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ORIGINAL ARTICLE

# Primary teachers' written unit plans in mathematics and their perceptions of essential elements of these

**Anne Roche · Doug M. Clarke · David J. Clarke · Peter Sullivan**

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**Abstract** The content and purpose of written unit plans in mathematics is an under-researched area. In this article, we provide a brief overview of research on teachers' planning processes and the place of mental and written plans. We report on data from a questionnaire completed by 357 teachers from Victorian Catholic primary schools, where we focused on possible elements of written unit plans for primary mathematics, and the relative importance which teachers attributed to these elements. We then discuss 48 written unit plans which were provided to us by primary schools from which the 357 teachers were drawn. There was considerable variation in the length, intended teaching time, and level of specification of key ideas in these plans. We discuss this variation, and some discrepancies between the ratings of teachers of the importance of certain elements and their presence in the plans we examined. We also suggest potentially productive areas of future enquiry.

**Keywords** Planning · Unit plans in mathematics · Planning models · Learning goals

> Plans are of little importance, but planning is essential– attributed to Winston Churchill
>
> No battle plan survives contact with the enemy– attributed to military strategist Helmuth von Moltke

A. Roche (✉) · D. M. Clarke
Australian Catholic University, 115 Victoria Parade, Fitzroy, Melbourne 3065, Australia
e-mail: anne.roche@acu.edu.au

D. M. Clarke
e-mail: doug.clarke@acu.edu.au

D. J. Clarke
International Centre for Classroom Research, Melbourne Graduate School of Education, University of Melbourne, 109 Barry Street, Carlton, Melbourne 3053, Australia
e-mail: d.clarke@unimelb.edu.au

P. Sullivan
Monash University, Clayton 3800, Australia
e-mail: peter.sullivan@monash.edu

## Background

Given the complexity of mathematics teaching, including addressing curriculum goals, engaging students, catering for the diversity of readiness, connecting mathematics teaching to students' experience, and assessing student learning, to name just a few issues, it is difficult to imagine that teachers of mathematics can perform their role without substantial planning. The former quote suggests that it is not so much the final document that is critical, but the process of creating the plan that is the key. The latter quote reminds us (maybe the battle/enemy metaphor is going a little far) that mathematics teaching involves the ongoing and interactive adaptation of planning "in the moment," and so it is essential for effective and adaptive teaching that all teachers are aware of all aspects of their planning at all stages.

There are at least three levels of teacher planning: for the year; for a unit (a sequence of lessons with a coherent focus, sometimes referred to as a topic sequence); and for a lesson. The research literature has largely focused on planning at the level of the lesson. Indeed, articles on planning from the USA commonly focus on implementing particular teaching pedagogies and activities. For example, Superfine (2008) noted that "planning commonly refers to the time teachers spend preparing and designing activities for students" (p. 11).

The study reported in this paper focuses on what teachers document specifically in written unit plans for mathematics, although it is stressed that our interest is not only on the documents themselves but in inferring the planning decisions that have led to such forms of documentation. To take another perspective on our focus, a number of writers have distinguished between the intended curriculum, the implemented curriculum and the attained curriculum (e.g. Robitaille et al. 1993), and Gehrke et al. (1992) contributed the planned, enacted and experienced curriculum to this list. This report addresses the teacher's intended or planned curriculum as represented in teachers' unit plans.

Our assumption is that planning plays a central role in teacher practice. It has been argued that decisions teachers make during planning have a profound influence on their behaviour in the classroom in that they tend not to stray from their plan (Barr 1988; Shavelson 1983; Zahorik 1970). Yinger (1979) suggested that "teacher planning is the major tool by which teachers manipulate the environments that later shape and control their own behaviour" (p. 164). It has also been found that plans made early in the year ultimately impact on what students learn (Floden et al. 1981; Walker and Schaffarzick 1974). Fernandez and Cannon (2005) distinguished planning from preparation, suggesting that planning refers to "activities related to knowing what to teach and how" whereas preparation refers to activities related to "getting and/or designing materials and setting up the classroom and work spaces" (p. 485).

Despite the centrality of planning in teachers' practice, it is interesting to note that research-based descriptions of the practices of effective mathematics teachers (e.g. Askew et al. 1997; Bonner 2014; McDonough and Clarke 2003; Stein et al. 2009; Sullivan 2011) do not emphasise planning. It could be argued however that many of the described practices are likely to be underpinned by sound planning.

We see the planning of mathematics teaching to be important at all levels, from the sequencing of content and the structuring of lessons to the selection and preparation of manipulatives and worksheets, but in this case the report focuses on how teachers document their planning of lesson sequences or units of work.

The following reviews some of the available literature on planning models and the processes used by teachers to plan, after which the origin of the framework that informed the data collection, is described. It is important to stress that unit planning, particularly in mathematics, is an under-researched area. For example, of 3,629 papers presented in the last 10 years at the annual conference of the International Group for Psychology in Mathematics (the major international conference on research in mathematics education), only three addressed planning at the unit/module or year level. This explains the lack of current references in what follows, and the inclusion of more general research on teacher planning.

