Defining the Problem in a Changing Landscape: How Leaders Plan for and Address Mathematics Curriculum Change

Margaret Marshman
University of the Sunshine Coast
mmarshma@usc.edu.au

Emily Ross
The University of Queensland
emily.ross@uq.edu.au

Anne Bennison
University of the Sunshine Coast
abenniso@usc.edu.au

Merrilyn Goos
University of the Sunshine Coast
mgoos@usc.edu.au

Curriculum change affords middle leaders opportunities for pedagogical and planning renewal. This paper reports case studies of two schools engaged in preparing for implementation of Version 9 of the Australian Curriculum: Mathematics. Drawing on interview data from a middle leader from each school, Bacchi's question, *What's the problem represented to be?* was used to explore factors underpinning how these leaders identified a *problem* to be addressed. Findings revealed that even when shown alternative interpretations of their perceived problem, these middle leaders were still *driven* by their own interpretation of the problem.

The Australian education landscape is marked by continual curriculum change, presenting both challenges and opportunities for educators. Remillard and Heck (2014) defined curriculum as "a plan for the experiences that learners will encounter, as well as the actual experiences they do encounter, that are designed to help them reach specified mathematics objectives" (p. 707, original emphasis). They presented a visual model of the curriculum policy, design, and enactment system that distinguished between the official curriculum, as specified by governing authorities, and the operational curriculum enacted in classrooms. How factors in the official and operational curriculum interact to exercise influence within a system is not well understood and need further exploration. Addressing this gap was one of the original aims of this research project, with a particular focus on how teachers could be supported to interpret and transform the revised official mathematics curriculum and bring it to life in the classroom.

Middle leaders (MLs) are focused on developing teaching and learning in classrooms (Grootenboer et al., 2023) and tend to lead collaboratively alongside their colleagues. MLs build teachers' capacity by organising how curriculum change will be implemented, providing opportunities for professional discussions, and negotiating instructional initiatives (Bryant et al., 2020). Recent changes to the F–10 *Australian Curriculum (AC): Mathematics* (Australian Curriculum, Assessment and Reporting Authority [ACARA], n.d.), therefore, provide an avenue for MLs to embark on local curriculum change and reflect on pedagogical practices within their schools. The revised *AC: Mathematics* is due to be fully implemented in Queensland primary and secondary schools by the end of 2024 (Queensland Curriculum and Assessment Authority [QCAA], 2023). AC implementation follows curriculum change in the senior secondary curriculum to include external examinations, which represented the most significant reform to senior secondary schooling in Queensland for many years. Schools' processes to enact curriculum reform, in this case implementation of Version 9 of the *AC: Mathematics*, provide the context for the research reported in this paper.

The original aim of the project was to explore the ways in which MLs addressed a problem they identified in relation to implementation of Version 9 of the AC: Mathematics. However, initial findings revealed that, in some cases, assumptions about their own school context underpinning their perceived problem were not always a true reflection of the situation. Thus, there was a need to explore how MLs identified and addressed a problem within their own school context. Bacchi's (2009) approach to problem representation was used to explore factors

(2024). In J. Višňovská, E. Ross, & S. Getenet (Eds.), *Surfing the waves of mathematics education. Proceedings of the 46th annual conference of the Mathematics Education Research Group of Australasia* (pp. 367–374). Gold Coast: MERGA.

underpinning how two MLs identified a problem within their own school context. Specifically, the following research question is addressed:

- How do MLs represent and address problems driven-by curriculum and pedagogy change?

Theoretical Framework

Investigating teacher professional learning in the context of curriculum reform provided the impetus for the project and led to the need to explore how MLs identify and represent problems within their own school context. The *official* curriculum sets out expectations for students' learning and has three components: curricular aims and objectives, the content of consequential assessments, and the designated curriculum (endorsed resources providing guidance to teachers) (Remillard & Heck, 2014). The *operational* curriculum includes the teacher-intended curriculum, the enacted curriculum, and student outcomes. Thus, the operational curriculum represents the transformation of the official curriculum into teachers' personal plans and how this plays out in the classroom.

