ENHANCING MATHS TEACHERS' PEDAGOGY IN SPECIAL SCHOOLS IN QUEENSLAND AUSTRALIA

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ABSTRACT

This paper reports on a project in one special school in Queensland Australia. The intention of the project was to improve the teaching and learning of mathematics to students from Preparatory to Year 12. The overarching concern of the project was the reported limited learning experiences provided to students, with maths learning reduced to a focus primarily on number. An action research/appreciative inquiry (AI) approach was used in the project to examine how teachers teach mathematics to the students. AI has been identified as a reconfiguration of action research within organisational settings such as schools. It closely interconnects with Timberley's Inquiry Cycle which was used in the project. The project also drew on the Most Significant Change Technique. Findings indicate more work is needed to capture the actual achievement of students. There is strong evidence to suggest that teachers (not all) lack sufficient numeracy and mathematics content knowledge. There is a need for special education teachers to have a repertoire of instructional strategies that they can use to assist students. The adoption of a professional learning community is commendable, however, when decisions, planning and resource making are left to a limited few or one member, it is difficult to see the benefits of such a community.

Keywords: *mathematics, special education, pedagogical content knowledge, professional learning community*

INTRODUCTION

This paper reports on a project at one special school in Queensland Australia. This project is more frequently referred to as the Triple M project. In what follows is a brief background to the project, the project problem, an explanation of the project, appreciative inquiry research and the program activities and outcomes as at July 2019.

Background to the project

The three-year project presented in this paper was informed by the final recommendations from the YuMi Deadly Maths Special Schools project completed in June 2016. Informal and formal discussions were held with the Principal and ad hoc conversations with project participants in the final round of workshops of the original project. It proposed to build on from the initial project that focused on the training of participating teachers with how to teach mathematics to students with intellectual disabilities, to extent and enhance teachers' maths pedagogy and continue to build sustainable success for students.

PROJECT PROBLEM

Whilst there was a very strong commitment from participating Principals and teachers with supporting students in the original project, the findings identified a need for teachers to continue to build and enhance their repertoire of maths instructional strategies to assist students with successful learning of mathematics. It is this finding that the current project discussed in this paper will address.

The combination of wide-ranging deficits in foundational knowledge about mathematics, experiences and skills and the pressure to increase student achievement, places students with disability at greater risk for failure unless their teachers provide specifically designed instruction and resources.

RESEARCH UNDERPINNING THE PROJECT

The project is guided by the research pertaining to school improvements in mathematics education for special schools. In what follows discussions are provided about multi-sensory teaching and learning, pedagogical content knowledge and the inquiry cycle of professional development.

Multi-sensory teaching and learning

Many students who experience learning difficulties can benefit from multi-sensory or multi-modal teaching practices (Witzel, Riccomini & Schneider, 2008). Multi-sensory and multi-modal teaching and learning can best be described as visual, auditory, kinaesthetic and tactile pedagogical practices which incorporate different ways of learning. Teachers can desist from limiting the learning possibilities of their students by endeavouring to use all of the senses when engaged in the teaching of mathematics. Rather than simply using reading or listening strategies to teach students, teachers should aim to use all of the senses to support active and interactive student learning. Bedard (2002) states there are three distinctive learning styles: auditory, visual, and tactile. Each student has his or her own unique learning preference style or way of processing and retaining information. When teachers use strategies for all learning styles, individual students are able to learn through their strongest modality (p.13).

Taljaard (2016) suggests that, ‘we all interact with the world around us with our five senses, but we process the information received in our distinct ways’ (p.47). As with any teaching facility, children who are being educated in special education schools are not all at the same educational level when it comes to what they know and what they understand about mathematics. Using multimodal and multi-sensory instruction can more fully engage students’ development of conceptual understandings of mathematics ideas, equipment and materials. This will, however, be contingent on a teacher’s pedagogical content knowledge.

Pedagogical content knowledge

There continues to be a strong consensus in teacher education literature that going beyond the dispensing of content, i.e., giving a test or grade, is the challenge for this century. Its resolution will depend on schools’ and teachers’ abilities to develop knowledge that supports and enhances more strategic learning and understanding of how to teach and organise schools in ways that respond to students’ diverse approaches to learning (Darling-Hammond, 2016, p. 85). Whilst teacher content knowledge is crucially important for improving teaching and learning, historically there has been a tendency to focus on such content, with scant attention paid to how teachers must understand the content of the subjects they teach (Loewenberg Ball, Thames, & Phelps, 2008). More recent findings show that content knowledge continues to be inert in classrooms unless it is accompanied by a rich repertoire of knowledge and skills related directly to the curriculum, instruction and student learning (Darling-Hammond, 2016). Shulman (2005) refers to pedagogical content knowledge as highly quality instruction that requires sophisticated pedagogical content knowledge. The appeal of this knowledge is that it bridges the content knowledge and the practice of teaching.

