

Insights into Ways that teachers plan their Mathematics Teaching

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Insights into aspects of teachers' planning reported here were gathered as part of a broader project examining aspects of the implementation of the Australian curriculum in mathematics. In particular, responses of teachers to a survey of various aspects of decisions that inform their planning are discussed. While there is diversity in processes teachers use for planning, a consistent theme was that teachers make active decisions at all stages in the planning process. There were slight differences in the ways that primary and secondary teachers plan. There are important implications from our findings for those who support teachers in the transition to the Australian Curriculum: Mathematics.

Introduction

The Melbourne Declaration (MCEECDYA, 2008) articulates an agreed commitment of Australian states and territories and the Commonwealth on the educational entitlement of all young Australians. This Declaration underpins the development of an Australian curriculum, and includes mathematics as one of eight learning areas where “English and mathematics are of fundamental importance in all years of schooling and are the primary focus of learning in the early years”. In enacting this, the Australian Curriculum Assessment and Reporting Authority (ACARA) (2012) outlines the rationale and guiding principles for the development of the Australian Curriculum: Mathematics (AC:M). That document explains the decision to develop discipline specific curricula, and also describes structures and processes to build connections between those disciplines. The overall Australian Curriculum, in addition to the discipline specific documents, describes cross curriculum priorities (e.g., Aboriginal and Torres Strait Islander histories and cultures), and general capabilities (e.g., numeracy, creative and critical thinking). There is an accompanying *Mathematics Shape Paper* (ACARA, 2009) which recommends reforms in curriculum documentation. For example, changes recommended are that:

- the content be succinctly and clearly described to support teacher decision making;
- the process strands, termed proficiencies (understanding, fluency, problem solving and reasoning), be integrated with the content strands;
- the curriculum be less “crowded” allowing for greater depth of study; and
- there be greater attention to statistics and probability at all levels of schooling.

Subsequent drafts of documents constituting the AC:M interpret these principles, outlining content descriptions and elaborations, achievement standards, and annotated student work samples.

There is an underlying assumption that curriculum documentation significantly informs the way teachers plan, teach and assess, and that improved planning can result in improved

teaching and learning. The following is a report of one aspect of a research project¹ that is seeking to elaborate the relationship between curriculum documentation and mathematics teaching. The focus of this report is on ways that teachers report that they plan.

There is a direct connection between planning and teaching. Teachers are best able to support students when they have a clear sense of what they intend students learn. Hattie and Timperley (2007), for example, reviewed a range of studies on characteristics of effective classrooms and found that feedback was one of the main influences on student achievement. They listed the key elements as being that students receive information on “where am I going?”, “how am I going?”, and “where am I going to next?” Presumably part of the planning process is anticipating how such questions might be answered for students, a key aspect of which is choosing the important aspects of the topic to be taught. Charles (2005) argued that focus on important ideas “had not become part of mainstream conversations about mathematics standards, curriculum, teaching, learning and assessment” (p. 9). One aspect of the overall project is exploring the extent to which the AC:M assists teachers in identifying and articulating the important ideas informing their teaching.

The overall project includes three data collection phases: a baseline survey; interventions; and development of exemplars. The following presents results from the baseline survey and in particular we describe teachers’ responses to a prompt related to their planning.

Curriculum Knowledge and Curriculum Planning

A second underlying assumption is that teachers’ planning decisions are informed by their knowledge of curriculum generally and the curriculum they are intending to teach in particular. There are two major categories of knowledge needed for the teaching of mathematics: subject matter knowledge; and pedagogical content knowledge. Hill, Ball, and Schilling (2008) described diagrammatically components of these two categories of knowledge. When converted to text, the sub categories of *Subject Matter Knowledge* were: common content knowledge; specialised content knowledge; knowledge at the mathematical horizon. The subcategories of *Pedagogical Content Knowledge* were knowledge of content and teaching; knowledge of content and students; knowledge of curriculum. Hill and colleagues did not elaborate what they meant by the term knowledge of curriculum. In discussing the issue of the knowledge of curriculum that teachers need, Shulman (1986) earlier said:

The curriculum is represented by the full range of programs designed for the teaching of particular subjects and topics at a given level, the variety of instructional materials available in relation to those programs, and the set of characteristics that serve as both the indications and contraindications for the use of particular curriculum or program materials in particular circumstances. (p. 10)

Note that this statement does not mention knowledge of the type of curriculum documentation that has been produced by the various Australian jurisdictions previously, the documentation associated with the AC:M, or indeed, more general discourse internationally on such matters, such as the core standards in the United States.