## Planning models

Different models have been proposed that suggest how teachers may be expected to develop plans and others that describe how teachers actually go about planning. Historically, it was considered that teachers used the rational model or objectives-first model (Tyler 1949). This linear model consists of four steps which include the following: (1) state the objectives, (2) select learning activities or tasks, (3) organise those tasks into an appropriate order and (4) indicate evaluation procedures. There is much evidence, however, that teachers do not actually plan this way (McCutcheon 1980; Yinger 1980; Zahorik 1975).

John (2006) argued that the rational planning model

> did not say enough about the uniqueness of teaching and learning. Used badly, such planning patterns can lead to a progressive disaggregation: teaching and learning are broken down into segments or key elements, which are then subdivided into tasks, which are further broken down into behaviours and assessed by performance criteria (p. 487).

He offered an alternative 'naturalistic' or 'organic' model which he claimed involved "starting with the activities and the ideas that flow from them before assigning objectives. In this way, lesson plans are perceived to be responsive to children's needs, and the teacher can pursue goals that are emergent rather than pre-determined" (p. 488).

In a similar vein, Brady (1992) described a continuum of curriculum development processes that moves from one end being the 'objectives model', which is fixed in sequence and limited in the amount of movement among elements in its development, to the other end being the 'interaction model'. Unlike the rigid sequence of the objectives model, the interaction model begins with any of the curriculum elements and can be followed in any sequence. This model is "regarded as interactive and progressively modifiable" in that the teacher "can move to and fro among the curriculum elements, returning to change or modify elements that have already been developed in part or full" (p. 74).

To determine how teachers used the curriculum elements within the objectives and interaction models, Brady (1982) developed two forms of a questionnaire (one for mathematics and one for social studies) which he administered to 277 teachers from 20 government schools in New South Wales. The study concluded that teachers drew upon both models rather than using a pure form of either. Brady noted the variation in teacher

planning and suggested that teachers' lack of knowledge of the processes of curriculum development could account for this variation.

While there are some common themes around the types of elements in the planning process and the types of decisions teachers might make while planning, much of how teachers plan is idiosyncratic (Toomey 1977), leading to great variation in the ways teachers plan. Zahorik (1975) reported that teachers differ in their views about the relative importance of the elements in the planning process, that is, which elements they tend to focus on first and most often. Sullivan et al. (2012c) reported that Australian primary mathematics teachers were more likely to plan collaboratively than secondary teachers.

## Mental plans and written plans

Teachers plan and make decisions about what and how they intend to teach. Sometimes, these decisions and plans are written down, but much of what is planned occurs mentally. Many studies (see, e.g. McCutcheon 1980; Peterson et al. 1978; Yinger 1980; Zahorik 1975) have investigated the planning processes or mental plans of teachers by observing teachers as they plan or by using techniques that require teachers to "think aloud" while planning or describe in interviews or reflect in questionnaires their thoughts and decisions as they plan. What teachers focus on during their mental planning provides important background of teachers' written planning. However, what teachers choose to commit to writing provides a lens into what they possibly hold to be most important. It is an artifact of their work as teachers. Its purpose may be personal or public but either way it represents a picture of their intentions.

### Mental plans

McCutcheon (1980) studied the planning processes of 12 elementary teachers in the USA by conducting classroom observations, interviews, and collecting teachers' planbooks, teacher guides and student work over a single year. She described the written and mental plans that the teachers engaged with, and suggested that mental planning had the potential to be perhaps the richest form of teachers' planning. Much of the mental planning never appeared in writing but often resembled a dry run of what teachers imagined would happen in the classroom. Most teachers claimed to participate quite frequently in this mental dialogue or reflection. Not surprisingly, experienced teachers in the group were more likely to report that they had a repertoire of ideas from which to draw when reflecting on their future teaching.

Zahorik (1975) proposed that teachers' 'real plans' and the ones that are written down may not be the same. He suggested that plans written for, and submitted to a principal may follow a model that the teacher does not support. He studied the planning of 194 teachers from Years 4 to 12 and some teachers in adult education courses in the USA by asking them to write down, in order, their actual decisions during the process of planning in a range of subject areas. He classified the decisions made by the teachers into eight categories (objectives, content, activities, materials, diagnosis, evaluation, instruction, and organisation). While no type of decision was made by all teachers, more teachers (81 %) made decisions about activities than any other category. Only

28 % of teachers chose objectives first in their planning. However, more experienced teachers considered objectives more often than less experienced teachers.

Peterson et al. (1978) used a "think aloud" technique to investigate the planning of 12 experienced teachers of social studies in the USA. The teachers were allowed 90 min to plan the day's teaching, during which time their planning was tape recorded. The results revealed that the largest proportion of verbal statements when planning, were centred on subject matter. Objectives constituted the smallest proportion of statements. Even though the teachers were provided with "desired cognitive and affective student objectives, they did not refer to them in their planning, nor did they relate their choices of instructional processes to learning objectives" (p. 424). Of greatest concern in the findings was that prolific planning about subject matter was associated with negative student attitudes toward that subject, the teacher, the materials and themselves as learners. It is possible to speculate that those teachers most meticulous in their planning were those least confident in their teaching. In this case, the negative correlation between planning and student attitudes might seem less paradoxical. Certainly, the research of Mutton et al. (2011), discussed below, suggests that less experienced teachers plan in greater detail. Whatever the explanation, teacher planning seems a very personal process.

