Middle Leadership: Critical Variables in Building and Implementing Digital Reforms in Primary Mathematics Education

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The aim of this paper is propositional and is based on research findings which suggest that success in mathematics teaching and reform is contingent upon having key personnel in schools to lead curriculum reform. Based on the outcomes of a large national study on successful practice in the teaching of numeracy for some of Australia's most disadvantaged learners, it was found that, among other practices, the appointment of a numeracy leader alongside the use of effective and appropriate digital tools (in particular apps) supported teachers to implement strong and effective numeracy practices. This paper presents a rationale for a renewed focus on practices that will enable success for all Australian students, but most particularly those who are most at risk of mathematical mortality.

There is a substantive gap in mathematical achievement across the social and geographical bands of schooling in Australia. In terms of equity, Australia is among the poorest performing systems in the OECD countries (Teese & Polesel, 2003). The problem of who succeeds in mathematics has been identified more than 50 years ago, yet the differential success still remains entrenched despite the plethora of research into quality practices in mathematics education (Jorgensen & Lowrie, 2015). There is a considerable tail in numeracy performance with particular social and cultural groups disproportionately represented in the tail – namely Indigenous, remote, low SES and rural students being most at risk of performing poorly in mathematics. Jorgensen (2012) has described this phenomenon as being one where the cultural heritage of the learners is being converted into scholastic mortality. That is to say, the funds of knowledge that many (marginalised) learners bring to school are not valued within mathematics and nor are they being converted into the dominant forms of knowledge valued within the assessment regimes that operate within the schools. As such, some students' cultural knowledges, dispositions and skills are not recognised and they are marginalised in their study through the non-transfer of those attributes into school mathematics practices. To reverse these trends, practices need to be identified that assist in the conversion of cultural heritage into scholastic success. The outcomes of a large national study into the successful practices in remote and very remote communities has shown that a number of practices appear to dominate many of the thirty plus case studies (Jorgensen, 2015). These practices include the use of middle leaders within the schools, whose role has been to mediate between the vision of the school and the enactment of practices at the level of the classroom; that includes the effective use of digital resources. This paper draws on these two foci to propose a model of professional learning for middle leaders alongside their teacher and school administration colleagues in the development of quality practices that may be useful in addressing access and success in mathematics teaching and learning. As little is known about how to specifically develop middle leaders (Gibbons & Cobb, accepted), the intent of the paper is to draw on the findings of a national project that has explored successful numeracy teaching in some of

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Australia's most disadvantaged communities and then to align these findings with more mainstream practices in major regional and urban centres.

Cultural Heritage and Scholastic Mortality

Borrowing the concepts of cultural heritage and scholastic mortality from Bourdieu's (Bourdieu, Passeron, & de St Martin, 1994) extensive theoretical project, this paper is underpinned by the assumption that many students enter the mathematics classroom with particular cultural and social knowledges (cultural heritage) which can result in success or failure (Jorgensen 2011). Some of these knowledges, skills and dispositions align with the desired practices of school mathematics such that these students are more likely to experience success in their study of mathematics. Conversely, there are students for whom many of the practices of school mathematics are incongruous with their cultural heritage and as such, are more at risk of failing or not succeeding in school mathematics. Such a position is one that challenges the hegemony of school mathematics where there is a strong belief system that success in school mathematics aligns with some innate ability of the learners. By better understanding the processes through which scholastic mortality occurs, educators can be better aware of the structuring practices that marginalise learners – often a level that is unconscious for all parties involved.

Fundamental to this paper is the proposition that new practices are needed in school mathematics to bring about changes that will enable greater access and success for all students, but most notably those who have been historically excluded from school mathematics. To this end, we draw on three disparate but connected approaches. First we draw on a large national study (Jorgensen, 2015) that has identified effective teaching practices initiated by middle leaders in some of the most disadvantaged communities in the Australian educational landscape – remote and very remote Indigenous settings. From this study, we draw on two of the key findings – first the role of middle leaders in bringing about reform at the level of school practices and these findings are connected to the work of Lamb et al (2015). Second, the use of quality digital media to support learning and this finding is connected with the work of Larkin (2013, 2014, 2015). We stress that 'quality' is fundamental to the approach we take in this paper. The authors draw on their collective (and diverse) wisdom to illustrate and argue the importance and interconnection of these practices in addressing scholastic mortality in mathematics education.