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The assumption mentioned above is that knowledge of curriculum informs planning. Yet it seems that the ways teachers plan is very much dependent on the overall schooling context and what they take the term curriculum to mean. Kilpatrick, Swafford, and Findell (2001), for example, argued that planning is critical, takes much effort and is the core activity of experienced teachers. Yet they claimed that the planning of US teachers consists of choosing activities and anticipating ways in which they will organise the activities. Similarly the significant research on teaching reported by Stein, Grover, and Henningsen (1996) described the initial phase in planning as the teacher taking the mathematical task as presented in instructional materials which, influenced by the teacher's goals, subject matter knowledge, and knowledge of students, informs the way they teach. In other words, these US teachers use instructional materials as the starting point for planning.

Our experience is that the planning of teachers in Australia is quite different. In all jurisdictions, schools develop yearly plans of the topics that form the skeleton of the curriculum. Teachers then, individually or in teams, plan units of work (or sequences of lessons) using the constructs, structures and detail of the relevant curriculum. It is assumed that previously the various state curriculum documents informed both types of planning in some way and that, in the future, teachers will consider the AC:M (or at least some variation of it) as the basis of both types of planning. It is, however, not clear when and how curriculum documents are consulted, and how that information informs planning. That is the focus of the data reported below.

The Context and Methods of the Data Collection

The overall focus of our project is on describing influences on teachers' knowledge and practice, and especially the ways teachers interpret and use curriculum documents. The project is using an adaptation of the schematic of Clark and Peterson (1986) that proposes that teachers' intentions (that is their planning) is informed, interactively, by their knowledge of curriculum and pedagogy, their dispositions (their beliefs, attitudes and values), and the opportunities and constraints arising from the context of teaching. We hoped to gain insights into ways these factors interact through seeking insights into teachers' planning.

To minimise preconceptions about the types of documents that teachers consult, the authority they attribute to those documents, the role of their experiences, the resources to which they may have access, and so on, we first conducted eight focus groups of primary teachers and four focus groups of secondary teachers. The prompts for those focus groups were intended to promote discussion and even argumentation among the teachers. For example, we presented participating teachers with extracts from the AC:M and asked questions such as: What does this extract mean to you? To what extent does this suggest changes to your current practices? What would you need to know to implement this aspect of the curriculum in your classroom? How might you assess whether students learn the content suggested by the curriculum content descriptions? How might this influence your planning?

The focus group interviews were recorded and transcribed, and the transcripts read to determine themes in the teachers' responses. These themes were used as the basis of a survey on which we sought responses from a broader range of teachers. The survey was piloted with one primary and one secondary group of teachers to check for coherence, ease of completion, and the clarity of the prompts.

There were six sections to the survey: the range and authority of documents that teachers consult; the ways that teachers describe important ideas in topics they were planning to teach, the processes teachers use in their planning; ways teachers match classroom tasks

with curriculum statements; the extent to which teachers incorporate aspects of mathematical reasoning into their planning and teaching (a key aspect of the AC:M); and what teachers identify as their professional learning needs associated with the interpretation of curriculum. Teachers were invited to complete an on-line version of the survey via a link on the web site of the *Australian Association of Mathematics Teachers*, and some groups of teachers to which we had occasional access completed a paper version of either the whole survey or particular whole sections of the survey.

The particular research questions that focus on teachers' planning were:

What is the comparative emphasis that teachers place on activities or curriculum documents in making planning decisions?

In what ways is the planning of primary and secondary teachers different?

