The Mathematics Instructional Leader:
What a Difference Crucial Conversations Make

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The aim of this study was to investigate the role of the instructional leader when introducing digital technology into the mathematics teaching in the Australian Curriculum. The research reported here involves the principal and five teachers from one school and is part of a larger study. Results indicated that principal-led 'crucial conversations' supported educational change that comprised not only curriculum change but also a transition from a pedagogy that draws on technology to a pedagogy in which technology is embedded.

The accountability of primary principals as instructional leaders has increased markedly with substantial challenges in Mathematics Education and the Digital Revolution. Accountability challenges in mathematics education relate to national numeracy testing (NAPLAN) and the new Australian curriculum, which includes mathematics as a learning area, and numeracy across the curriculum as a general capability (Australian Curriculum and Reporting Authority (ACARA, n.d.). The cross curricula focus of numeracy is defined in terms of its social utility (Australian Association of Mathematics Teachers, 1997): "To be numerate is to use mathematics effectively to meet the general demands of life at home, in paid work, and for participation in community and civic life" (p.15).

The digital revolution involves the integration of digital resources into the curriculum (e.g., interactive multimedia resources; audio, photo and video resources; interactive assessment resources; digitised collections of curriculum resources). The Australian government is supporting the integration of digital resources into the curriculum, spending $32.4 million targeting digital resources, professional learning, and infrastructure upgrades (DEEWR, 2012) and using *Scootle*, a new social network, to assist teachers to **"learn,** teach and collaborate using digital resources" (Education Services Australia, n.d.). With the rollout of the National Broadband Network (NBN), even greater use of digital resources and improvements in student outcomes is expected (Department of Broadband, Communications and Digital Economy, 2013).

In view of the challenges presented by the new Australian curriculum and the digital revolution, the Chief Scientist has argued strongly for inspired school leadership to build teacher capacity and improve students' outcomes in mathematics: "Inspiring leaders will encourage innovation and support teachers as they develop particular ways to deliver the curriculum" (Chubb, 2012, p. 9).

Literature Review

Principals and other school instructional leaders are expected to be agents of change, guiding and engaging with teachers to respond to new educational directions. This role is very challenging in the case of updated reconceptualised curriculum and the digital

revolution, because major changes need to be made regarding *what* is taught (new curriculum), *how* it is taught (digital resources), and *when* the change needs to be implemented (with pressure on schools in early NBN rollout areas). Furthermore, instructional leaders need to be able to persuade teachers of *why* there is a need for change, because these leaders are highly dependent on teachers to implement changes. Similarly, teachers are highly dependent on instructional leaders because they are struggling to keep pace with educational change (Hargreaves & Shirley, 2009), changes in professional practice requires considerable teacher learning (Cobb & Jackson, 2011), and the changes needed to ensure academic rigour is maintained or enhanced (Jackson, Shahan, Gibbons, & Cobb, 2012). Of the numerous models available to support transition to the purposeful use of technology in education, the model selected to guide this study is the Substitution Augmentation Modification Redefinition (SAMR) Model (Puentedura, 2015). This model is appropriate because it describes four levels of increasing sophistication in the use of digital technology (see Figure 1).

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

Figure 1. A model of increasing digital use (Puentedura, 2015).

Supporting teachers presents a significant challenge for principals and other instructional leaders because teachers need to adapt to curriculum changes while integrating digital resources into their teaching practices. Millet and Bibby (2004) provide insight into how principals can successfully undertake this leadership task by considering all school staff as members of a professional learning community (PLC). Within their school PLC, principals need to foster a collaborative learning culture where collaborative relationships, shared vision and shared values promote the active development of practices to enhance student learning (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006). The principal also needs to understand a teacher's capacity to change by examining the context and culture of the teacher's 'situation', or working environment (Millet & Bibby, 2004). In addition, the principal needs to be able to have 'crucial conversations' (Patterson, Grenny, McMillan, & Switzler 2012) where topics of change and how to go about that change can be had in a safe environment. These conversations enable the PLC to stay focused on the goal at hand that leads to action and results rather than being distracted by argument and side taking. The recommended initial steps for action in a PLC include: clear identification of the goal with ownership of that goal being accepted by all; a combined 'head and heart' approach where teachers become passionate about the educational change and work logically towards achieving it; and alertness to when conversations change from positive and goal focused to *crucial* where important differences in opinion need to be heard so that a balanced approach to goal setting and achievement is possible. Achieving a task of this

magnitude is difficult when educational change comprises not only curriculum change but a reconceptualised view of technology and pedagogy. In order to better understand how this change occurs in schools, the following research question was posed:

How does one primary school principal, as the mathematics instructional leader, support teachers to integrate digital resources into the mathematics curriculum and across the curricula via numeracy?

