurement and geometry, are afforded the attention they deserve. As Owens and Outhred (2006) explained, the measurement and geometry content strand provides rich opportunities for visual reasoning, representations of mental schemas and engagement with physical objects and representations. Thus, practical nature of this strand promotes advanced mathematics reasoning.

An additional challenge for curriculum design and implementation is the concern raised about teachers' Pedagogical Content Knowledge (PCK) (Hill, Rowan & Ball, 2005) and the extent to which teachers rely on support documents and textbooks to present mathematics content. Generally, curriculum documents, and certainly the Australian Curriculum for Mathematics, presume that teachers are able to make connections between and across mathematics strands in order to promote mathematics thinking. Recent literature measuring teachers' pedagogical content knowledge identified a deficiency in their ability to progress students' knowledge to develop further mathematical understanding after assessment (Callingham, 2010; Watson, Callingham, & Donne, 2008; Watson, Callingham, & Nathan, 2009). Furthermore, a broad literature base indicates that teachers' content knowledge is limited (da Ponte & Chapman, 2008; Vinson, 2001; Weiss, 1995) and that many teachers have difficulty relating and separating concepts of length, area and volume within the measurement and geometry content strand. For example, many teachers incorrectly assume that when the perimeter of a figure increases, so too does the area of the figure (Ma, 1999); and that as the length of the sides of a square double,

so does its area and volume (Tierney, Boyd, & Davis, 1990). Such limitations in content knowledge influence the effectiveness of PCK and therefore disrupt links between curricula and teaching and learning. Consequently, any evaluation of the Australian Curriculum needs to be undertaken within the context that teacher's content knowledge and pedagogical content knowledge is generally limited.

This chapter is structured under three headings: 1) a description and synthesis of the content; 2) the representation structure and framing of the strand; and 3) the assessment practices: backward mapping from national assessment. Each of these sections provides commentary of aspects of the Curriculum and integrates research findings into the argument. A discussion and conclusions are then presented.

## A Description and Synthesis of the Content

### *Connectivity Within and Across the Strand*

Within any mathematics curriculum, there has been a concerted push to ensure that measurement and geometry understandings are introduced, developed and applied in connected ways. In both primary (Bobis, Mulligan, & Lowrie, 2009; Zevenbergen, Dole, & Wright, 2004) and secondary (Goos, Stillman, & Vale, 2007) contexts researchers have advocated for concepts and understandings to be simultaneously presented to students in order to foster deeper levels of reasoning. As Battista (2007, p. 891) acknowledged "understanding measurement [and geometry] requires an integration of procedural and conceptual knowledge". Without a connected curriculum there are few opportunities for students to confront the relationships between and among concepts.

Recent mathematics education research has identified the need for teachers to emphasise connections between subject matter that have the same conceptual underpinnings (Bobis, Mulligan, & Lowrie, 2009) but also to establish sound understandings across topics. As Reid (2005) explained:

no matter how knowledge-content is organised in the official curriculum, the decision about whether or not to work within or across discipline boundaries is a professional one that is taken at the classroom level as teachers work through the issue of how best to develop the capabilities. (p. 63)

With respect to measurement and geometry concepts, Booker and Windsor (2010), for example, maintained that students should represent and solve related problems in a variety of ways in order to articulate and generalise their solutions. They argued that aspects of measurement and geometry understandings constructed in primary school had the facility to help students "to construct algebraic notation in a meaningful way through their representations using materials, diagrams, models, tables and graphs in their search for patterns and

generalizations" (p. 418). Other studies have demonstrated the connectivity between measurement and geometric understandings and other strands including the number concepts (Bragg & Outhred, 2004) and algebraic reasoning (Clements & Battista 1992). Teachers require more explicit direction on how to make links across content strands in the Mathematics Curriculum to ensure that existing topics of early mathematics are tightly interwoven and foundations are developed for subsequent learning (Carraher, Schlieman & Schwartz, 2008).