Research has demonstrated that professional learning is enhanced when it occurs in school-based contexts so that teachers can try out and validate ideas in their own classrooms, and collectively discuss issues and problems with supportive colleagues (e.g., Loucks-Horsley et al., 2003; Mewborn, 2023). Garet et al. (2001) conducted a large-scale survey of more than 1000 mathematics and science teachers in the US to investigate characteristics of professional development that teachers found effective. Their analysis revealed that teacher knowledge, skills and classroom practice were positively influenced by three core features of professional development activity: a focus on content knowledge and how students learn this content; opportunities to engage in active learning, such as planning classroom implementation and sharing outcomes with colleagues; and coherent connections with local curriculum frameworks. Results also indicated that the structure of effective professional development was significant, with sustained and intensive learning being more effective than shorter duration activities such as one-off workshops. Each of these core and structural features of effective professional development was incorporated into the design of our project along with support for action research to implement aspects of the professional learning.

Identifying Problems

MLs and teachers usually rely on their own experiences and strategies to identify problems with curriculum implementation and pedagogical practices. Bacchi (2009) introduced a *What is the problem represented to be?* approach to policy analysis. Policy is the action plan designed to fix a specific issue (Parliamentary Education Office, 2023) and assumes that something needs fixing. Bacci's approach involves interrogating the problem from different perspectives and results in a problem-questioning paradigm rather than a problem-solving paradigm (Tawell & McCluskey, 2022). How problems are represented conveys different implications for how the issue is considered and, therefore, influences the solution methods trialled. Bacchi (2009) proposed using the following six interrelated questions to analyse problem representations:

- What's the "problem" represented to be?
- What presuppositions or assumptions underlie this representation of the "problem"?
- How has this representation of the "problem" come about?
- What is left unproblematic in this problem representation?
- What effects are produced by this representation of the "problem"?
- How/where has this representation of the "problem" been produced, disseminated and defended? How could it be questioned, disrupted and replaced? (p. 2)

The first question of problem representation is designed to clarify what the problem is and whether it is also connected to other problems. The second question considers presuppositions or assumptions, challenging policy makers to consider what knowledges are taken-for-granted and what meanings are drawn from different representations. Cultural premises and values should be considered. The third question is concerned with considering the history of the current representation and the conditions that facilitated this problem representation becoming the dominant one. With the fourth question it is necessary to consider the perspectives that have been silenced. The fifth question provides an opportunity to identify and assess critically the consequences of the problem representation using questions such as: what is likely to change/stay the same? who is likely to benefit/be harmed? The final question challenges policy makers to consider how representations become dominant and consider the production, dissemination, and defence of the problem (Bacchi, 2009). Although Bacchi's methodological approach is designed for analysing policy (including educational policy) rather than school-level or classroom-level contexts as in this project, her overarching question provides a means of capturing participants' own interpretation of the curriculum implementation problem they wish to solve; in other words, what they thought the "problem" was.

Research Design

This project was conducted over 2 years (2022–2023). The project supported 17 MLs, working in school-based teams in seven Queensland independent schools to develop small action research projects in which they identified a curriculum implementation problem, formulated their own questions to address the problem, and collected data to answer these questions (Loucks-Horsley et al., 2003). In this paper, we draw on data collected from participants in two schools, chosen because of the insights gained about how these MLs represented and enacted a curriculum implementation "problem" they identified.

Participants

The experiences of Sage and Tom, MLs from two independent schools in Brisbane, are reported in this paper. Sage was the Assistant Head of Primary at Coromandel College, a P-12 urban independent, faith-based school. She was a mid-career educator who was tasked with leading the curriculum implementation of mathematics, even though mathematics was not an area in which she felt confident. Tom was a very experienced educator and well-established as Head of Mathematics at Shaftston Hall, a P-12 independent girls' school with high academic expectations. He was seeking to develop students' problem solving and reasoning capabilities.

Data Collection and Analysis

The project team (the four authors of this paper) supported school teams through three face-to face professional learning workshops involving all participants and four Zoom mentoring sessions with individual school teams. The workshops were conducted at the beginning, middle, and end of the project and included opportunities for participants to share progress and receive feedback. Mentoring sessions were conducted between professional learning workshops and involved more individualised support for school teams from a member of the project team. Data sources included each school team's initial project plans and transcripts of the mentoring sessions and workshop sharing sessions. Additionally, two semi-structured interviews were conducted via Zoom with the leader of each school team which were recorded and transcribed.