Developing a Rationale for Middle Leaders in Digital Mathematics

In this section we draw on three disparate literatures to assist the development of a rationale for middle leaders to work across mathematics and digital media. The impetus for this unification of these areas comes from the *Remote Numeracy Project* (Jorgensen, 2015) where it has been found across numerous sites, in some of the most disadvantaged communities, there has been significant gains in students' mathematics learning. By examining these sites to develop case studies, and then working across the sites, it is possible to identify positive emerging trends in practices. Two of the more salient of these practices have been the middle leader and the use of digital technologies to engage and motivate learners but equally as a tool for teachers' assessment and recording. Of particular value has been the iPad since there are many apps that teachers can easily access – both in terms of affordability (often free) and access- it is easy to download the apps. This makes for a valuable resource on the proviso that there is prudent selection of apps that promote mathematical learning (Larkin, 2015). The success of these practices depend on the

interaction among the envisioned practice, enabling practice and enacted practice by members aligned to various school roles (see Table 1).

Table 1
Practice Model (Jorgensen, 2015)

Level of Practice	Role/s undertaken	Personnel
Envisioned Practice	The vision of the school	Leadership team
Enabling Practice	A boundary rider who liaises between the leadership team and classroom teachers	Middle leader
Enacted Practice	Enactment of practice/s within the classroom	Classroom teacher

Middle Leaders

Important for this paper is a discussion on the middle leader and how they mediate between the leadership team and the classroom teachers. The middle leader often arises from models of curriculum or instructional leadership where there is a devolution of leadership that effectively empowers an intermediary role between the leadership team and teachers. Sometimes referred to as devolved leadership or distributed leadership (Niesche & Jorgensen, 2010), the middle leader can assume a valuable role in supporting teachers to enact quality teaching practices that are consistent across the school. This role often creates a tension for the middle leader between the promotion of professional accountability seen through quality teaching practices, and formal accountability (Bennett et al, 2012). Here the line management framework can dominate or give way to a framework of professional collegiality. Success seems to rest with the skill of the middle leader when negotiating their authority within this collegial framework. When successful, the middle leader provides an environment where collaborative learning permits each teacher's assumptions to be open to scrutiny leading to professional discussions. Findings from the Remote Numeracy project suggest that when middle leaders encourage risk taking this allows teachers to be innovative in dealing with specific problems they confront on a daily basis. Although it is important to note that this level of success did not automatically happen by being issued with the title of M*iddle Leader.* Each successful middle leader had various types of expertise they were able to drawn on while also being accorded legitimacy from the formal leader. As a result many middle leaders in the *Remote Numeracy Project* seemed to serve a key role in the enabling practices within a school or classroom setting (Jorgensen, 2015).

There has been a wide range of terms used for this middle leadership role including but not exclusively - numeracy leader, numeracy coach, curriculum leader, head of curriculum, or head of department (often used in the secondary school). What is common is that the person in the role, regardless of how it is labelled, mediates between the vision of the leadership and the enactment of practice with classroom teachers. The role is pivotal for supporting teachers to be able to deliver quality mathematics learning in their classrooms. Often the schools are developing a whole-school approach and the role is central in ensuring that all teachers are on the same page in terms of the rollout and uptake of the school approach.

Emerging from the *Remote Numeracy Project*, it was found that there were a number of characteristics that were repeatedly evident among the numeracy middle leaders. These roles, skills and attributes were shaped by the context of the communities but there was

considerable homogeneity in the characteristics across the study. In some cases, it was noted that a characteristic may have been absent and that this was articulated as a need among the community, but by and large, there was considerable consistency across the schools. Middle leaders:

- work collaboratively with classroom teachers while being a guide and or mentor
- have strong mathematical content knowledge;
- have strong mathematical pedagogical knowledge;
- mediate the vision of the leadership team so as to enact the envisioned practices with the classroom teacher;
- provide support and insights into collecting, using, interpreting and developing strategies based on evidence;
- support teachers to develop differentiation strategies to cater for diversity within classrooms;
- require a high level of trust, respect and autonomy from and of the staff;
- work with the leadership team to provide feedback and input into the future direction and needs of the school and mathematics programs; and
- make sense of the social, cultural and political contexts within which they work in order to make informed choices of the actions and reactions of their contexts and participants. (Jorgensen (Zevenbergen), 2016)

For the middle leader to support teachers to implement quality practices in mathematics teaching and learning requires considerable professional learning. This is more so the case when the school is seeking to adopt a school-wide approach. Within any given school there are newcomers, old timers and those in between so having an approach that caters for this diversity in teaching experience requires someone who is able to lead curriculum innovation. Often the formal leadership team is occupied with the (excessive) bureaucratic demands that permeate the operations of schools with little intellectual or temporal space for managing and leading curriculum. As such, having a middle leader who is able to take the vision of the school and reshape it into the desired practices in mathematics is a desirable skill and role (Gresalfi & Cobb, 2011).

In returning to our original concerns with regard to scholastic mortality, within a reform context of a school, attention needs to be paid to the cultural heritage of the leaners and how practices can be developed that not only cater for the diversity of backgrounds within a classroom/school, but equally on how to engage learners. The increasing pressure on schools to be compliant with National Curriculum: Mathematics outcomes, and to perform well on national and international tests (such as NAPLAN) suggests that there is less flexibility now than in the past in terms of what teachers are able to undertake. To this end, the use of digital tools and, of most interest to us, is the use of apps, as these can be explored to support and engage students in the learning of mathematics

It is the middle leader who needs the usual repertoire of skills to induct staff into quality pedagogical practices in mathematics based on quality research, as well as in the use of apps to support learning. By quality we understand this to mean tools that provide opportunities for deep learning as opposed to skill and drill learning. That is not to negate skills approaches but to acknowledge that more is needed if deficit approaches used for equity groups are to be ameliorated. Perceiving disadvantaged learners as needing basic skills as their core learning fails to account for the rich and engaging experiences possible in mathematics. Rich apps can assist in providing quality experiences for students in their mathematics learning.

Digital Media to Support Mathematics Learning

Arising from the *Remote Numeracy Project* was the engagement brought about through digital media – most notably through interactive whiteboards and handheld technologies. While there was some variation in the use and uptake of these digital tools across the study, what was common was that they acted as a strong stimulus for engagement of learners. Middle leaders, teachers and administrators all strongly supported the value of digital tools as pedagogical strategies but were equally strong in their support for iPads for fiscal reasons. Many mathematics programs are available but are very costly. Apps, in contrast, are cheap, affordable and accessible making them appealing to middle leaders, teachers and school leadership teams.

The comprehensive work of Larkin[i] (2015) in the identification and application of quality apps to support mathematics learning has been a developing enterprise over some years. Larkin (2013) has developed frameworks to analyse what constitutes a quality app in mathematics education. Like many of its digital predecessors, apps have the potential to simply substitute for what are common practices in mathematics education but with some caveats. Larkin's work has highlighted that while there may be a plethora of apps available, only some are of the required quality to promote deep mathematical thinking and learning. A way to conceptualise and assess the quality of learning has been achieved through a number of frameworks employed by Larkin. What is paramount in addressing issues of scholastic mortality is the engagement of learners in quality learning experiences. The digital tools need to extend beyond "baby-sitting activities" to engage learners at a deep conceptual level of understanding. It has been Larkin's mission to sort the wheat from the chaff in terms of quality apps and to support teachers in the identification of quality apps and how best to use them to support mathematics learning. Larkin (2016 in press) extends his original research, which focussed on Number and Algebra apps, to include an evaluation of Geometry apps. This is an important addition to the framework as Geometry apps are likely to require high level representations of geometric structures.

A model that outlines the assessment of effective apps aligns somewhat with the SAMR model which is based on the increasing sophistication in the evolution of digital media to support mathematical learning. The four levels of the SAMR model illustrate the sophistication of technologically enhanced learning (see Table 2).