So we pose the question, to what extent does the Measurement and Geometry strand of the curriculum highlight the relationships not only within the strand, but also across the other strands? In other words, are concepts and understandings addressed in isolated or connected ways? The following section provides a synthesised year level description of how closely aligned sub-strands are presented throughout this content strand.

Initially, we look at the connection between measurement and geometry concepts in the curriculum. Figure 1 highlights the connection (or not) between the sub-strands. If we consider the overarching framework of this strand, the dotted lines represent connections across sub-strands within each Year level. In Foundation and Year 1, there are no explicit connections between the sub-strands. Perhaps this is based on the assumption that students have acquired limited prior knowledge of such concepts at an early age—however, recent literature demonstrates young children's ability to use measurement vocabulary and apply it to pertinent situations in holistic and sometimes relatively sophisticated ways (MacDonald, 2010; Sarama & Clements, 2004). More problematic is the lack of explicit connectivity between *shape* and *location and transformation* until Year 5. At Year 5, there seems to be many pedagogical opportunities for connected and rich learning situations. For example, in Year 5, the connections between *shape* and *location and transformation* can be seen from the outcome: "Describe translations, reflections & rotations of 2D shapes" and the connection between *shape* and *geometric reasoning* is identified through the outcomes: "Apply the enlargement transformation to familiar 2D shapes & explore the properties of the resulting image compared with the original"; and "Estimate, measure & compare angles". Yet a worrying dimension to this analysis is the fact that many of the connections seemingly established in Year 5 appear not to be reinforced in Year 6. In fact, the connections across sub-strands are limited in Year 6 (and the only other instances of this lack of connectivity occur in the first two years of schooling) (see Figure 1). We trust that Year 6 has not become a revision year. There have been ongoing calls for curriculum designers and classroom practitioners to provide rich tasks for students to engage with (van den Heuvel-Panhuizen, 2010) in order to provide depth and scope within concept

development. Measurement and geometry understandings are highly suited to such opportunities and rich-task development (Bobis, Mulligan, & Lowrie, 2009).

Figure 1 also displays the scope and sequence of sub-strand content across years. Three of the five sub-strands are introduced during the Foundation year, with Geometric Reasoning introduced in Year 3 and Pythagoras and Trigonometry content in Year 9. The *using units of measurement* sub-strand is common from Foundation through to Year 10 and this has links with *shape* (especially in primary school) and then *geometric reasoning* (in secondary school). Interestingly, *shape* and *location and transformation* cease to be sub-strands in Year 7 and the connectivity is then between *geometric reasoning*, *units of measurement* and, in years 9 and 10, *Pythagoras and trigonometry*. The spiraling effect of the curriculum allows students to build on concepts based on previous knowledge. Although we hoped for far reaching connections across sub-strands, it could be argued that there are relatively sound connections within and between sub-strands in the Measurement and Geometry content strand. Nevertheless, some explanation as to why sub-strands disappear at certain stages or levels must be articulated. Otherwise, the establishment of mathematics understandings within these sub-strands (e.g., links between *shape* and *geometric reasoning*) will be lost. Figure 1 presents the scope and sequence of each of the sub-strands of the Measurement and Geometry strand and highlights the connectivity between them. Our representational interpretation of the curriculum illustrates (through dark bolded lines) where strands begin and end. The dotted lines highlight contents specific links across strands with information about when these links occur by year.

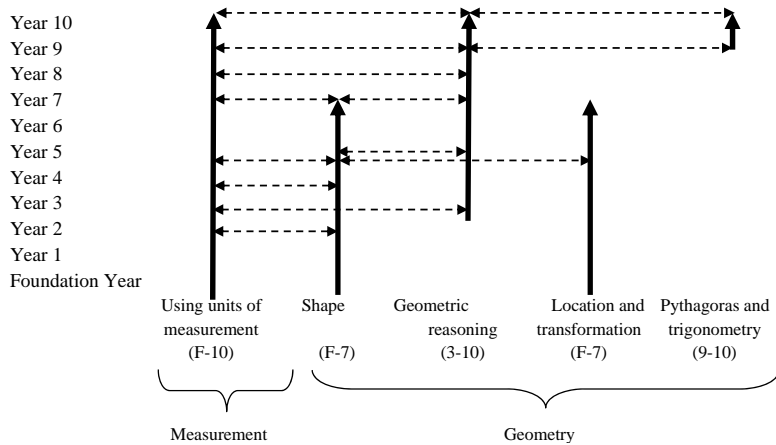


Figure 1. Connections between the Measurement and Geometry content strand throughout the Australian Curriculum