## Written plans

Few studies have examined the written plans of teachers. Studies that have done so have generally described plans that were sketchy in their detail and usually created for the teachers' personal use. It is important to note that we are drawing specifically on research into teacher planning in Western school systems. It is quite possible that teachers' lesson plans are both more systematic and more detailed in non-Western cultures. Accounts by Fan et al. (2004) and Isoda et al. (2007) suggest that Chinese and Japanese teachers are much more structured in their use of lesson plans.

McCutcheon (1980) noted that the teachers' written plans tended to be in the form of lists. The lists contained activities, concepts and skills that they anticipated covering in the unit. The plans resembled

> a grocery-store list, a memory jogger…. Many teachers glanced at plans in their planbook before a lesson to remind them what to do, then checked off items as they were completed, just as we cross off items from our list as we find them in the grocery store so that we can easily see what remains to be located. Planbook planning, then, served as a reminder of activities planned in advance of what occurred (p. 6).

One teacher, however, added notes to her plan that indicated any additional content that was explored in the lessons. In this way, her plan also included what was actually covered, rather than simply that which she hoped to cover. In general, most teachers listed activities and only listed objectives in their plans if there was a requirement to do so by their principal. While there was some view that planbooks should be sufficiently detailed such that a substitute teacher could use them, most teachers reported that they created a new set of plans should a substitute be required. In the case of planning for mathematics, many of the teachers used textbooks as their source of activities and the

textbook served as the basis of a teacher's, long-range planning. Planbooks served as short-range planning tools, often for no more than a week.

In a US study by Brown (1988) of 12 middle-school teachers' instructional planning in English, social studies, mathematics and science, the form of teachers' planning documents tended to consist of lists and notes and most teachers considered activities first. She noted that 'the content of the teachers' unit notebooks in previous years confirmed that teachers planned in a "nested style"' (p. 74). That is, teachers' unit plans were subdivided into weekly plans and further into daily plans. However, the teachers differed in the amount of detail their plans contained, and no teacher appeared "to develop new units of instruction and rarely constructed new lessons" (p. 78), nor did they develop their own objectives, but used the district curriculum guide to determine these.

## Purposes of a written plan

There are many reasons why a teacher may put in writing a unit plan or lesson. It may serve as a reminder or prescription of what a teacher intends to do, or ultimately as a record of what has been covered. It increases the chances that there is a coherent flow of mathematical ideas from one grade level to another. The planning document can serve as a basis for discussion between colleagues, of obvious benefit to less experienced teachers (Davis and Krajcik 2005; Steketee and McNaught 2007). Pooling knowledge and ideas when units are created collaboratively in professional learning communities has been shown to positively impact teacher learning and student achievement (Ball and Cohen 1996; Gilbert and Gilbert 2013). The written plan can enable adaption of national, state and district curriculum to local needs, and it provides a place where useful resources can be listed and accessed. Finally, a major benefit of a written unit plan is that the plan from a given year can provide the basis of the planning for the following year, without major "reinventing of the wheel."

The amount and type of detail included in the document may be influenced by requirements from the school or system, and whether or not the document is for personal or public use. Shavelson (1983) suggested that a teacher's plan serves as "a simplified model of a real situation in order to reduce its complexity" (p. 393).

The purpose of plans and their form may change as a teacher acquires experience. Mutton et al. (2011) analysed post lesson interviews with 17 beginning teachers in the U.K., across the last year of teacher training and the first 2 years of teaching. They noticed that teachers in training planned in the form of a script "which represented the knowledge and content that needed to be covered in the lesson" (p. 408). They suggested this was a necessary stage as the preservice teachers did not yet have detailed knowledge of the students or a sufficient repertoire of pedagogies. However, once in the role of teacher, a shortage of time and the need to be responsive to students on the run drove the need to move away from planning as 'script'. The beginning teachers eventually came to realise that "planning was the anticipation of what might happen rather than their determination of what would happen: this was planning as visualisation, rather than planning as a template" (p. 408). Mutton et al. (2011) further concluded that in order to plan more effectively, these beginning teachers needed to reduce the detail in their plans and suggested one way to do this was to use preexisting plans that could be adapted for their own classes.

If a plan is taken to be too prescriptive then this may affect the manner in which teachers interact with students. Zahorik (1970) concluded that planning per se made teachers less sensitive to students' thoughts and ideas. Teachers who planned, "tried to shape pupils' responses to reflect the teacher's views much more frequently, than teachers who did not plan" (p. 148). Teachers who did not plan were more likely to request a student to expand on their idea or thought.

