

# Conceptualising the critical factors that influence teachers' mathematics planning decisions for student-centred learning

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The process of planning to teach mathematics is complex and idiosyncratic and is gaining increased attention in educational research. In this paper, I propose a framework for conceptualising the critical factors that influence teachers' mathematics planning decisions. The framework is informed by the analysis of teacher survey data ( $n=114$ ) and two case studies, a Year 1 ( $n=5$ ) and Year 5 ( $n=4$ ) teaching team. In this paper I illustrate the way the framework enhanced the analysis and discussion of the Year 5 case study. The potential of the framework to drive future research and teacher professional learning is discussed.

The planning and teaching of mathematics is complex and idiosyncratic where teachers are faced with ever-increasing demands to plan and enact effective, student-centred, mathematics learning sequences and experiences (Sullivan, Clarke, Clarke, Farrell, & Gerrard, 2013). During the process of planning to teach mathematics, teachers are faced with a "cornucopia of decisions" (John, 2006, p. 489) including consideration to curriculum, tasks, pedagogy, assessment, and differentiation. Ultimately, these planning decisions have the power to directly impact student engagement (Attard, 2013) and learning about mathematics (Kilpatrick, Swafford, & Findell, 2001). Planning, therefore is a critical phase of the learning and teaching cycle. Despite efforts by teachers to plan experiences that encompass the complexities of mathematics teaching, the day-to-day realities of planning for student-centred learning are difficult and there is limited research in this field to inform practice.

Within the field of mathematics education, most research focuses on particular aspects of mathematics learning and teaching, such as student engagement (Attard, 2013), the types of knowledge required by teachers to be effective (Ball, Thames, & Phelps, 2008), as well as aspects such as the role of school leadership in creating and sustaining effective learning environments (Grootenboer, 2018). What is lacking, however, is a framework that draws together these various components in a holistic manner to support researchers, policymakers, school leaders and teachers to navigate the inherent idiosyncrasies and the non-linear nature of mathematics planning. This paper reports specifically on these critical factors and complex relationships as one aspect of a larger study (Davidson, 2018). The elements of these relationships inform a framework for conceptualising the way these critical factors shape teachers' mathematics planning decisions and the potential for using this framework in research and practice is explored.

## A proposed framework

The framework, as presented in this paper, emerged as an outcome of a larger study (Davidson, 2018) that investigated primary teachers' mathematics planning processes for student-centred learning. The larger study was framed through the paradigm of pragmatism, which comprises constructivist underpinnings, to investigate teacher planning through practical research methods (Biesta, 2010). Data collection and analysis were approached using the convergent parallel mixed-method design (Morse, 1991). This included collection, analysis, integration, and interpretation of survey ( $n=114$ ; see e.g., Davidson 2016) and case

study data that drew on two teaching teams (see e.g. Davidson, 2017) to inform the development of the proposed framework.

The overall study was informed by a framework (see Sullivan, Borcek, Walker, & Rennie, 2016) that suggested that teacher planning and subsequent actions in the classroom are a function of their beliefs about mathematics, their knowledge about learning and teaching mathematics, and the constraints that teachers believe may be encountered. The Sullivan et al. (2016) research framework, together with pragmatic and constructivist perspectives, contributed positively to the identification of critical issues impacting primary teachers' mathematics planning. Furthermore, drawing on the Sullivan et al. (2016) framework helped clarify what to research in the survey iterations that subsequently formed a network of important themes to be further investigated in the case studies. However, in analysing and discussing the findings, it became apparent that the framework was insufficient to describe the intricacies of mathematics planning and necessitated a reconceptualised framework (Figure 1) that captured these complex relationships. Specifically, the Sullivan et al. (2016) framework was reconfigured to reflect the multifaceted nature of mathematics planning as illustrated in the various layers. The framework was also adapted to incorporate and emphasise the following key findings: the centrality of student engagement and learning, and the overarching influence of school context and leadership on teachers' planning decisions for student-centred learning.