It is important to note that at a meta-level, connections across content strands have been formed. For example, although *location and transformation* ceases in Year 7, there is a direct developmental link within this understanding and that of *linear and non-linear relationships* (which are described in the Number and Algebra strand). There are other links within and across content strands which also drive a connectivity agenda, however, we are concerned that the frameworks currently established do not provide teachers with easy access to such models, nor a holistic view of the curriculum.

It is certainly the case that the approach of the Australian Curriculum is to build on students' understandings within topics and content areas and have them relate to each other once understandings have been separately scaffolded and understood. By way of example, the definition of a square is as follows: *A square is a quadrilateral that is both a rectangle and a rhombus* (ACARA, 2011, p. 71). This definition highlights the hierarchical properties of the quadrilateral family rather than isolating a shape as a discrete prototype (Bobis, Mulligan, & Lowrie, 2009)—and indeed emphasises the importance of establishing connected understandings within a single sub-strand. Most definitions of a rhombus describe its properties as *a four-sided shape with four equal sides with opposite angles equal* (O'Brien & Purcell, 2004). Never do these definitions have a shape of a square as an example of a rhombus—the representations are always of a figure with two obtuse and two acute angles. Other examples would include teaching perimeter and area, and area and volume understandings through an integrated approach. However, as the document stands we do not have access to the level of depth required to ascertain whether such learning experiences are to be promoted in future supplementary documents (e.g., units of work). Nevertheless, what we do know is that scant attention is given to such integrated teaching in current state curricula.

Although there is a strong indication that such connected learning opportunities are endorsed in the Curriculum, substantial and sustained professional learning opportunities need to be provided for teachers (Bezzina, Starratt, Burford, 2009; Reid, 2005; Reid, 2010). There is a view that the Australian Curriculum may be an enabling process that changes practices in the classroom (Tonkin & Wilkinson, 2010) however, the nexus between policy and practice needs to be strong (Green, 2010). If this fails to happen, the curriculum will become fragmented with concepts being introduced and reinforced in isolated ways. This “warning” is particularly pertinent to the Measurement and Geometry content strand since most learning opportunities, in both primary and secondary school contexts, will revolve around the Number and Algebra content strand. This practice will occur irrespective of curriculum initiatives—and possibly even if professional learning opportunities at pre-service and in-service levels are saturated with experiences which enhance the

Measurement and Geometry strand—given the overwhelming focus of Number and Algebra in national assessment and policy frameworks (Lowrie & Diezmann, 2009).

To this point, the Australian Curriculum needs to have better scaffolds for classroom teachers to engage students within and across content strands. We argue that this could be achieved through the four proficiency strands and especially through the *understanding* and *reasoning* proficiency areas. The description of the proficiencies identify that students “make connections between related concepts and progressively apply the familiar to develop new ideas” (*understanding* proficiency) and “when they adapt the known to the unknown, when they transfer learning from one context to another” (*reasoning* proficiency) (ACARA, 2011, p. 3). We argue that such statements may not be enough<sup>1</sup>. Anderson (2010) asserts that the mathematics draft curriculum has failed to clearly link the connection between the mathematical content prescribed; and the *proficiencies* and actions associated to working mathematically within content areas, particularly in reasoning and problem solving. It is Anderson’s (2010) view that teachers will need support in teaching reasoning and problem-solving skills if the outcomes of the Australian Curriculum are to be fulfilled. From our perspective, ACARA should provide meta-models which not only describe the connectivity between sub-strands within the Measurement and Geometry content strand, but also models which highlight the connectivity of sub-strands across the three content strands.