Table 2
A Model of Increasing Digital Adaption (Puentedura, 2015)

Level	Description
4. Redefinition	where technology allows for the creation of new tasks, previously inconceivable
3. Modification	where technology allows for significant task redesign
2. Augmentation	where technology is used as a substitute with function change
1. Substitution	where technology is used as a substitute without function change

Moving Forward: Professional Learning Models

This paper has been propositional and seeks to find new ways of working with schools and teachers that will bring about scholastic success, particularly for students who are most at risk of failing in school mathematics. Lamb's work with instructional leaders (Lamb,

2010; Lamb, Diezmann & Fox, 2015) has led to theoretical proposition being advanced (Lamb & Branson, 2015) that has assisted in the refinement processes of working with leaders in rolling out reforms. Aligned with a design research approach (Cobb, Jackson and Dunlap (2015), she advocates for professional learning communities in which the staff across a school (or region) work collaboratively on building innovation and reforming practices. This can be achieved by having all staff fully informed of the school vision requiring orientation and preparation for reforming practice. Once this stage is underway, an audit of current practices including school documents and resources is necessary. Next a situational analysis assists all school staff to understand the current priorities and goals, which is instrumental for reforming practices and building trust, rapport and strengths among the school staff. Implementation of reforms can then be undertaken using a collaborative design research approach across the school in which teachers build their repertoire of skills and understandings based on evidence. These steps are also supported by the work of Gibbons & Cobb (accepted) where they recommend actions to be taken by the middle leader that result in quality instructional practices. These actions during group sessions were 1) doing mathematics 2) examining student work, 3) analysing classroom video, and 4) rehearsing aspects of practice. When in the classroom the middle leader would, 5) co-teach, 6) model and 7) debrief (p.7).

The Middle Leader as Curriculum/Digital Reformer

Within the design research approach, the middle leader plays a critical role. The person, who has the qualities identified earlier in this paper, must be able to work with teachers to build their skills in mathematics teaching and learning as well as in the selection, uptake and evaluation of digital resources, e.g. apps.

Within the digital resources, most notably the use of apps, the middle leader will be seeking those apps that are in the upper levels (3 and 4) of the SAMR model – ones that promote change and deep learning in mathematics. Larkin's evaluative framework is designed to help teachers assess apps and then select those that promote deep understandings as opposed to reinforcing skills and practicing drills (low levels of SAMR model).

From our collective work in design research, we would propose that the model for professional learning would follow an iterative process such as that below:

- Working with schools to identify their vision for mathematics
- Working with schools to identify a pathway to achieve their vision for mathematics
- Working with middle leaders to translate their vision into practice
- Working with middle leaders to develop their skill sets
- Middle leaders working with teachers
- Middle leaders assessing progress – of teachers and students
- Middle leaders sharing data with school leaders, teachers and community.
- Evaluating, reflecting and revising.

The middle leader serves a critical role in this model – not only as the lynchpin to the enactment of the school vision in terms of their advocacy for authentic mathematics education, but also in supporting teachers to build their knowledge and skills and then applying these in the classroom. This applies to the pedagogies for teaching mathematics, the use of digital resources, planning for quality learning, and assessment of and for learning.

It is our intent to work with this model and work in schools to promote the role of middle leaders in mathematics, and through the use of digital media (most notably Apps)

to bring about change to support quality teaching and learning in mathematics classrooms. Working with schools to identify middle leaders, upskilling middle leaders to be able to work with both school leadership teams and classroom teachers, and developing competencies in the use of apps, will be a key feature of our future work. Collectively the research team has a diverse strength base to bring about reform and to work with teachers/schools in enabling the reform to gain traction.

Where to From Here?

As a team, our collective experience and learnings suggest that a key area for research and professional learning (impact of research) lies in the curriculum reform nexus of middle leadership and the use of digital tools (most notably apps). The team is seeking to develop this work more generally in terms of working with teachers to explore this exciting and innovative potential as well as developing the work more theoretically. Our collective experience – in curriculum, equity, leadership and digital learning – enables a deeper understanding of issues, but also a practical wisdom brought about through our diverse experiences in working with teachers and in research. It is out intent to develop this work in a more grounded way and to work closely with selected schools to bring about change and to explore the impact of that change – on students, teachers, leaders and the overall school.

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