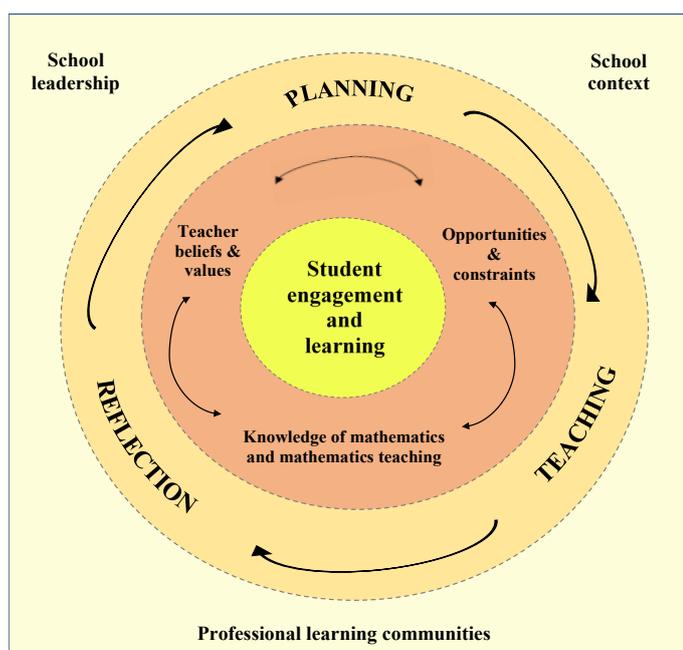


Figure 1. The proposed framework.

The central aspect of the framework presented in Figure 1, *student engagement and learning* is well researched (e.g., Attard, 2013) and is a key issue in mathematics education as this can be fostered by teachers and influence student learning, (e.g., Bong, Cho, Ahn, & Kim, 2012). While improving student learning in mathematics is at the heart of educational reform, so too is providing student-centred learning experiences that foster students' disposition, motivation, and confidence towards mathematics (ACARA, 2015). Therefore, if primary teachers are to plan student-centred learning sequences and experiences, it is reasonable to expect the teachers to have the necessary knowledge to do so and value mathematics with productive dispositions, which leads into the second layer of the framework.

One aspect in the second layer of the framework illustrates the way *teacher beliefs* influence the way teachers teach. This includes their likelihood of enacting curricular reform to bring about educational change (e.g., Stein & Kim, 2008), and has been shown to influence student engagement and learning (e.g., Askew et al., 1997). The inference is that teachers' beliefs towards mathematics will impact their planning decisions about various aspects of teaching, including creating the classroom environment, student groupings, task selection, pedagogical approaches, and so on. In this study, beliefs are defined in terms of Thompson, Philipp, Thompson, and Boyd's (1994) conceptual and calculational orientations towards mathematics and mathematics learning. For example, a teacher with conceptual orientations is described as having actions that are driven by "an image of a system of ideas and ways of thinking she intends her students to develop" (Thompson et al., 1994, p. 86), whereas characteristics of a teacher with calculational orientations include "an emphasis on identifying and performing procedures" (Thompson et al., 1994, p. 86). In particular, the literature highlighted teachers with conceptual orientations as being more effective (e.g., Askew et al., 1997).

The next aspect in the second layer suggests that teachers' *knowledge of mathematics and mathematics teaching* influences their planning and subsequent teaching decisions. Ball et al. (2008) offer a schematic representation of the knowledge used by teachers for the teaching of mathematics. It includes two major categories: subject-matter knowledge and pedagogical content knowledge, that is, teachers' knowledge of mathematics and their knowledge of *ways* of teaching mathematics. The inference is that, to effectively support their students, teachers have a responsibility to understand curriculum expectations as well as the concepts they are teaching and how they are going to teach and assess those concepts (see Davidson 2016; 2017).

The third aspect in the second layer is drawn from Clark and Peterson (1986) who proposed that planning is shaped by both perceived and experienced *opportunities and constraints* that influence the planning and teaching process. Various aspects of schooling, including access to a critical friend (Clarke, 1994) or a support person such as the school's mathematics leader (Sexton & Downton, 2014), as well as a teaching team's sense of collective efficacy (Bandura, 1997), can either inhibit or support teachers from working in certain ways, which has implications for classroom culture (Goos, 2004) and student dispositions (Dweck, 2000), which leads us into the outer layer of the framework.