### Readiness

To date, much debate concerning the Australian Curriculum for Mathematics has centred upon the inclusion of the content knowledge and proficiencies students should possess and be equipped with to flourish in an increasingly global society (Bezzina, Starratt & Burford, 2009; Reid, 2010). An area that needs further exploration revolves around students’ readiness to engage with the content knowledge prescribed in the curriculum. Recommendations from the National Numeracy Review (Council of Australian Governments [CoAG], 2008) suggest:

That from the earliest years, greater emphasis be given to providing students with frequent exposure to higher-level mathematical problems rather than routine procedural tasks, in contexts of relevance to them, with increased opportunities for students to discuss alternative solutions and explain their thinking. (p. xii)

We argue that students bring with them significant measurement and geometry knowledge when they arrive at school. This knowledge often exceeds knowledge

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<sup>1</sup> We acknowledge that subsequent documentation and support documents may well be developed by State jurisdictions.

beginning students have on other mathematics strands and thus there is more potential to engage in deeper levels of understanding at an earlier age in this strand (Highfield, Mulligan & Hedberg, 2008; Owens, 2002).

MacDonald (2010) considered the impact of young children’s informal measurement experiences on their ability to compare like attributes; directly compare objects; use appropriate language to describe measurement attributes in comparison; and order objects using direct comparison. She discovered Kindergarten students without any formal learning in measurement were capable of demonstrating comparison between similar and different objects, and at the most sophisticated level, comparison between more than two objects. As Barrett and Clements (2003, p. 515) argued, “measurement takes its meaning from comparisons of real objects; as such, children’s schemes for measuring linear objects become more sophisticated when they are grounded in realistic situations based in comparison”. MacDonald (2010) claimed students’ positive outcomes in comparative measurement generate confidence, and consequently, positive self-efficacy when encountering measurement curriculum material in classroom settings. Although the notion of confidence building is critical at every grade level, we emphasise it here (in the early years of schooling) since curriculum content appropriateness begins with what prior understandings and skills students have acquired—and these foundations build any curriculum.

Several researchers (including MacDonald, 2010; Bobis, Mulligan & Lowrie, 2009) have shown that students naturally compare the measurement of objects to their own body. Consequently, the measurement outcomes of the Australian Curriculum for Mathematics should present opportunities for students to use their resources and prior experiences to demonstrate their knowledge of informal comparison. This is beneficial to students’ understanding as Bush (2009), Jacobbe (2008) and O’Keefe and Bobis (2008) agree that students experience difficulty when measuring an attribute in regards to choosing appropriate units to measure different attributes; and the comparison of attributes. Students’ understanding of attributes will develop over time provided teachers use a variety of measurement tools for students during tasks involving the measurement of an attribute (Castle & Needham, 2007). At present we find that tools and concrete materials are not afforded the attention required in order for such development to take place. Perhaps these working mathematically characteristics are embedded within the four proficiencies but we would like shifts between informal and formal measurement to be horizontally rich rather than just vertically linked. In other words, students should be encouraged to discover and explore measurement and geometry understandings throughout their schooling rather than such experiences dissipating as students get older. The initial sub-strands of *using units of measurement, shape, and location and arrangement* (see

Figure 1) provide scope for rich learning opportunities, and we trust that support documents that accompany this Australian Curriculum will highlight the importance of embedding the four proficiencies into all sub-strands of this strand. Otherwise, progression through the curriculum will result in less engagement with realistic and practical measurement connections and move toward rule-based procedures that only have application for some students (see Ness & Farenga, 2007 for a description of how young students construct a sense of ratio through practical experiences from an early age).