The Study

The results reported in this paper are part of a larger study. Participatory action research was used in this study because it empowers participants to engage in cyclic iterations of planning, action and observation, and reflection to improve professional practice (Carr & Kemmis, 1986). The study included two complete cycles of participatory action research. The key participant reported in this paper is a primary school principal with a special interest in the use of digital technology in the teaching of mathematics and numeracy across the curriculum. Additional participants were the curriculum leader and three Year 3 teachers. One Year 3 teacher had been teaching for four years and the other two teachers were in their first year of teaching.

Data Collection

The data collection comprised artefacts, observations, interviews, and field notes. The artefacts were school planning documents, teacher work and student work produced during this project. For each cycle, one lesson per class was observed by four school participants, the teacher delivering the lesson (lessons were recorded on video) and one of the researchers. The researchers kept field notes documenting any critical incidents or issues that arose. Interviews were conducted with the teachers after each lesson during the two cycles.

Data Analysis

Data were analysed to construct a rich narrative account of how the principal inspired and supported the integration of digital resources in the teaching of mathematics and numeracy across the curriculum. All data was subject to *content analysis,* seeking evidence of the eight characteristics of a professional learning community, such as shared values, shared vision, and collective responsibility (Stoll et al., 2006). This data was used to create a chronological account of the principal's journey, with critical incidents identified. In addition*, a quality analysis* was undertaken on excerpts of classroom lessons in which digital resources were employed. This quality analysis complemented the content analysis of the lessons.

Study Progression

Phase A: Introduction to project. Step 1 involved a half-day professional development session with the primary school principal participating in this study. This session outlined how digital technology could enhance current pedagogical practices.

Phase B: Audit and preparation. Steps 2 and 3 involved a situational analysis of the current integration of digital resources. Step 2 was an audit of school planning documents. Step 3 consisted of an interview with the Principal.

Phase C: Implementation. Step 4 was two iterative cycles of planning, action and reflection by the teachers, principal and researchers and focused on the incorporation of digital resources into classroom teaching.

Results and Discussion

Phase A: Introduction to the Project

Step 1: Half day professional development. During this session, the principal was introduced to ways to extend the use of concrete materials to include digital technologies as a first step in educational change. The principal identified that the Year 3 teachers were using digital technology to investigate the use of water around the school saying:

> They're [teachers and students] going for a walk around the school to identify uses of water, all around the school, where the water is coming from, what they're using it for. So they'll take their iPad and take photos and download those photos and put them in a disk.

This comment identifies good use of the camera function within the iPad but does not provide any functional change beyond having photographs of the various water points around the school. Discussion between researchers and the principals then focused on ways to allow for functional change that could lead to task redesign incorporating a problematic situation that would engage student interest.

Phase B: Audit and Preparation

Step 2: Audit of school planning documents. The principal provided Year 3 planning documents prior to the situational analysis interview. These included planning documents from the Year 3 Mathematics unit as well as from the Literacy, Science, History/Geography and Religion units in which numeracy could be embedded. These documents allowed the researchers to consider not only the mathematics but instances of numeracy being taught across the curriculum and how digital technologies were being incorporated to support mathematics learning and numeracy development.

The Mathematics unit had a focus on the teaching of subtraction. This unit used some concrete materials but mainly considered the steps in the calculation of abstract numbers without context. It appeared that no attention was given to either numeracy or the use of digital technologies. The Literacy unit did not identify any aspects of numeracy within its content. The only digital technology identified in planning was the use of a data projector. The Science unit included numeracy content targeting measurement in planning, but did not identify any digital technology to be used. The History/Geography unit did consider numeracy in the display and interpretation of data. Digital technology was also identified in planning as the use of a DVD to show historical footage. The Religion unit did not include any numeracy content although the use of a data projector to display *YouTube* clips was detailed in the unit plan.

The unit plans prepared by these three Year 3 teachers included some evidence of planned teaching of numeracy across the curriculum. Using Puentedura's (2015) SAMR Model to guide analysis of the use of technology, it was clear that the planned technology use was restricted to the first level of technology use, *Substitution*, where technology was used as a substitute without any functional change. It is worthy of note that even at the

Substitution level, there was limited evidence technology use in the mathematics unit or other units.