The outer layer of the framework relates to the influence that a school's unique environment, which includes the *school's context, leadership, and professional learning communities*, has on shaping teachers' planning and teaching opportunities. For example, school policies and decisions have the potential to support or inhibit teachers from working in certain ways and are associated with barriers to school improvement efforts (e.g., Lamb & Branson, 2015) and educational change (e.g., Gaffney, 2012). Various factors, such as school culture and leadership, contribute to any team's ability to plan for reform teaching in an effective and sustainable manner (DuFour & Eaker, 1998).

Each layer of the proposed framework identifies critical factors that shape teachers' mathematics planning and teaching decisions to help build a comprehensive picture of the issues facing teachers when planning for student-centred learning. The dotted lines illustrate the interdependence of each layer of the framework. This framework is issued to analyse and discuss the findings of the case study presented in this paper.

## Method

In this paper I report findings from a Year 5 teaching team ( $n = 4$ ) who taught at a large metropolitan government school servicing a diverse middle-class population. The team comprised of Donna (the team leader and classroom teacher), Sophie (the school's

mathematics leader and classroom teacher), Rebecca (classroom teacher) and Natalie (classroom teacher). Pseudonyms are used throughout. The method for this aspect of the study, instrumental case study design (Stake, 2005), data collection and analysis mirrored the approach described in Davidson (2017). The method for developing the proposed framework emerged as a result of five cycles data analysis (Merriam and Tisdell, 2016) of survey and case study data (see Davidson 2018), and an ongoing review of the literature. The first three cycles as described in Davidson (2017) involved coding and triangulating data sources, using the research framework to guide the analysis to identify emerging themes (such as engagement) and provide thick description of the case (Stake, 2005).

The fourth cycle included determining which categories were worthy of inclusion in the framework. To do so, Guba and Lincoln (1981) suggested including categories that “provide a unique leverage on an otherwise common problem” (p. 95). For example, across the data sets “student engagement” emerged as a critical factor impacting teacher’s planning decisions and deemed a vital element to include in the new framework. The fifth cycle involved making inferences from the data to construct the framework. Merriam and Tisdell (2016) argued that linking the categories in a meaningful way such as through a visual representation, serves to illuminate the phenomenon being studied, in this case primary teachers’ mathematics planning processes, and the ways the categories resulting from the data analysis interact or relate to the findings. However, caution must be exercised when theorising about data to avoid overgeneralising and “going beyond the data into a never-ending land of inference” (LeCompte & Preissle, 1993, p. 269). Therefore, to instil confidence in the reliability and validity of my observations and interpretations data sources underwent a rigorous member-checking and peer-examination process. This included participant feedback on the accuracy of my depiction of data analysis that contributed to strengthening the credibility of the proposed framework.

## Findings and Discussion

The following section contains a snapshot of noteworthy episodes of my initial observations and data collection with the Year 5 teaching team. The account illustrates how I used the framework to analyse and discuss the findings to form a more comprehensive understanding of the critical issues facing primary teachers’ in their mathematics planning.

### *Teachers’ Planning Decisions: Alignment of Teachers’ Orientations, School Expectations and Impact on Student Engagement and Learning*

During my initial observations, team members were invited to complete a beliefs survey (Tatto et al., 2008) used to determine teachers’ orientations. All team members’ responses indicated a clear inclination towards conceptual orientations. Despite teachers’ responses to the beliefs survey I observed planning approaches consistent with calculational orientations during my initial observations. This included administering traditional ‘pen and paper’ type student assessments, consideration of task types, and approaches to student grouping that appeared to be influenced by school expectations. For example, the teachers described how they were required to adopt a ‘3:2’ approach to their mathematics planning and teaching. Each week the team taught three days on ‘number’ and two days on ‘non-number’. For example, over the course of a three-week teaching period, or 15 teaching days, nine of those days were allocated to teaching order of operations (BODMAS), where students were placed in ability groups based on an initial assessment consisting of 11 questions in order of difficulty: nine algorithms and two worded problems for students to solve (see Figure 2).

Q1. $5 + (3-2) =$	Q10. Find n. $5-2n = \frac{5^3 - 2^2}{7-1}$
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Figure 2. Sample questions from BODMAS initial assessment.