Data analysis was conducted by considering the full data set for each case. Bacchi's (2009) questions were used to identify themes from the data (Tawell & McCluskey, 2022). Transcripts from workshop sharing sessions, mentoring sessions, and interviews were read by members of the project team. Comments made in relation to each of Bacchi's (2009) questions were identified. The project team met to discuss the analysis and resolved any differences in interpretation. The answers to Bacchi's questions for each case provide insights into how the MLs represented a problem in their school context. Two case studies follow.

Findings

Case Study 1

Coromandel College is relatively young school which has grown quickly in size in the last ten years. It is now a mid-sized, co-educational school with above average socio-educational advantage. Sage and four members of the teaching team participated in the project.

What's the "problem" represented to be? Initially Sage represented the problem as the implementation of a school mathematics program based on a textbook rather than the curriculum, "We need[ed] some programmes … because we didn't really have anything" (Sage, 1st mentoring). Now though, she thought the implementation of the pedagogical elements of the textbook program were patchy:

> Even within this team, you know, [there is] a variety of uptake of *Stepping Stones* [A commercial whole primary school mathematics program] as well. So, we've got some teachers who have implemented that as is and then others who haven't, for various reasons. (Sage, 1st mentoring)

What presuppostions or assumptions underlie this representation of the "problem"? Sage's representation of the problem developed from the presuppositions that fast growth of the school population had led to variable implementation of the *Stepping Stones* program (https://www.origoeducation.com.au/). Her aim was to build teacher capacity and confidence to teach mathematics and she saw the curriculum reform as an opportunity to build a more consistent whole school pedagogical approach and move away from the textbook:

> So, it was good timing to review what our program was, and to look forward to what's happening with the changes to the new curriculum … So, what we're trying to do is get that consistent approach and make sure that we've got everybody on the same page. (Sage, 1st mentoring)

How has this representation of the "problem" come about? The broader school team (four primary teachers from different year levels) agreed with Sage that decisions of pedagogy and resource selection were driven by lack of confidence among staff to teach mathematics. The school team expected that professional learning would result in increased confidence, "As we become more versed in the pedagogy, whatever it might be, and we get more trained and skilled in it, then without a doubt, our confidence will go up" (Lyn, 1st mentoring). Hence, project development at Coromandel College centred on boosting staff confidence to teach mathematics. The school team trialled pedagogical techniques for broader representations and modelling and shared their work in staff meetings routinely by unpacking the techniques, outcomes for student learning, and implementation. Teacher confidence data were collected pre- and post-intervention through online surveys.

What is left unproblematic in this problem representation? Sage acknowledged that she herself lacks confidence in her knowledge of mathematics and mathematics teaching practices:

> Maths is not my natural … Yeah, I have to work hard at maths. And what I've found, for my own schooling versus what I've done as a teacher, I've had to kind of reteach myself in order to teach students. (Sage, Interview 2)

She claimed that most of the school team, except for one teacher, would feel similarly about teaching mathematics. Consequently, it was assumed that teacher confidence was the issue.

Professional learning in mathematics was no longer a focus for Sage. Her recent professional learning has directly supported her leadership roles. She described a culture of support in providing professional learning opportunities for staff:

> We have we never really been denied access to professional development. You know, if people want to apply for something, nine times out of ten, they can go to it. But what's happened is it's been very ad hoc … it never really comes back to then bring everybody together or how that might align to that pedagogical framework of what we want. (Sage, Interview 1)

Thus, Sage assumed there had been opportunities for teachers at Coromandel College to undertake professional learning in mathematics. Although Sage acknowledged that the school is very well-resourced, she reflected that equitable resourcing is logistically challenging, particularly given the primary school size.