Teachers' Planning Processes

At the start of the survey, teachers were invited to indicate the frequency with which they consulted various documents and made decisions. David Clarke and colleagues (in press) reported that teachers' decisions are informed just as much by their experience, their colleagues in the case of primary teachers, and their assessments of students as they are by formal curriculum documents.

Next, teachers were asked to respond to the following prompts:

What is the next mathematics topic you are planning to teach?

What is the most important idea that you will focus on for that topic?

Nearly all teachers responded to the first prompt by listing a topic that was easily recognisable as part of the mathematics curriculum such as Algebra or Addition and subtraction. Doug Clarke and colleagues (in press) reported that responses to the second prompt indicated that the important ideas listed by many teachers would not provide the sort of focus that Charles (2005) was proposing, with around 32% of primary teachers simply listing a sub-topic of the larger mathematical topic (e.g., measurement—perimeter and area, and 13% making a statement which could apply to most other topics and not specifically an important idea tied to the particular topic (e.g., real life applications). The equivalent percentages for secondary were 56% and 17%, respectively.

The items that form the basis of the data below follow on directly from these prompts. This particular item was:

Rank the following statements in order from 1 to 6 in terms of "closeness" to what you will do when you are planning and teaching that mathematics topic (use 1 for most like you, 2 for the next most like you ... 6 for least like you)

The responses from secondary and primary teachers to this prompt and a subsequent one are presented separately.

Secondary Teacher Responses

Table 1 presents responses of the secondary teachers. In Table 1 (and Table 2 below), even though the numbers represent ranks, the mean is presented to act as a general guide to the responses overall (with a low score representing a higher rank), along with the percentage ranked by teachers in the top two categories, providing a sense of the priority teachers give to the particular planning strategy.

Table 1

Ranking of Statements on Specific Planning Process in Order (secondary) (n = 130)

	Mean	% of teachers ranking this in the top two
Based on what I know about the students already, I will collect the relevant classroom activities to which I have access, choose the ones that fit the topic, and then decide the order in which I will use them.	2.5	56
I will read the official curriculum documents to identify the specific learning goals and then plan my teaching based on that.	3.2	43
I will look through a textbook or other teacher resource and plan teaching which relates to the given content.	3.3	36
I will look at the school-based curriculum documents then identify specific learning goals, and select activities from there that I will use with my students.	3.4	32
I will meet with other teachers, we will share our experience and ideas, then plan the activities and resources we will use.	3.6	27
I will read the official curriculum documents to identify the specific learning goals and then use the teaching ideas and resources that they suggest.	4.5	18

There were no significant differences between the responses of teachers to these items, based on their age, experience, system, gender, or whether they completed the survey online. In the case of this table, of some interest is whether there were differences by state. For these teachers the ranking and proportions in the top two categories were similar across the three states that had enough responses to allow comparisons.

The first observation from the table is the diversity of responses suggesting that teachers have different priorities and processes for their planning. Some base their planning on judgments and activities, others refer to official curriculum documents, others to texts (although fewer than we had anticipated for these secondary teachers) and a smaller number rely on school developed documents. Indeed, even the most popular option, that of collecting relevant classroom activities, was only selected in the top two factors by just over half of the teachers. While some secondary teachers report using a text, only around one third ranked this in the top two categories, suggesting that the common impression that secondary teachers rely on largely on texts for planning may be incorrect for this sample.

A second inference from the responses is that teachers make judgments about what their students need and plan accordingly. Rather than the common conception that teachers are passive users of curriculum, it seems that these teachers at least make active decisions about the content of their teaching.

It also seems that planning is an individual rather than collaborative enterprise for these secondary teachers, with only 27% listing meeting with other teachers in the first two ranks.

Because we were not sure that the options offered in Table 1 represented the planning processes of all teachers, the teachers were also invited to respond to the following prompt:

If none of the statements in the question above are at all close to a description of how you would plan this topic, please write a description of how you would plan your next mathematics topic:

There were only 16 written responses indicating that most teachers felt that their specific planning processes were represented in the list of options. On other similar items, there were many more teachers who gave written responses. Of the teachers who did respond, the

responses were sophisticated and detailed, and the most common category of response was those that considered the options presented (shown in Table 1) did not capture the complexity and subtlety of their planning. For example, the following are some of those written responses:

Identify the learning from Australian curriculum document. Look to see how new texts have interpreted the content. Reflect on what they have said, consider what I know already about the topic and the students' existing knowledge. Consider where the topic goes and what preparation is needed for future topics. Gather all relevant and interesting resources. Select for engagement.