By contrast with many other countries, the expected role of the Australian mathematics teacher in planning *at the year and unit level* is considerable (cf Japan, as outlined by Isoda et al. 2007). Interestingly, the various chapters of the 2010 Yearbook of the National Council of Teachers of Mathematics (USA) titled *Mathematics Curriculum: Issues, Trends, and Future Directions* assume a model of curriculum planning where the teacher is not involved in the development of unit plans, but rather steps in at the level of the lesson. In most US states, teachers do not create written unit plans, but choose from particular activities in units which have been written at a project, state or district level, and are mandated by the state or district for local use (Reys et al. 2010). Brown (1988) described US teachers as curriculum implementers, not curriculum planners.

There appears to be a widespread belief in Australia that scripted units or lessons produced by commercial publishers or state and territory curriculum authorities are unlikely to facilitate the type of teacher decision making that can lead to quality teaching (Sullivan et al. 2013a). Indeed, the national professional standards for Australian teachers (Australian Institute of Teaching and School Leadership 2011), under Standard 2.3 (curriculum, assessment and reporting), at the lowest of four levels (graduate), expect that teachers will "use curriculum, assessment and reporting knowledge to design learning sequences and lesson plans" (p. 10). The emphasis in the standards on the role of assessment resonates with research by Sullivan et al. (2013a). This research reports that, in rating the contribution of different resources to unit planning, "the results of my own assessment" was the most commonly chosen resource for both primary and secondary teachers. This prioritisation of assessment information reflects contemporary enthusiasm for the contribution of formative assessment to instruction (Black and Wiliam 1998) and poses the question of the extent to which unit or lesson plans also specify assessment strategies or instruments to be employed.

The issue of what can reasonably be expected of a mathematics teacher in curriculum planning remains one for discussion. Ball and Cohen (1996) noted that curriculum materials could "place teachers in the center of curriculum construction and make teachers' learning central to efforts to improve education, without requiring heroic assumptions about each teacher's capacities as an original designer of curriculum" (p. 7). Steketee and McNaught (2007) conducted research in which graduate teachers placed in "hard to staff" rural schools in Western Australia were provided with detailed profiles of their students' mathematics understanding, following one-to-one interviews conducted by final year preservice teachers. These profiles had the potential to identify whole class, small group and individual needs. However, fortnightly video conference sessions with the graduate teachers and the researchers revealed that the teachers experienced considerable difficulty in curriculum planning based on identified needs. This may reflect no more than beginning teachers' well-documented pre-occupation with content rather than student learning. Yet again, the obligation to speculate demonstrates the need for greater understanding of teacher planning.

## Theoretical framework and research questions

The theoretical framework that informed the study reported in this paper was developed as part of a larger research project, Peopling Educational Policy (PEP)[1], which has been examining the implementation of the new *Australian Curriculum: Mathematics* (AC:M), including ways in which teachers plan their mathematics teaching (Sullivan et al. 2012a, b), their ability to describe the purpose of tasks, and needed support in implementation (Sullivan, et al. 2013a, b).

The first step in the broader PEP project was to seek information from teachers on various aspects of curriculum including their planning. Informed by data emerging from 11 focus group conversations with primary and secondary teachers in Victoria and New South Wales, a broader group of teachers from all Australian states and territories was invited to complete a detailed survey on planning (Sullivan, et al. 2012a). The survey, which took typically around 30 min to complete and involved 34 items, included six sections: the range and authority of documents that teachers consulted, the ways that teachers described important ideas in topics they are planning to teach, the processes teachers used in their planning, ways in which teachers matched classroom tasks with curriculum statements, the extent to which teachers incorporated aspects of mathematical reasoning into their planning and teaching (a key aspect of the recent *Australian Curriculum: Mathematics*) and what teachers identified as their professional learning needs associated with the interpretation of curriculum.

One of the items within the survey related to the planning priorities of teachers. Teachers were invited to consider six descriptions of possible planning processes and then rank each statement in terms of its closeness to their planning process (1 closest, 2 next closest, etc.). Even though the numbers in Table 1 represent ranks, the mean is presented to offer a general guide to the responses overall (with a low score representing a higher rank) of just the primary teacher respondents, along with the percentage ranked by teachers in the top two categories, providing a sense of the priority teachers gave to the particular planning strategy. "Learning goals" here can be thought of as similar to objectives discussed earlier.

As indicated in their responses in the table, there was a diversity of ways that teachers reported they plan, suggesting that they had different priorities and processes for their planning. Some based their planning on judgments and activities, others referred to official curriculum documents, yet others made judgments after discussion with others. Indeed, even the most popular option, collecting relevant classroom activities, was only rated in the top two by just over half of the teachers.

[1] The Peopling Education Policy project is funded by the Australian Research Council (LP110100062) with additional funding provided by the NSW Department of Education and Training, Victorian Curriculum and Assessment Authority, Catholic Education Office Melbourne, and the Australian Curriculum Assessment and Reporting Authority. The project is a collaboration between Monash University, Australian Catholic University, University of Melbourne, University of Newcastle, University of Sydney, and University of Technology Sydney. The content is the responsibility of the authors and the views expressed do not necessarily represent the views of the universities or the research partners.

Drawing on focus group and survey data, described in Sullivan, et al. (2012c), a theoretical framework for teacher planning was proposed (see Fig. 1).