What effects are produced by this representation of the "problem"? This representation of the problem suggests that building teacher confidence in teaching mathematics will *fix* the problem. However, the representation of the problem was challenged by the findings from the pre-intervention survey. The findings showed that teachers overwhelmingly felt confident in teaching mathematics and creating tasks and rubrics to support the collection of student evidence of learning in mathematics. However, the teachers unanimously asked for more professional development to support teaching mathematics. Many commented that they could not remember the last professional development they attended with a focus on mathematics:

> That was good to see that people are feeling pretty confident with that [teaching mathematics]. But the area where they just jumped out at us is that people want more PD. That was the thing that they just, they couldn't remember when they'd last done any numeracy or maths PD in or … what they had done was pretty light on or they couldn't really remember what it was that they even did. (Sage, 2nd mentoring)

How/where has this representation of the "problem" been produced, disseminated and defended? How could it be questioned, disrupted and replaced? After considering the issue to be one of PD, Sage sought PD targeting mathematics pedagogical content knowledge. Finding PD addressing mathematics lesson planning and lesson structure, Sage, with one other member of the project team, attended the PD over several sessions. She then used this knowledge to develop a pedagogical framework for the teaching of mathematics in the primary school. In isolation of her team, Sage developed a framework that provided teachers with essential elements for lesson plans, unit overviews and mathematics resources kits. These became part of the "non-negotiables" of teaching mathematics. After developing the pedagogical framework and presenting this to staff, Sage still did not feel confident that this was the right direction. "I've made it up. I still don't know whether it's going to work, but we have to kind of test it out and see" (Sage, Interview 2).

Case Study 2

Shafston Hall is a well-resourced school with a long history of success in academic, sporting, and creative arts spheres. The school has a stable teaching staff who are attuned to the school's high academic expectations. Tom, the secondary school Head of Mathematics, has taught mathematics for 40 years, including nine years at this school. Over the last 20 years, he developed a reputation for innovative teaching of mathematical modelling using inquiry.

What's the "problem" represented to be? Tom came with a plan that aimed to develop problem-solving and modelling skills in Years 7–9 students. A further aim was to help students understand how they will be assessed in the senior secondary years when Problem Solving and Modelling Tasks (PSMTs) contribute 20% to the mandatory part of the high-stakes internal assessment of student's final grades. With the recent re-introduction of external examinations at the end of secondary school, Tom is also aware of time constraints for developing their mathematical understanding compared to the previous school-based assessment:

We tend to focus a lot more on just the knowledge and procedures and just getting through the course … And trying to develop some sort of understanding so that they can solve the complex problems. Now with the external exam, we have to cover everything, and we cover everything very superficially, really, each lesson is a new topic, and we don't have a lot of time to consolidate anything. (Tom, Interview 1)

Tom's action research project represented the problem in terms of lack of time and student characteristics (prior knowledge and attitudes to mathematical modelling) without appearing to consider the school culture that seems to be influencing student outcomes.

What presuppositions or assumptions underlie this representation of the "problem"? Tom wanted Years 7–9 students to learn to think mathematically so used the various aspects of the Instrument Specific Marking Guides to draw students' attention to the elements of the modelling processes: formulate a model, with appropriate assumptions and variables; solve the mathematical problem; evaluate and verify the results as well as the strengths and limitations of the model; and communicate the findings (QCAA, 2019). He thought this would allow these younger students an opportunity to learn the process, away from the pressures of the senior secondary assessment:

> And I guess some of the stuff that we're doing with the year 7s, 8s and 9s, we put it under the guise of preparing the kids for problem solving and modelling tasks at year 10, 11, and 12. But realistically, what I wanted to do is to get a foot in the door in terms of just giving the kids some time to be able to just work on problems. (Tom, Interview 1)

For several years at Shafston Hall, PSMTs had been assessed and were scheduled in Years 7–9 lessons for either two weeks of full-time work or four weeks part-time, with students spending lessons working on the problem and teachers helping them. However, there has been no noticeable improvement in PSMT performance in either the junior or senior secondary years. Some teachers were resistant to this approach: Tom explained that "I've got teachers who don't want to do it at all" and "it's a fight all the way". Other teachers feel obliged to "help" students because students are not accustomed to working on such tasks. Tom knows that this well-meaning approach only perpetuates a cycle of learned helplessness such that students expect to be told what to do when they get stuck (or even before they start). The Years 7–9 students also treat these tasks as high stakes assessment and are consumed with performance anxiety that reduced their willingness to take intellectual risks. Students focused only on the assessment grade rather than the knowledge and understanding associated with the task.