Step 3: Situational Analysis. The principal indicated that the focus of professional learning within the PLC was primarily on literacy, numeracy and higher order thinking skills. She also noted that teachers had made the shift from outcomes-based assessment to criterion-referenced assessment. The principal stated that she expected teachers to understand the difference between "gimmicks and what is actually going to enhance teaching and learning" and noted that "that they [teachers] are discerning enough to know what makes a difference to a lesson". When questioned further about how she encouraged teachers to integrate digital technologies in their teaching, she replied:

> I have had stronger conversations when individuals [interested in the use of digital technology] have brought in their learning plans but I want teachers to feel safe before I ask them to take that next challenge. When we got the iPads two years ago I said, right, we are not going to get any until we have done some work, some work around the General Capabilities and then make a decision on, do we even want iPads...We visited two other schools that had iPads and I wanted us to have that discussion together from a position of information. I then organised some professional learning both from the technical position of how to use your iPad as well as how to integrate it [into the curriculum]. That all happened before we made a decision to buy them.

This discussion suggests that the principal did not make a unilateral decision. She encouraged the exchange of differing views, thereby making it safe for teachers to express their opinion. It was the teachers' decision to adopt the use of iPads into their classrooms and as a result they have taken ownership of this change thereby making a commitment to effective iPad use.

Phase C: Implementation

Cycle 1, Planning, Action, and Reflection. The planning of lessons in the first cycle of the project was initially prepared by each classroom teacher and then shared at a meeting with all teachers, the curriculum leader and the principal. This meeting provided feedback to each of the teachers and gave each of the five school members' ownership of the final lessons.

During the *action* step a researcher attended lessons, observed and recorded them. She was accompanied by the principal, curriculum leader and the other two teachers. One of these three lessons will be discussed here as an example typical of the teachers' professional practice. The lesson called "Time Travellers" made use of a PowerPoint slideshow of children from the class meeting the school bus in the morning. The problem situation was created by asking students to indicate on their individual laminated clocks what time each member of the class should join the bus. The PowerPoint slideshow had a slide for each child and asked students to draw the time on their clock. After discussion, the teacher wrote on the whiteboard the correct time before proceeding. Students found this lesson very engaging as they each eagerly waited for their photo to appear.

Following the lesson, the five staff and the researcher adjourned to the staff room where the researcher asked the five members of the team to *reflect* on the lesson. The buzz from them was on the level of student engagement and how the use of their photographs via the data projector had made this possible. The use of technology meant that each student was 'hooked' and actively wanted to participate because it involved them. The principal moved beyond this discussion to consider additional aspects of the pedagogy saying:

With the clocks everyone felt really confident to just go. They knew the red [large hand on the clock], the blue [small hand on the clock], the minute, the hour…the ones who needed to keep using this could. It is having the resource there to help everyone. Like everyone had a clock right there on their desk, they could use.

After this positive discussion about the successful lesson, the researcher moved the discussion to the role that technology had played in the lesson. It was evident that the PowerPoint slideshow with student photographs had achieved the specific purpose of student engagement. But the teachers were challenged because technology was being used as a mere substitute for more traditional pedagogical practices without it changing the function of the task. Discussion on task modification where the use of technology allows for task redesign resulted. The principal took the lead, looking for clarification allowing the other teachers to ask questions, and supporting a discussion on how to approach this type of planning. The researcher outlined the importance of task redesign to take advantage of technology. She also pointed out the planning task should ensure that the academic rigour of the task is not lost when technology is used; rather it should add a dimension not possible without it. At the end of the discussion, it was agreed that all five school members would work on the one lesson together with a view to making the use of technology more purposeful as a pedagogical tool to enhance student learning.

Cycle 2, Planning, Action, and Reflection. The principal, curriculum leader and teachers collaboratively planned a probability lesson that promoted the use of accurate change vocabulary to describe the probability of chance events. Each pair of students had a laptop and was directed to the Math and Teaching Technology Innovation (2014) website to source virtual manipulatives. On this site students, created their own spinner combinations where they were asked to make spinners to represent probabilities of landing on one colour that were: certain, impossible, unlikely, and had an even chance.