Of my concern was that these teacher-designed initial assessments were often not targeted at the intended level and had implications for the usefulness of information gained from administering such an assessment to inform subsequent teaching. It could be assumed that a teacher with conceptual orientations might view the skill of BODMAS as forming part of the larger concept of multiplicative thinking and also has implications for their *knowledge of mathematics and ways of teaching mathematics* (Ball et al., 2009, the second layer). On the other hand, I sensed that the team’s approach to planning mathematics, such as grouping students by ability, was influenced by the *school’s leadership* and policies (the outer layer).

This mismatch between organisational structures and teaching aspirations appeared to be a source of internal conflict for the Year 5 teachers in their planning discussions concerning the impact of approaches to differentiation, teacher expectations, and student mindsets, that came to a head during our seventh meeting together. During this meeting we had a powerful and honest discussion about the unintended impact their groupings were having, particularly on their ‘top’ students. When discussing their ‘top’ students’ responses to a task, initial comments included “They weren’t amazing” (Sophie, 16.8.2016) and “I was a little bit disappointed” (Donna, 16.8.16). Reasons given for this included that students were being “lazy” (Rebecca, 16.8.16), and that generally, their top students displayed a lack of effort. Consistent with research about the impact on ability grouping (e.g., Clarke & Clarke, 2008), the Year 5 teachers were open and honest about how they perceived student groupings to impact their students’ mindsets (Dweck, 2000). Whereas another student, who was given “top” group work, demonstrated increased levels of effort and “absolutely killed it because he wasn’t a member of the [top] group and he felt like he had something to prove” (Donna, 16.8.2016).

It is possible to attribute these tensions, in part, to the school’s strong focus on data and assessment (i.e., *school context* and *leadership*) and the extent to which the team felt autonomous in their planning routines (i.e., a *constraint*). For example, upon my initial visits, the team insisted they did not group their students based on ability but rather used “fluid groupings”. However, from their descriptions and my observations, their groupings were not particularly fluid. I also attributed such groupings to the physical classroom environment and the interpretation of the school’s commitment to “open plan collaborative learning spaces . . . to ensure a . . . differentiated curriculum” as described in their annual report. Furthermore, Sophie, a Year 5 teacher and the school’s mathematics leader was participating in a mathematics professional learning (PL) program external to the school, indicated that she did not feel supported by the school’s leadership team to share her new knowledge (see e.g., Sexton & Downton, 2014), and that the team viewed her involvement in the PL as “separate” from their regular practice. Such observations and specifications appeared to narrow teachers’ planning and teaching options consistent with findings about influences (i.e., *opportunities and constraints*) on teachers’ planning decisions and subsequent classroom actions (e.g., Clark & Peterson, 1986). Therefore, if the goals of reforming mathematics education include improving *student engagement and learning* that is at the core of the proposed framework, not only is it a reasonable expectation that teachers are

disposed towards conceptual orientations, but also that the *school environment* provides *opportunities* to do so.

It should also be noted that such frank discussions were possible among the Year 5 team, in part, due to the high level of trust shared amongst the team members that each had described in their individual interviews. For example, when asked what she believed the secret ingredient to successful team planning was, Rebecca responded,

I think it comes down to trust. You've got to trust them to share your ideas...because if you don't have that you're not going to blossom.

Given that collective teacher efficacy contributes to teachers' willingness to accept challenging goals and its connection to improved student achievement (Goddard et al., 2000), it is reasonable to conclude that team planning offers a vehicle to support some teachers in overcoming challenges in their mathematics teaching, and that fostering collective capacity of teaching teams to support planning is a worthwhile aim for school leaders. In terms of the proposed framework, while collective capacity is considered under *opportunities and constraints* it also has implications for *school leadership* located in the outer layer of the framework.

Lastly, my role as participant evolved into that of a critical friend to support the team enhance their planning. I also assumed a mentoring role for Donna, the team leader, to support her to facilitate the planning meetings. This included discussing planning approaches she could utilise in my absence, for example, strategies to develop the teams' mathematical knowledge such as analysing professional readings and developing key mathematical foci. While the school employed a Leading Teacher, he did not attend the Year 5 planning meetings regularly, and his focus was rather on ensuring teaching teams were conducting and analysing assessment data such as NAPLAN. That is, while being interested in mathematics learning and teaching, this was not his area of expertise, which was instead embedding general theories of learning and teaching. This is important given that a key component of sustainable PL is teachers having access to more accomplished colleagues who can work closely with them to address problems of practice (e.g., Goos, Bennison, & Proffitt-White, 2018). An implication of which is that schools who aim for their collaborative planning to be more productive may consider *opportunities* for involving a support person such as an experienced teacher, team leader, school mathematics leader, or external critical friend to support team planning meetings, particularly those with a passion for mathematics teaching and who have additional expertise in mathematics curriculum leadership.