How has this representation of the "problem" come about? Exacerbating this problem is the school's cultural context, an elite institution steeped in conservative traditions that are difficult to change. Students have succeeded in mathematics without demonstrating advanced problem solving and modelling capabilities now demanded by the new senior secondary mathematics subjects. Teachers, likewise, have developed pedagogical repertoires that "work", but do not necessarily develop the skills and dispositions that students need to succeed in the new curriculum and assessment regime. Parents are also a part of this context. Tom reported that he often receives phone calls or emails from upset parents who want to know why he has changed the way mathematics is taught—that might potentially disadvantage their daughters:

> So, the parents have high expectations of their daughters doing well. And the kids have high expectations, and they equate the fact that just because they do lots of work, that they should get good results. And when they don't do that, then it becomes a bit of a bit of a problem. (Tom, Interview 1)

Tom explained that all his past efforts to begin developing PSMT-capacities in this school's junior secondary students have failed.

What is left unproblematic in this problem representation? The influences on the operational curriculum, including teachers' conservative beliefs and pedagogical practices, the high academic expectations of the school, and parental beliefs and expectations of what mathematics teaching should look like mean that instigating a cultural change will be challenging. The *silences* are that teachers and parents have a strong belief in how success in mathematics was achieved, albeit the previous school-based assessment system.

What effects are produced by this representation of the "problem"? Tom's *representation of the problem came about* because he understood the difficulty in bringing about cultural change and designed a project to work within these contextual constraints. To do this, he aimed to promote incremental change in teaching practices by raising teachers' awareness of students' unproductive attitudes and beliefs about mathematics. In this action research project, he wanted to try a slower and longer-term approach, introducing the separate parts of the modelling cycle over time in a developmental progression. He also planned to survey student attitudes at the beginning and end of the project, which will provide valuable data on one of the key influences on student outcomes.

How/where has this representation of the "problem" been produced, disseminated and defended? How could it be questioned, disrupted and replaced? Tom tried a slower and longer-term approach. He introduced the separate parts of the modelling cycle over time in a developmental progression and developed a teacher guide to support the implementation of the PSMT. He surveyed student attitudes at the beginning and end of the project to provide data on one of the key influences on student outcomes. The students worked collaboratively on problem-solving tasks with teacher input only as necessary:

> A think, pair share situation. So, we'd have a problem. ... We don't have any input to start with, we have the students sit in in groups of three, ... they had some time to think about the problem, what things they need to look up ... think about certain strategies that they might have themselves to approach it, then of course, they would have time together as a group to come up with these questions. ... we really wanted the teacher to step back and have more of a student-centred learning situation. ... the teacher would then be walking around looking at their groups, maybe having some input that would maybe steer them in the right direction. (Teacher at final PD Day)

Discussion and Conclusion

Sage wanted a pedagogical framework for teaching mathematics, believing it would build her teachers' confidence to teach mathematics and produce consistency across the school. However, the initial teacher survey showed most teachers were confident teaching mathematics and wanted mathematics-focussed professional development. Despite these survey results, Sage followed her initial assumption that all teachers lacked confidence in mathematics and chose for only herself and one other teacher to attend the professional development requested. Sage then developed a lesson structure to ensure a whole school approach to teaching mathematics.

Tom wanted to deepen students' understanding of problem solving and mathematical modelling to address student achievement concerns by developing an approach to teaching the elements of the PSMT task. Tom acknowledged the school's cultural pressures including teachers' conservative beliefs and pedagogical practices, the high academic expectations of the school, and parental beliefs and expectations of what mathematics teaching should look like. The high expectations of the school community drove him to remove the task from the assessment program while students developed their capacity to complete the PSMTs, rather than address the focus on assessment results and the strong belief in how success in mathematics was achieved, albeit the previous school-based assessment system.