### *Terminology and Language*

In terms of mathematics terminology, particular words have been used to describe and represent mathematics concepts, symbols and images—and these words have been used interchangeably (e.g., flip and reflection) and differently (column graph and bar chart) within and between states syllabi. As we move toward an Australian Curriculum, such idiosyncratic and inconsistent usage is heightened. Although there has always been a transition between using appropriate mathematics terminology and using “everyday” word usage to describe specific mathematics concepts, it appears that such practices are not only unwarranted but also problematic. Communication is an essential ingredient when exploring mathematical ideas and relationships. As Muir (2006) argued, the use of estimation prior to measuring attributes allows students to practise communicating their expectations and theories in meaningful ways. Communication during measurement is viewed as a valuable tool to build students’ use of mathematical language (Thom, 2002) and to consolidate conceptual understandings. Indeed The National Numeracy Review (CoAG, 2008) recommended:

That the language and literacies of mathematics be explicitly taught by all teachers of mathematics in recognition that language can provide a formidable barrier to both the understanding of mathematics concepts and to providing students access to assessment items aimed at eliciting mathematical understandings. (p. xiii)

Hence, teachers must facilitate students’ learning that everyday vocabulary, such as ‘pie’ or ‘column’, can adopt different meanings when used in the context of measurement and geometry in the classroom (Ernst-Slavit & Slavits, 2007; Lowrie & Diezmann, 2009). Moreover, it is much better to encourage the use of precise terminology with children from an early age to avoid confusion and inconsistencies as they developmentally progress through the curriculum. An example of this is the apparent interchangeable use of “features” and “properties” when describing geometric terms. Dawe and Mulligan (1997) found that over 10% of children failed to correctly respond to a Basic Skills Test mathematics item as they were unable to comprehend the wording of the task as opposed to a lack of mathematical

knowledge. Lowrie and Diezmann (2009) described the confusion that surrounds the use of the term “flip” when students are required to reflect a shape. Typically, students adopt a practical “everyday” definition to such terminology which can completely disrupt mathematics sense making. We note that terminology such as “slides” and “flips” are used in Year 2 and Year 3 and yet “translations” and the “reflections on” are terms used by Year 5. The same case could be made for the description of shapes. Owens (2002) found that precise mathematics terminology can readily be adopted by young children rather than using imprecise terminology and then changing this as they progress through schooling. Appropriate terminology should be used from the Foundation year onwards.

### *The Representation, Structure and Framing of the Strand*

To a large extent, there are no content-based surprises in this strand—in the sense that most of the sub-strands identified in the document have been traditionally present in most other state syllabi. Thus, the content that framed state documents has been encapsulated in this national strand. Indeed, there does not appear to be any content taken out of the measurement and geometry strand and moved into one of the other two strands (whereas *chance* understandings, for example, have moved from Number strands of state curricula and embedded within the Statistics and Probability strand of the Australian Curriculum).

A fundamental change in framing this strand of the curriculum has been the inclusion of the term Geometry to describe concepts and understandings that are connected and related to measurement concepts and understandings. In previous state syllabi, geometry (or Space as it was commonly referred to in most documents) was not incorporated into the measurement strand. Furthermore, the term geometry was rarely used to describe mathematics understandings in primary school settings (only named in the New South Wales and South Australian syllabus documents). In the Australian Curriculum, the term geometry is used to describe content in both primary and high school situations. Although many teachers could bring these changes down to semantics; noteworthy, is the extensive history and debate regarding the use of this term in mathematics curricula. For example, Riemann (cited in Millman, 1977) maintained that geometry and space are distinct fields within mathematics and that geometry was founded on proofs and axioms. By contrast, space was transformational in nature and design. Clements, Grimsom and Ellerton (1989), in a chapter which outlined historical changes in mathematics curricula in Australia, noted that more pure forms of Euclidean geometry had been replaced with transformational geometry under the (New) mathematics movement of the 1970s. From our perspective, the name change to Geometry does not come with a shift in intent or practice in the new Australian Curriculum.