All elements of this framework relate to both unit and lesson planning to some extent. The framework assumes that yearly plans have been developed previously using a separate process, and deliberately separates the four top processes into two sets, as the two pairs (on the left and right, respectively) seem to operate together. The left hand pair refers to external input such as resources and curriculum documents and the right hand pair illustrates the extent to which teachers draw on their experience and judgments. The subsequent phases are about the goal setting and sequencing of the experiences planned for the students (see Sullivan et al. 2012c for a fuller discussion of the development of this framework). The framework is aligned to the "interaction" approach proposed by Brady that was discussed earlier. Is it noted that the framework is both more explicit and more comprehensive than the *Understanding by Design* process (Wiggins and McTighe 2005). Their process focused on goal setting, assessment of prior knowledge, and the planning of learning experiences, which clearly are only part of the planning process.

Although we are comfortable that the framework reflects the process of teacher planning as emerged from focus group and survey data, our focus in this paper is on the substance and priorities reflected in written unit plans for mathematics. The research questions addressed in this paper are as follows:

- Which elements of a written unit plan for mathematics instruction do teachers' claim to be essential?
- Which elements do teachers claim to have in their unit plans?
- Which elements are actually present in their written unit plans?

**Table 1** Ranking of statements on the planning process in order ($n$=117) (Sullivan, et al. 2012b, p. 21)

| | Mean | % of teachers ranking this statement 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. | 2.6 | 52 |
| I will read the official curriculum documents to identify the specific learning goals and then plan my teaching based on that. | 2.8 | 48 |
| I will meet with other teachers, we will share our experience and ideas, then plan the activities and resources we will use. | 3.2 | 48 |
| 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. | 3.7 | 20 |
| I will read the official curriculum documents to identify the specific learning goals and then use the teaching ideas and resources that they suggest. | 3.9 | 23 |
| I will look through a textbook or other teacher resource and plan teaching which relates to the given content. | 4.7 | 10 |

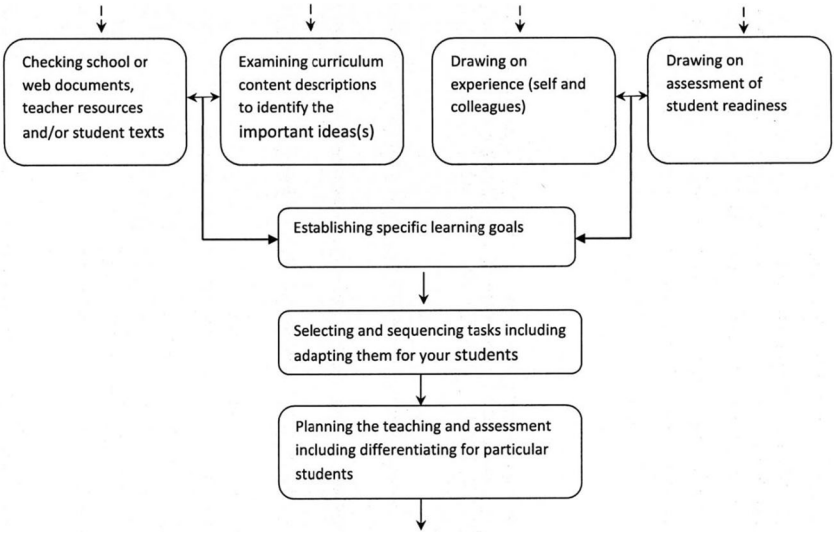


**Fig. 1** A proposed framework for teacher planning based on focus group and survey data

## Methodology

Following piloting with a smaller group, 357 primary teachers from Victorian Catholic Schools completed a questionnaire in which they were asked to rate a number of potential elements of a written unit plan in mathematics as either "essential," "desirable" or "not needed." Further, they were asked to indicate for each element whether or not it was in their current plans. Of the 357 teachers, 146 were junior primary, 101 middle primary, 90 upper primary and 20 were in mathematics education leadership roles with no regular class.

Some of the results were quite surprising to us. For example, 97 % of teachers claimed that pre-tests were present in their written unit plans, and the same percentage indicated that their plans included "the key mathematical language involved in the unit."

In light of these results, it was decided to request three written unit plans of their choosing from each of the 24 schools involved in completing the original questionnaire about essential elements of written unit plans: one from junior primary, one from middle primary and one from upper primary. Even though the request to schools came at a possibly inconvenient time (December), there was a very positive response, and 48 unit plans from 15 schools were provided. There was no apparent confusion on the part of teachers in relation to our request. Primary teachers in Australia generally plan in units, and presumably these are considered "useful chunks" into which teachers believe the curriculum can be usefully partitioned. Although we cannot be sure, it is a reasonable assumption that the unit plans which the schools gave us were among those which they considered to be of higher quality than others they might have provided.

The process of data analysis was straightforward in this study. Courtesy of focus group discussions, survey data and piloting, it was possible to anticipate the elements of written unit plans which teachers might consider essential or desirable. Only 9 of the 357 respondents made use of the "other" option to suggest an additional element and all

of these 9 suggestions could be reasonably accommodated within the categories already present within the questionnaire. This suggests that the set of categories represented a comprehensive listing of all mathematics lesson plan elements judged relevant by primary teachers in Victorian Catholic schools.