This paper has focused on two schools with different contextual features and different approaches to identifying problems of curriculum implementation in mathematics at the primary and secondary levels. In both Coromandel College and Shafston Hall, the MLs were focused on developing teaching and learning in classrooms (Grootenboer et al., 2023) and the problems these MLs identified were based on assumptions and presuppositions that could be made visible and either challenged or affirmed through their participation in the project. Our interviews provided opportunities for these MLs to explain how they represented the curriculum implementation problem and reconsider or elaborate on their underlying assumptions about the problem and how it came about. We led them through a process to consider additional data which made them question the problem, but (after dabbling in the issue) they continued with their original issue/problem regardless. As a ML, Sage chose to organise how the curriculum change would be implemented in agreement with Bryant et al. (2020) through the lesson structure she developed but chose not to build teachers' capacity by providing opportunities for professional discussions and negotiating instructional initiatives. Tom too organised how the curriculum change would be implemented.

The MLs chose the problem to address with their action research project. Like Bacchi (2009), we suggest that what a school curriculum leader proposes to do or to change in response to curriculum reform reflects how they understand the "problem" within their context that needs to be solved. We argue it is important for researchers to understand and interrogate these problem representations to gain insights into their rationales and implications. This kind of analysis shifts our thinking from problem-solving towards exploring the dimensions of problems and how they are shaped, as well as assumptions that underlie problem representations and their possible effects.

Acknowledgements

Ethics approval A221741 was granted by the University of the Sunshine Coast, participants gave informed consent, and pseudonyms for participants and schools were used. This project was funded by Independent Schools Queensland. The authors thank the teachers who participated in the project.

References

Australian Curriculum, Assessment and Reporting Authority [ACARA]. (n.d.). *What's changed in the new Australian Curriculum?* https://v9.australiancurriculum.edu.au/resources/stories/curriculum-changes

Bacchi, C. (2009). *Analysing policy: What's the problem represented to be?* Pearson Australia.

Bryant, D.A., Lun, W.Y. & Adames, A. (2020). How middle leaders support in-service teachers' on-site professional learning. *International Journal of Educational Research, 100,* 1–17. https://doi.org/10.1016/j.ijer.2019.101530

Garet, M., Porter, A., Desimone, L., Birman, B., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal*, *38*(4), 915–945. https://doi.org/10.3102/00028312038004915

Grootenboer, P., Tindall-Ford, S.K., Edwards-Groves, C. & Attard, C. (2023). Establishing an evidence-base for supporting middle leadership practice development in schools. *School Leadership & Management*, *43*(5), 454–472. https://doi.org/10.1080/13632434.2023.2271957

Loucks-Horsley, S., Love, N., Stiles, K., Mundry, S., & Hewson, P. (2003). *Designing professional development for teachers of science and mathematics* (2nd ed.). Corwin Press.

Mewborn, D. (2003). Teaching, teachers' knowledge, and their professional development. In J. Kilpatrick, W. G. Martin, & D. Schifter (Eds.), *A research companion to principles and standards for school mathematics* (pp. 45–52). National Council of Teachers of Mathematics.

Parliamentary Education Office. (2023). *What is the difference between policy, act, and legislation in Australia* [Online]*?* https://peo.gov.au/understand-our-parliament/your-questions-on-notice/questions/what-is-the-difference-between-policy-act-and-legislation-in-australia

Queensland Curriculum and Assessment Authority (QCAA). (2019). *Mathematical methods 2019 v1.2. General senior syllabus.* QCAA. www.qcaa.qld.edu.au/downloads/senior-qce/syllabuses/snr_maths_methods_19_syll.pdf

Queensland Curriculum and Assessment Authority (QCAA). (2023, July 11). *Memo: Australian Curriculum Version 9.0: Revised implementation schedules, professional learning and resources.* QCAA. http://www.qcaa.qld.edu.au/downloads/memos/23/043-23.pdf

Remillard, J., & Heck, D. (2014). Conceptualizing the curriculum enactment process in mathematics education. *ZDM Mathematics Education*, *46*, 705–718. https://doi.org/10.1007/s11858-014-0600-4

Tawell, A., & McCluskey, G. (2022). Utilising Bacchi's what's the problem represented to be? (WPR) approach to analyse national school exclusion policy in England and Scotland: A worked example. *International Journal of Research & Method in Education*, *45*(2), 137–149, https://doi.org/10.1080/1743727X.2021.1976750