I have developed notes specific to that topic by following the syllabus then finding the appropriate resources from text books, web sites or other resources that would suit the students in that particular class adjust or change my teaching to suit their needs.

I would obtain the topic to be taught from the schools' program. Using the official text book I will prepare a lesson plan, develop warm-up exercise, lesson presentation (may involve, overheads, Powerpoints, physical models), classwork (taken from textbooks, or material I have available (or available from school), homework, end of topic test.

I check the school based documents to check our timing, confirm the learning goals in the official curriculum documents and then will select from many sources the resources that meet the needs specific to my class and the students in it.

These examples are representative of the responses of other teachers. The responses indicate that these teachers have thoughtful and multi-step processes for their planning, they plan idiosyncratically, and make active decisions. This is discussed further below.

Primary Teacher Responses

The primary teachers also were invited to rank the same items after they had nominated the next topic they were to teach. Their responses are presented in Table 2.

Table 2

Ranking of statements on the planning process in order (primary) (n = 97)

	Mean	% Teachers in top two
Based on what I know about the students already, I will collect the relevant classroom activities to which I have access, choose the ones that fit the topic, and then decide the order in which I will use them.	2.5	55
I will read the official curriculum documents to identify the specific learning goals and then plan my teaching based on that.	2.9	49
I will meet with other teachers, we will share our experience and ideas, then plan the activities and resources we will use.	3.3	46
I will look at the school-based curriculum documents then identify specific learning goals, and select activities from there that I will use with my students.	3.8	15
I will read the official curriculum documents to identify the specific learning goals and then use the teaching ideas and resources that they suggest.	3.8	23
I will look through a textbook or other teacher resource and plan teaching which relates to the given content.	4.7	10

The top two options for these primary teachers were also the most highly ranked by secondary teachers, with the main difference being the higher ranking of planning with other teachers. As with the secondary teachers, there is a diversity of ways that these teachers plan, and it can be inferred that they make active decisions in their planning. The

primary teachers generally gave a lower ranking to referring to a text as part of the planning process, but a higher ranking to meeting with other teachers to plan.

As with the secondary teachers, the primary teachers were also invited to describe their planning if none of the above descriptions matched the way they plan. There were also just 12 replies, as with the secondaries, indicating that the above were meaningful descriptions of their planning. Some of the additional descriptions focused on the role of the team:

We meet as a team and share out the term's maths planning. Each teacher volunteers to prepare two or three weeks' learning for the whole stage. When it is your turn, you write up the next week's maths on a proforma and put a copy of the plan and any relevant worksheets and activities in each person's pigeonhole. A copy is also placed on (xxx) and referred to in the following year. If appropriate, a Notebook file is developed on the topic and saved on (xxx) for use with interactive whiteboards.

Other comments emphasised the role of pedagogy such as:

Although I rated the above 1-6 in reality I pre-test the children on the concept then through discussion we share their results and knowledge then I pose questions relating to the concept (to engage their lateral thinking skills) we then go back and discuss then I show examples then I ask them to write examples and come to front of their class and reflect. The children then reflect on that child's knowledge etc. This is a process and a cycle and over an hour lesson we can reflect on many concepts and take the understanding of each concept to a deeper level. I use texts, curriculum doc to guide me. I rarely give out a work sheet.

One of the responses indicated an emphasis on integration across topic boundaries.

I will consider my students' current understanding of the topic (sampling and distribution) based upon the level of understanding they have demonstrated already. I will then devise an inquiry topic which will necessitate deep exploration of sampling (beyond their current understandings) in order for the students to resolve the inquiry question, regardless of what line of approach they take. I will ensure that the inquiry cannot possibly have a 'correct' answer which will necessitate the students gathering and presenting evidence to argue and justify their solutions in class. I will then look at the curriculum documents for my state, recognise that my students are working well above where they are 'supposed' to be, shrug it off and advise them of that because it amuses them that EQ thinks they are incapable of such deep understandings at their age.