The *action* again involved all five school participants and a researcher in the classroom participating in or observing the lesson. Again, the students were highly engaged with the use of technology but many spontaneous opportunities for learning were not followed up. Firstly, students had to construct a spinner that had an equal chance of landing on one of two colours. They were then directed to spin the spinner 10 times and discuss the results. Similarities and differences were discussed. The teacher then asked the student to spin the spinner 100 times and compare their results. The spinner tool allowed for immediate feedback with a graph showing the distribution of each colour. Again, class discussion resulted where the teacher was able to hook up different computers to show the class the differing results. This discussion of why some graphs looked different introduced the use of experimental probability and various unique combinations of spinners were created. The Year 3 students were then directed to create a spinner that had five colours on it, but there was a 50% chance of the spinner landing on one colour. The rigour of the tasks was maintained throughout the lesson and the teacher was able to orchestrate the discussion when she showed different student solutions. At the conclusion of the lesson, the students were able to confidently construct digital spinners that addressed the chance elements posed by their teacher. As they had been able to access quickly the results through the use of the virtual manipulatives, they were able to predict outcomes of various spins.

The *reflection* on this lesson was led by the principal who led the planning relating to the intentional use of technology in the lesson. When asked by a researcher if she thought the use of technology was extending the pedagogy, she answered:

> I would say it was quite a different purpose. The last time we [the technologies] were more about the notion of display where we could have just used an overhead projector or written it up on the board. But we were trying to do something different, to enhance the learning, the mathematics itself [with technology].

When the classroom teachers were asked to comment, they could see the benefits of this approach with one saying:

> My students could easily see what the outcome would be if they made it four sections or five sections being easily able to change and then spin the spinner 10 or 100 times and get an immediate response...Children were able to share their results or repeat their experiment to see if they got the same result as their classmates. It all happened so fast!

The principal agreed saying:

> It would have not have been possible to have that lesson drawing a spinner and doing (sic) the experiment 10 or 100 times…you couldn't see the fear of making a mistake on their faces today because you could just push the button and it would all disappear and they could do it again.

The collaborative nature of this planning exercise seemed to have all teachers including the principal positive about the potential of this type of task. They had learnt together as a team to tackle the integration of technology into a mathematics lesson and were rewarded by the students' engagement and achievement.

Conclusion

Instructional leaders in the primary school are confronted with educational change demands that extend beyond changes to curriculum to one that requires them to lead a transition in pedagogy from one where technology was not prioritised to one where technology use was optimised thereby creating redefined or novel 21st century pedagogical approaches. The achievement of this change requires inspiring leaders to promote and support innovation in the delivery of curriculum (Chubb, 2012). But innovation is hard to grapple with as teachers try to see what the innovation might look like and why it would be more effective than what they currently do. One model supporting teachers with the purposeful employment of technology into pedagogy is the SAMR Model (Puentedura, 2015). This model helps teachers see how technology can be used beyond the simple substitution of existing pedagogical practices with technology to one where tasks are redesigned and new tasks are created capitalising on the affordances of technology, such as the rapid spinning of 100 spinners and the recording of this experiment. But guidance from the SAMR Model is not sufficient. The principal needs to stimulate and support the professional learning community in this endeavour (Lamb, 2010).

The principal as instructional leader was very aware of the pressures for curriculum change in line with the new Australian Curriculum: Mathematics and numeracy across the curriculum. She is also confronting the digital revolution and the need for her teachers to keep pace with this change. Her approach to confronting these changes is reflective of a leader who understands the need to foster a collaborative learning culture where collaborative relationships, shared vision, and shared values were promoted (Stoll et al., 2006). Her approach was reflective of collaborative conversations that allowed difficult points to be discussed in a safe environment.

The principal in this study worked alongside her teachers in the PLC. She engaged fully in the project, proposing, analysing and owning the changes in pedagogy as much as the teachers. She created an environment for all to feel safe as she had *crucial conversations* with two first year teachers, one in her fourth year out and her curriculum

leader. Importantly, she joined with them in this professional journey celebrating the growth in their professional knowledge of how to commence the incorporation of technology into the teaching of mathematics and numeracy across the curriculum. The journey has just commenced with the PLC planning and practising the new pedagogies which over time should become part of their professional repertoire with the embedding of technology becoming second nature. The challenge will be to overcome the obstacles at each level of the SAMR Model to ultimately effect a transformation in pedagogy made possible by technology.

Acknowledgement

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