## Results

The data from the questionnaire on essential elements and an analysis of the elements of the actual written plans are combined in Table 2. The second column shows the percentage of teachers who indicated that a given element of a unit plan was "essential." The third column shows the percentage of teachers who indicated that the given element was present in their unit plans. The fourth column followed the analysis of the actual written plans provided by teachers, and shows the percentage of the 48 unit plans which included the given element.

In considering the data in the table, it is possibly of greatest interest to consider any major discrepancies between the elements teachers rated as essential for a written unit plan, their indication of the presence of the given element in their own plans, and the extent to which the element was present in the 48 plans we collected.

In many ways, the content descriptions in the AC:M were not very different from those in the various Australian state and territory curriculum documents. However, the proficiencies (fluency, understanding, problem solving and reasoning) represent the more aspirational aspects of the new curriculum. The relatively low percentages in the final column of the table in relation to links to the AC:M proficiencies are not surprising as, at the time of data collection, teachers completing the questionnaire would not have been sufficiently familiar with the newly prescribed proficiencies to include them meaningfully in their lesson or unit plans.

In relation to assessment, the discrepancies between the three columns were considerable. Rubrics for assessment tasks and suggestions for extended assessment were rated as essential by 24 and 46 % respectively of teachers, and yet were only present in one unit plan in both cases. Interestingly, 97 and 94 % of teachers claimed their unit plans included pre-tests and post-tests, respectively. However, only 69 and 52 % of the actual plans had these tests, respectively. It is possible that the teachers had tests or other assessments written in separate documents and the teachers who sent us their plans either forgot to include them or did not consider them part of our request for a written plan; however, the difference is sufficiently great to be noteworthy, even allowing for such lack of provision.

A listing of the key mathematical language involved in the units was high in all three columns, with 96 % of the provided plans having such a list. The schools represented in this survey clearly attach high importance to documenting this aspect. Also present in 11 out of the 48 units was a list of the words/statements associated with the relevant AC:M proficiencies. Interestingly, in the national survey, teachers acknowledged that much of the language associated with the reasoning proficiency of the AC:M was not language they currently used with their students (Clarke et al. 2012). For example, only 35 % reported using the word generalising regularly in their teaching.

**Table 2** Teachers' views on essential elements for a unit plan and elements present in unit plans

| Some possible elements of a unit plan | % of teachers who rated element essential ($n$=357) | % of teachers who indicated element was in their unit plans ($n$=357) | % of unit plans with element present ($n$=48) |
|---|---|---|---|
| Important ideas and learning intentions | | | |
| The ideas relevant to your unit identified in the Australian Curriculum (AC) or AusVELS[a] content descriptions | 81 | 81 | 75 |
| The ideas relevant to your unit identified in the AC or AusVELS proficiencies (problem solving, fluency, reasoning, understanding) | 69 | 63 | 21 |
| Other important mathematical ideas relevant to your unit, not necessarily in the AC | 44 | 82 | 100 |
| Overall learning goals for students for unit | 90 | 92 | 96 |
| Learning intentions for students per lesson | 78 | 84 | 60 |
| Assessment | | | |
| A pre-test | 85 | 97 | 69 |
| A post-test | 86 | 94 | 52 |
| Suggestions for extended assessments | 46 | 59 | 2 |
| Rubrics for particular tasks | 24 | 40 | 2 |
| Assessment tasks specific to the proficiencies | 59 | 64 | 15 |
| Ways of assessing student attitudes | 18 | 24 | 4 |
| Ways of tracking improvement anecdotally | 48 | 54 | 48 |
| Tasks/lessons | | | |
| Titles of tasks/lessons | 64 | 86 | 67 |
| Detailed descriptions of the tasks/lessons | 69 | 89 | 88 |
| Suggested order of tasks/lessons | 63 | 92 | 92 |
| Links to relevant resource materials (print or online) | 68 | 89 | 81 |
| Information on how work might be differentiated (if at all) for different students within the unit | 60 | 77 | 50 |
| Identification of AC content descriptions addressed by the tasks | 44 | 48 | 0 |
| Identification of AC Proficiencies addressed by the tasks | 39 | 36 | 2 |
| The key mathematical language involved in the unit | 88 | 97 | 96 |
| Pedagogies and lesson structure | | | |
| Questions you might ask students as they are working on the tasks/lessons | 54 | 74 | 60 |
| Time allocations for unit length (number of days/weeks/lessons) | 46 | 83 | 83 |
| Suggestions for grouping of students | 17 | 35 | 27 |
| Suggestions on particular equipment or other resources to be used | 54 | 86 | 81 |
| Suggestions on forms of technology to be used | 36 | 73 | 67 |
| Suggestions on lesson structure | 45 | 74 | 88 |

[a] AusVELS is the Victorian state curriculum with the AC:M embedded

## Further examination of the 48 written unit plans

Of the 48 unit plans provided, there were 16 written for junior primary, 17 for middle primary and 15 for upper primary. Fourteen (29.2 %) were designed for a straight grade (e.g. year 2) and 34 (70.8 %) were created for a composite class (e.g. year 5/6). The topics addressed derived from a variety of mathematical content. Using the AC:M content strands, 34 of the units were from Number and Algebra (although none specifically addressed Algebra), 13 were Measurement and Geometry, and only 1 was Statistics and Probability. There were no units structured around themes like sustainability or the Olympics.