Not only has the term space (and its stand-alone position as a content strand) been removed from the mathematics curriculum, the underlying emphasis on spatial and visual reasoning has been somewhat neglected. We argue that notions of spatial and visual reasoning are not only essential ingredients of mathematical thinking and processing (Diezmann, Lowrie, Sugars, & Logan, 2009; Lowrie & Diezmann, 2009; Owens & Outhred, 2008; Presmeg, 2008) but are increasingly important in a digital age where tools provide increased flexibility to represent mathematics ideas in graphical forms (Lowrie & Logan, 2007). As Battista (2007) highlighted in his chapter on the development of geometric and spatial thinking in *The second handbook of research on mathematics teaching and learning*, spatial reasoning is both a critical and integrated aspect of the measurement and geometry field. The development of geometric thinking relies on the production of drawings, diagrams and spatial reasoning. Battista (2007, p. 844) claimed “in geometric thought, one reasons *about* objects; one reasons *with* representations”. In fact, there is no reference to spatial or visual reasoning in the entire document. The lack of attention afforded spatial reasoning in the curriculum is compounded by the fact that no indirect mention of such processing is framed within the four proficiency strands. For example, there is no mention of “drawing a diagram”, “imagining in your mind’s eye”, or any intent to promote reasoning which encourages students to manipulate or move objects within an internal, visual, space. Such processing is accepted as an essential aspect of mathematics reasoning. Without such reasoning, the depth of understanding within this mathematics strand is lost. Therefore, the “signposting” (for teachers) that spatial and visual reasoning is critical to this strand has been removed from both content and mathematical proficiencies.

The other signposting change involves the placement of *Measurement and Geometry* within the same strand. The Australian Curriculum (ACARA, 2011) describes this change:

Measurement and geometry are presented together to emphasise their interconnections, enhancing their practical relevance. Students develop increasing sophistication in their understanding of size, shape, relative position and movement of two-dimensional figures in the plane and three-dimensional objects in space. They investigate properties and use their understanding of these properties to define, compare and construct figures and objects. They learn to develop geometric arguments. They make meaningful measurements of quantities, choosing appropriate metric units of measurement. They understand connections between units and calculate derived measures such as area, speed and density. (p. 2)

In most other (state) syllabus documents, measurement was afforded its own placeholder particularly in primary school curricula. The representation and framing of a document which integrates the conceptual foundations of measurement and geometry should be applauded since rich learning opportunities

and deep thinking can occur. As with all of the sub-strands within this strand, the sequencing and development of concepts and understandings seem both logical and appropriate. We welcome this connectivity however, measurement concepts and understandings, in particular, have a narrow focus. As mentioned in the previous section, we are somewhat disappointed with the fact that the representation and framing of the document is displayed in a piecemeal manner. So many concepts and understandings are addressed within a given Year level (e.g., measure and compare length, mass, capacity and time with relationships between time units) without any clear modelling or direction. For example, would it not be best to actually compare relationships between mass units and relationships between capacity units as well as relationships between time units? If such learning opportunities are not promoted, engagement with this strand in the curriculum will be limited to procedural knowledge, the development of formulae, and conversion procedures between units of measure. As many experts have argued, relatively sophisticated measurement and geometry understandings can be developed from an early age provided students are afforded opportunities to explore, interrogate and derive meaning from realistic and challenging experiences (Clements & Sarama, 2004; MacDonald, 2010). The intent of this strand is admirable, however unless much more explicit connections between concepts are presented, this strand of the curriculum will be fragmented.