In summary, if a goal of mathematics reform is to encourage teachers to plan and teach using student-centred approaches, it is reasonable to expect *teachers' beliefs* (the second layer) are aligned to conceptual orientations and that school leaders foster learning environments (the outer layer) that encourage teachers to plan and teach consistent with conceptual orientations. Therefore, from a school leadership standpoint, an important consideration for effective mathematics planning is that leaders provide staff with *opportunities* to investigate, trial and be exposed to alternate, student-centred, pedagogies. This includes supporting teachers to feel empowered for their planning routines that inform their teaching actions to ultimately improve *student engagement and learning*.

## Conclusion

This paper introduced a framework that provides context for conceptualising the multifaceted nature of mathematics planning and contemplating the critical factors that influence teachers' mathematics planning decisions. While it is difficult to represent fully the scope of factors shaping teachers' planning decisions, the reported findings intended to illustrate some of the complexities of planning for student-centred mathematics learning that

are represented by the framework. Analysis of case study data from a Year 5 teaching team provided descriptions of how teachers' mathematics planning decisions were influenced by their beliefs, their knowledge, and constraints. These decisions, however, were also influenced by the school's unique environment, and together, had implications for student engagement and learning. It is these complex, multifaceted and interdependent relationships that the proposed framework intended to capture, and that assisted in analysing and discussing the findings. The framework has potential to frame further research such as exploring approaches that support teachers in planning effective student-centred mathematics learning sequences and experiences. It may also be a helpful model for policymakers and school leaders when designing PL opportunities. This includes helping mathematics educators understand and reflect on the intricacies and associated challenges of planning for student-centred mathematics learning. Therefore, future research on the potential of the framework in a range of educational settings is recommended.

## References

- Australian Curriculum Assessment Reporting Authority [ACARA]. (2015). *The Australian Curriculum: Mathematics*. Retrieved from <https://www.australiancurriculum.edu.au/f-10-curriculum/mathematics/>
- Askew, M., Brown, M., Rhodes, V., Wiliam, D., & Johnson, D. (1997). *Effective teachers of numeracy: Report of a study carried out for the Teacher Training Agency*. London, England: King's College.
- Attard, C. (2013). "If I had to pick any subject, it wouldn't be maths": Foundations for engagement with mathematics during the middle years. *Mathematics Education Research Journal*, 25(4), 569–587.
- Ball, D. L., Thames, M., & Phelps, G. (2008). Content knowledge for teaching what makes it special? *Journal of Teacher Education*, 59(5), 389–407.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W. H. Freeman.
- Biesta, G. (2010). Pragmatism and the philosophical foundations of mixed methods research. In A. Tashakkori, & C. Teddlie (Eds.), *SAGE handbook of mixed methods in social & behavioral research* (pp. 95–118). Thousand Oaks, CA: SAGE.
- Bong, M., Cho, C., Ahn, H., & Kim, H. (2012). Comparison of self-beliefs for predicting student motivation and achievement. *The Journal of Educational Research*, 105(5), 336–352.
- 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, NY: Macmillan.
- Clarke, D. M., & Clarke, B. A. (2008). Is time up for ability grouping? *EQ, Autumn*, 31–33.
- Davidson, A. (2016). The priorities and challenges of primary teachers' knowledge in their mathematics planning. In B. White, M. Chinnappan, & S. Trenholm (Eds.), *Opening up mathematics education research: Proceedings of the 39th annual conference of the Mathematics Education Research Group of Australasia* (pp. 180–187). Adelaide, Australia: MERGA.
- Davidson, A. (2017). Exploring ways to improve teachers' Mathematical Knowledge for Teaching with effective team planning practices. In A. Downton, S. Livy, & J. Hall (Eds.), *40 years on: We are still learning! Proceedings of the 39th annual conference of the Mathematics Education Research Group of Australasia*. Melbourne, Australia: MERGA.
- Davidson, A. (2018). *Investigating primary teachers' mathematics planning processes for student-centred learning and teaching*. Doctoral dissertation, Monash University: Australia.
- DuFour, R., & Eaker, R. (1998). *Professional learning communities at work: Best practices for enhancing student achievement*. Bloomington, IA: Solution Tree.
- Dweck, C. S. (2000). *Self-theories: Their role in motivation, personality, and development*. Philadelphia, PA: Psychology Press.
- Goos, M. (2004). Learning mathematics in a classroom community of inquiry. *Journal for Research in Mathematics Education*, 35(4), 258–291.
- Goos, M., Bennison, A., & Proffitt-White, R. (2018). Sustaining and scaling up research-informed professional development for mathematics teachers. *Mathematics Teacher Education and Development*, 20(2), 133–150.
- Grootenboer, P. (2018). *The practices of school middle leadership: Leading professional learning*. Singapore: Springer.
- Guba, E. G., & Lincoln, Y. S. (1981). *Effective evaluation*. San Francisco, CA: Jossey-Bass.
- John, P. D. (2006). Lesson planning and the student teacher: Re-thinking the dominant model. *Journal of Curriculum Studies*, 38(4), 483–498.