Eighty-five percent of the teachers who completed the questionnaire about the essential elements of a unit plan claimed that the most common way of developing written units plans at their school was in teams (pairs or larger), rather than as individuals (for themselves or for others) or by outside consultants. We can reasonably conclude therefore that the majority of the units we examined were developed by a team and for a group of teachers to use. Earlier research (Sullivan, et al. 2013a) indicated a considerable difference between the sources of curricular authority appealed to by primary and secondary teachers in their planning. Secondary teachers made far greater use of commercial resources, particularly textbooks.

The unit plans varied greatly in size, comprehensiveness and completeness. They ranged from 1 page to 13 pages and 350 words to 3,285 words, with most being around 1,000 to 2,000 words. Thirty-nine unit plans included outlines of individual lessons. Eighty-eight percent of these were detailed such that the lesson structure (e.g. tools session/introduction; whole class focus/activities; summary, etc.) was evident. The number of lessons per unit ranged from 3 lessons to 14. Not including the nine plans that did not include lessons, the mean number of lessons specified in the writing of the unit was 7.8 and the median was 8.

All plans stated some type of objective first whether they were descriptions from curriculum guidelines or 'key ideas' or 'key mathematical understandings'. All but one unit plan out of the 48 contained a section called "Key Ideas". Key ideas tended to be written as single word concepts. For example, a year 2 unit plan on addition and subtraction had these concepts listed as key ideas (addition: partitioning, identity, property, and commutativity. Subtraction: separation and comparison. Part-part-whole). A year 3/4 unit plan on multiplication and division listed these key ideas: meaning of the numbers, commutativity property, distributive property, visualisation, relationship to division, relationship to multiplication, division with remainders, estimation, and part-part whole.

All units contained a section called "Key Mathematical Understandings" or "Key Understandings". This consistency seems remarkable given the high level of variation in the unit plans. All schools were supported in their planning by school mathematics advisers (SAMs) which might contribute to the level of consistency. However, the considerable variation in other aspects of the unit plans is in contrast with this aspect.

In relation to the key understandings, many of the units (43) framed these as statements for students. For example, a year 4 unit plan on multiplication included these key mathematical understandings:

We understand/know that…

1. We can use our place value knowledge to break up larger numbers so that they are easier to multiply and divide e.g. 14×7 is the same as (10×7)+(4×7) etc.…
2. There is an inverse relationship between multiplication and division.
3. We can use division facts to help us solve multiplication problems.
4. When we multiply numbers, the product is called a multiple, e.g. 6×3=18 ➔ 18 is a multiple of 6 and 3.
5. Times tables facts help us recall multiples.
6. A factor is a number that divides a given number exactly, e.g. the factors of 6 are 1, 2, 3, 6.

Thirty unit plans contained a single learning intention for each of the lessons. Twenty-two out of the 30 learning intentions were restated key ideas or a key mathematical understanding taken from the beginning of the document. Eight unit plans had learning intentions for each lesson that were entirely new statements, not mentioned elsewhere in the document.

Given the level of detail of many of the unit plans (e.g. 88 % had detailed descriptions of tasks/lessons), we were surprised that only 35 % of teachers claimed that it was essential that units from the previous year be used as the basis for developing the next year's unit on the same topic. This rating is hard to align with the 71 % of teachers who claimed that it was essential that their units be placed in an electronic depository for communal access in subsequent years. Seventy-one percent claimed it was essential that units be written into a previously developed template, with 95 % claiming that this currently happened in their unit plans. Indeed, every one of the units we examined had common templates for unit plans across the given school.

## Discussion

As has been outlined, planning exerts an important influence on what happens in the classroom. However, the planning processes of mathematics teachers are an under-researched area, with the large majority of research reporting on the US context, predominantly at the level of the lesson. Much more is expected of Australian mathematics teachers in respect of planning than is the case in most other countries (see, e.g., Huang and Bao 2006; Reys et al. 2010). The present study provided the opportunity to examine more closely the planning processes of Australian teachers of mathematics, and the written unit plans which emerged from this work.

Based on the 357 responses to the questionnaire about written unit plans for mathematics, it is clear that written planning in these primary schools is a collaborative effort, but the products vary considerably in length (from 1 to 13 pages in our set), in intended teaching time (3 to 14 lessons), and in the level of specification of key ideas/understandings/skills and possibly in their purpose.