Again these free format responses illustrate the complexity and sophistication of teachers' planning routines, the active role that they play, and their willingness to consult with planning team members. These issues are discussed further below.

Discussion and Conclusions

The results reported are from a survey on aspects of teachers' planning processes. There are important implications for those who educate and support mathematics teachers.

It seems that, from these data, there is a wide diversity of emphases and sequences of actions in the planning processes reported above. This suggests that any professional learning on planning should start from the processes that teachers use, and that teacher educators and others, rather than imposing particular routines on teachers, should help them to find ways to make their own processes better.

It can also be inferred that teachers do not follow recipes and instructions but make decisions based on their own judgments, and those of colleagues (in the case of primary teachers), on ways to increase the chances of their students learning. Curriculum developers, administrators, policy makers, school leaders, teacher educators and others should find ways to support teachers in their decision making rather than trying to curtail it. In particular, attempts to be overly prescriptive or to provide "teacher-proof" lessons will be counterproductive.

A surprising finding is that there were few differences in the spread of responses between the categories of teachers. One difference was that the primary teachers reported more emphasis on collaborative planning and secondary teachers claimed to plan by themselves. Another difference was the secondary teachers used texts more than primary teachers, although interestingly still less than we had anticipated that they would. It seems that it would assist secondary teachers if routines in schools were established to facilitate collaborative planning.

It also seems that the planning of many teachers is substantially informed by curriculum documentation. Our project will continue to explore ways that teachers use such documentation and which aspects they find helpful. It is surprising, given the resource intensive nature of the preparation of such curriculum documents, that there is limited recent Australian research on how they are used. Certainly, an Australian mathematics curriculum, with common documentation and supporting resources provides an ideal context for such research to receive renewed attention.

References

- ACARA (2012). The shape of the Australian Curriculum. Accessed Jan 2012 from http://www.acara.edu.au/verve/resources/The_Shape_of_the_Australian_Curriculum_V3.pdf
- ACARA (2009). Shape of the Australian Curriculum: Mathematics. Downloaded in Feb 2012 from http://www.acara.edu.au/verve/resources/Australian_Curriculum_-_Maths.pdf
- Charles, R. (2005). Big ideas and understandings as the foundation for early and middle school mathematics. *NCSM Journal of Educational Leadership*, 8(1), 9-24.
- Clark, C. M., & Peterson, P. L. (1986). Teachers' thought processes. In M. C. Wittrock (Ed.) *Handbook of research on teaching* (pp. 255–296). New York: Macmillan.
- Clarke, D. M., Sullivan, P., & Clarke, D. J. (in review). Important ideas in mathematics: What are they and where do you get them? *Australian Primary Mathematics Classroom*.
- Clarke, D. J., Clarke, D. M., & Sullivan, P. (in review). Resources that support teachers' planning. *Australian Primary Mathematics Classroom*.
- Hattie, J., & Timperley, H. (2007) The power of feedback. *Review of Educational Research*, 77(1), 81-112.
- Hill, H., Ball, D., & Schilling, S. (2008). Unpacking pedagogical content knowledge: Conceptualising and measuring teachers' topic-specific knowledge of students. *Journal for Research in Mathematics Education*, 39, 372-400.
- Ministerial Council for Education, Early Childhood Development and Youth Affairs (MCEECDYA, 2008). Melbourne Declaration on educational goals for young Australians. Downloaded on Feb 2012 from http://www.mceetya.edu.au/mceecdy/melbourne_declaration_25979.html
- Kilpatrick, J., Swafford, J., & Findell, B. (Eds.). (2001). *Adding it up: Helping children learn mathematics*. Washington, DC: National Academy Press.
- Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4-14.
- Stein, M. K., Grover, B. W., & Henningsen, M. (1996). Building student capacity for mathematical thinking and reasoning: An analysis of mathematical tasks used in reform classrooms. *American Educational Research Journal*, 33(2), 455–488.