#### *Assessment Practices: Backward Mapping from National Assessment*

Although we do not advocate for national testing—in fact, we find it both problematic and limiting—we acknowledge that high stakes testing has an influence on teaching and pedagogical practices. Furthermore, the adoption of Australian Curriculum may well be influenced by how well it aligns to the type of content currently being presented in the National Assessment Program: Literacy and Numeracy (NAPLAN). The introduction of the NAPLAN has provided a control mechanism for standardising what is being taught within the respective state syllabi. The Australian Curriculum further reinforces this consistency and yet the public accountability that surrounds the NAPLAN will remain influential with or without a national curriculum. Researchers (including Reid, 2010 and Wyatt-Smith & Klenowski, 2010) have argued that the formation of the national curriculum has been done with little recognition of the assessment evidence used to inform the advancement and use of achievement standards—possibly because most states have been wary of the extent to which the content of the national document mirrors that of their state document. Since little is known about “the nature and extent of assessment evidence” that teachers will be required to collect and analyse (Wyatt-Smith & Klenowski, 2010, p. 38) we can only assume that the NAPLAN will drive assessment practices and state standards. It is vital that teachers are familiar and

comfortable with the alignment of achievement standards to assessments of the Australian Curriculum (Wyatt-Smith & Klenowski, 2010).

Elsewhere, our colleagues have identified the high proportion of graphics tasks in national mathematics assessment items (Diezmann, 2008; Greenlees, 2011). Many of these items require high levels of spatial reasoning (Lowrie & Diezmann, 2009) – skills that are often developed within this strand of the curriculum. We undertook an analysis of the mathematics items in the first three years of the NAPLAN (2008 to 2010). A high proportion of these items required specific measurement- and geometry-content understandings. If we consider the 2008 data initially, in the Year 3 instrument, for example, 43% of the questions (15/35 items) had a measurement or geometry base. This high proportion was consistent across the other three tests in that year with 53%, 59% and 50% for Years 5, 7 (combined tests) and 9 (combined tests) respectively. We also analysed the questions within the categories of measurement and geometry. Across each year level, there were more geometry-based items than measurement items with questions that required an understanding of both categories (i.e., measurement and geometry) not required until Year 7 in the 2008 tests. In fact, the Year 7 test required students to link conceptual understandings from both categories, or across other strands, on 20% (13/64 items) of those items identified within this strand. More connected items appear in the 2009 and 2010 tests, with evidence of integrated concepts at Year 5.

Measurement and geometry concepts certainly feature prominently in what is being assessed at a national level. However, it could be indicative of how these topics are being taught presently that there are a minimal number of items in which integrated concepts are being assessed. It will be interesting to see how the national assessment will reflect the new curriculum once implemented.

### Discussion and Conclusions

One of the most positive aspects of this strand is the fact that measurement and geometry are seen as interconnected however teachers need to be supported in effectively utilising this strength. The Australian curriculum will not have an impact on teaching and learning unless there is a significant and sustained professional development program incorporated into implementation of the curriculum. Moreover, the fact that measurement and geometry (formally space) are now embedded within the same strand provides great potential for teachers to provide learning opportunities that are rich and conceptually connected.

A number of conclusions emerged from this chapter which have direct impact on teaching and pedagogical practices and the professional development that needs to surround the implementation of the curriculum.

- It was pleasing to see some connectivity of concepts and understandings within sub-strands and across strands. We advocate that more could be included and that learning experiences should include the simultaneous presentation of concepts (e.g., perimeter-area; area-volume; volume-capacity) in order to provide opportunities to engage in rich, open-ended investigations.
- Further learning opportunities should be presented within the Curriculum so that students who are conceptually ready to engage more deeply with mathematics understandings can do so. A clearer scaffold of content should be provided so that teachers are better equipped to move students towards more sophisticated conceptual understandings.
- Correct measurement and geometry terminology should be introduced immediately to the curriculum rather than using everyday words which become obsolete as students progress through the curriculum.
- The move to combine measurement and geometry in one strand provides teachers with opportunities to emphasis interconnections within and between concepts and this heightens the practical relevance of this strand. It is important, however, that teachers are provided with focused and sustained professional development in order to ensure such connections are made.
- It is disappointing that spatial and visual reasoning has not been afforded any prominence in the Curriculum. Given the types of skills students require in a technology age, there is no better place to reinforce such processing than in this strand.
- It is evident that measurement and geometry concepts are well represented in national assessment instruments. The high proportion of items which relate to these concepts will inevitably ensure the strand has high prominence in the foreseeable future.

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