Teachers are busy people, which may explain some of the discrepancies between those elements of written unit plans which they rated as essential and those elements that were actually in their own plans. This was particularly the case with aspects of assessment, including extended assessment tasks, scoring rubrics, pre-tests and post-tests. In light of the demands of the teaching workplace, it was surprising that only

35 % of teachers claimed that it was essential that units from the previous year be used as the basis for developing the next year's unit on the same topic. A number of years ago, Shulman (1987) commented,

> One of the frustrations of teaching as an occupation and profession is its extensive individual and collective amnesia, the consistency with which the best creations of its practitioners are lost to both contemporary and future peers. … It is devoid of a history of practice (pp. 11–12).

Although we would acknowledge the importance of teachers developing units of work with regard to the particular needs of the students they are teaching at a given time, it would seem that there may be considerable and unnecessary "reinventing the wheel" in the case of these teachers. It may be that both unit plans and a teacher's lesson plans are seen as local responses to the needs of individual classes or particular grade level cohorts. It is also possible that unit and lesson planning structures remain a matter of individual teacher style and are not developed for long-term use by a variety of teachers with a range of classes over time. This image of unit and lesson plans as personal and with limited shelf-life sits in strong contrast with practices in Japan and China, where lesson refinement is a well-established practice, with implications of agreed structure and specific principles shared by the broad community of teachers (see, e.g., Huang and Bao 2006; Isoda, et al. 2007). This personal and ephemeral aspect would help to explain the variation in unit plan structure and content across the examples accessed in this study.

Possibly, the most interesting aspect of the data was the variation in the way in which the written unit plans approached what might be called learning goals or objectives. This varied at both the unit level and at the level of the lesson plan. In offering our model in Fig. 1, it is interesting that the element of the model which sits below the four "preparatory steps", *Establishing specific learning goals*, did not appear to be part of the process of the most highly rated description of the planning processes in Table 1: *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.* The three planning descriptions which involved learning goals all rated lower than this one overall. This is consistent with the research of McCutcheon (1980), where teacher planning prioritised activities rather than objectives.

Given the very detailed listing of key understandings and key ideas in some units, it would be hard to imagine that such listings would be drawn upon meaningfully in preparation for teaching and in classroom decision making. For example, in a single unit on fractions for years 5 and 6, there were 9 statements from the Victorian curriculum guidelines, 8 Key Ideas, 12 Key Understandings and 11 Key Skills followed by 9 lessons, with the ninth being a post-assessment. It appeared that the list of key ideas was far more extensive than the intentions of the unit. That is, it seemed that this list was possibly a reminder to the teachers of important ideas in fractions for their own knowledge, rather than a list pertinent to that particular unit on fractions.

On the other hand, at the time of writing, in many schools with which we work, it is common for teachers to be asked by school principals or other leaders to identify learning intentions for each lesson and to state criteria for student success in the

achievement of those intentions. This appears to be based on the meta-analyses of Hattie (2009), who claimed that "effective teachers plan effectively by deciding upon appropriately challenging goals, and then structuring situations so that students can reach these goals" (Hattie 2012, p. 47). Unlike the long lists of key ideas referred to above, such learning intentions are more likely to underpin the planning of specific lessons and decision making during a lesson. Further research may be required on the importance of, and the means by which, such learning intentions are best communicated to students, if at all.

## Recommendations

Drawing on the responses of teachers to our initial national survey, the Victorian questionnaire reported here, the unit plans that were provided to us as part of the process, and our own interpretations, we suggest to teachers that their unit plans could productively include the following:

- explicit identification of the content descriptions and proficiencies of the AC being addressed;
- articulation of the key mathematical ideas that are inherent in the goals for the unit;
- indication of pre-requisite and new language and terminology associated with the unit;
- suggestions of the focus for individual lessons that make up the unit, including particular tasks and activities which might form the basis of the lessons;
- resources that can support the teaching of the lessons;
- an indicative order of the lessons; and
- information about assessment tools, including strategies that inform learning.

This report has provided the empirical foundation for these suggestions. The practical implications will be discussed in greater detail in a future article directed specifically at a teacher audience. What is worthy of note is that using the written unit plan as a vehicle, the survey required teachers to reflect on what they really value with respect to lesson preparation, content and delivery. As a result, we have uncovered what teachers consider to be the essential considerations which should drive their instruction.

There are at least four aspects arising from our findings that we feel are worthy of further research. First, it would be interesting to study more closely how teachers' written plans are developed, and the *order* in which different components are addressed (Tyler 1949). Second, it would be helpful to gain more insight into why teachers' reported perceptions of the importance of particular elements in a written unit plan and the presence of these in their own plans differ.

A third approach would be to look more closely at how the written plans, once created, are actually drawn upon prior to a given lesson, and during the lesson. That is, what work do teachers intend that unit plans actually do? Fourth, and more specifically, in the actual preparation time for a given lesson, what reference do teachers make to the key understandings, key skills and learning intentions which they have documented in the unit plan (Peterson et al. 1978)?

In this paper, we have analysed teachers' unit plans. This analysis has raised significant questions about the status and intentions of such plans and the processes which led to them. Underlying these processes are pedagogical traditions, institutionalised expectations, and fundamental assumptions about the role of teacher planning and of plans. Our work to date suggests that this is fertile ground for further research.

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