- Kilpatrick, J., Swafford, J., & Findell, B. (Eds.). (2001). *Adding it up: Helping children learn mathematics*. Washington, DC: National Academy Press.
- Lamb, J., & Branson, C. M. (2015). Educational change leadership through a new zonal theory lens: Using mathematics curriculum change as the example. *Policy Futures in Education, 13*(8), 1010–1026.
- LeCompte, M. D., & Preissle, J. (1993). *Ethnography and qualitative design in educational research* (2<sup>nd</sup> ed.). Orlando, FL: Academic Press.
- Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation*. San Francisco, CA: Jossey-Bass.
- Morse, J. M. (1991). Approaches to qualitative and quantitative methods. *Nursing Research, 40*, 120–123.
- Sexton, M., & Downton, A. (2014). School mathematics leaders' perceptions of successes and challenges of their leadership role within a mathematics improvement project. In J. Anderson, M. Cavanagh, & A. Prescott (Eds.). *Curriculum in focus: Research guided practice: Proceedings of the 37th annual conference of the Mathematics Education Research Group of Australasia* (pp. 581–588). Sydney, Australia: MERGA.
- Stein, M. K., & Kim, G. (2008). The role of mathematics curriculum materials in large-scale urban reform: An analysis of demands and opportunities for teacher learning. In J. Remillard (Ed.), *Teachers' use of mathematics curriculum materials: Research perspectives on relationships between teachers and curriculum* (pp. 37–55). New York, NY: Routledge.
- Stake, R. E. (2005). Qualitative case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (3<sup>rd</sup> ed.) (pp. 443–466). Thousand Oaks, CA: Sage.
- Sullivan, P., Clarke, D. J., Clarke, D. M., Farrell, L., & Gerrard, J. (2013). Processes and priorities in planning mathematics teaching. *Mathematics Education Research Journal, 25*(4), 457–480.
- Sullivan, P., Borcek, C., Walker, N., & Rennie, M. (2016). Exploring a structure for mathematics lessons that initiate learning by activating cognition on challenging tasks. *The Journal of Mathematical Behavior, 41*, 159–170.
- Tatto, M. T., Schwille, J., Senk, S., Ingvarson, L., Peck, R., & Rowley, G. (2008). *Teacher education and development study in mathematics (TEDS-M): Policy, practice and readiness to teacher primary and secondary mathematics. Conceptual framework*. East Lansing, MI: Teacher Education and Development International Study Centre, College of Education, Michigan State University.
- Thompson, A.G., Philipp, R.A., Thompson, P.W., & Boyd, B.A. (1994). Computational and conceptual orientations in teaching mathematics. In D.B. Aichele & A.F. Coxford (Eds.), *Professional development for teachers of mathematics* (pp. 79–92). Reston, VA: National Council of Teachers of Mathematics.