Timperley inquiry cycle

Whilst a focus on professional learning communities is critical to rich and insightful teaching and learning in classrooms, there is much debate about how teachers can be professionally supported with developing their pedagogical content knowledge so that it leads to more effective teaching practice. A synthesis of research that focused on teacher professional development (Timperley, 2011) identified that teacher engagement in professional learning can have a substantial impact on student learning. The synthesis also found that one-off professional learning events with external experts who presented prescribed practices to teachers were ineffectual and had limited impact on student outcomes. Where student gains were identified, a number of elements were strongly related to these gains. Referred to as a *Cycle of Inquiry*, (Timperley, 2011) consistently found that elements such as "grounding learning in immediate problems of practice, deepening relevant pedagogical content and assessment knowledge, and engaging existing theories of practice on which to base ongoing inquiry process" (p. 5) all contributed to teachers becoming collectively and individually the drivers for acquiring the knowledge require for effective teaching and learning.

METHODOLOGY

An action research/appreciative inquiry (AI) approach was used in the project to examine how teachers taught mathematics to the students (Ford & Ashford, 2000; Hammond, 1996). AI has been identified as a reconfiguration of action research within organisational settings such as schools. It is described as a strategic planning model, participatory, and a system-wide approach that seeks to discover what works based on solutions that exist currently within organisations such as schools. It closely interconnects with Timberley's Inquiry Cycle discussed earlier. The project also drew on Most Significant Change Technique (Davies & Dart, 2005). This approach promotes considerations of how people are brought together as a collective in a group context to participate in organisational learning and change, knowledge sharing and making sense of impact.

The project combined mixed model (quantitative and qualitative questions) and mixed method (quantitative and qualitative stages in the design) approaches (Johnson & Onwuegbuzie, 2004) in an explanatory design. It involved three studies (Table 1) that used multiple data collection methods and analysis. Study 2 and 3 are the focus of this paper.

Table 1. Overview of Studies

Component	Description
Study 1: Design and development of evaluation (Feb 2018-2019)	The 10 steps of Most Significant Change (MSC) model to monitor and evaluate the fidelity of the PLC design and implementation: a) defining domains of change, b) define feedback and reporting loops and, c) data instrument design using Concerns Based Adoption Model (CBAM).
Study 2: Data collection, analysis and monitoring (Feb 2018-2019)	The Concerns based Adoption model to conduct online surveys, conduct a social network analysis to identify how networks are operationalised in the PLCs and,
Study 3:	Professional learning workshops, visits to classrooms and resource development.

The Stages of Concern About an Innovation (George, Hall & Stiegelbauer, 2006) was developed as one of three diagnostic dimensions for the Concerns-Based Adoption Model (CBAM), a framework for measuring implementation and for facilitating change in the school. The Stages of Concern Questionnaire (SoCQ) provided a way for the project leader, administrators and PLC team to assess teacher concerns about strategies, programs or materials introduced in the school. An important caveat is necessary here. The SoCQ was conducted with a small sample and once only. It is not ethical to generalise beyond this limitation. Further, other forms of data need to be considered in conjunction with the results of the SoCQ.

Study 2: The concerns-based adoption model to conduct online surveys

The Seven Stages of Concern About an Innovation are called stages because usually there is a developmental movement through them, for example, the user of an innovation may experience a certain type of concern rather intensely, and then as that concern subsides, another type of concern may emerge (George, Hall & Stiegelbauer, 2006). The Stages progress from little to no concern, to personal or self-concerns, to concerns about the task of adopting the innovation, and finally to concerns about the impact of the innovation. The SoCQ is a tool for determining where an individual is in the stages. According to George, Hall & Stiegelbauer (2006, p. 8) the emergence and resolution of concerns about innovations appear to be developmental, in that earlier concerns must first be resolved (lowered in intensity) before later concerns can emerge (increased in intensity). Figure 1 provides a profile of concerns of the participant group *(n=6)*. In doing so, it provides relative intensity of each stage for the PLC team.

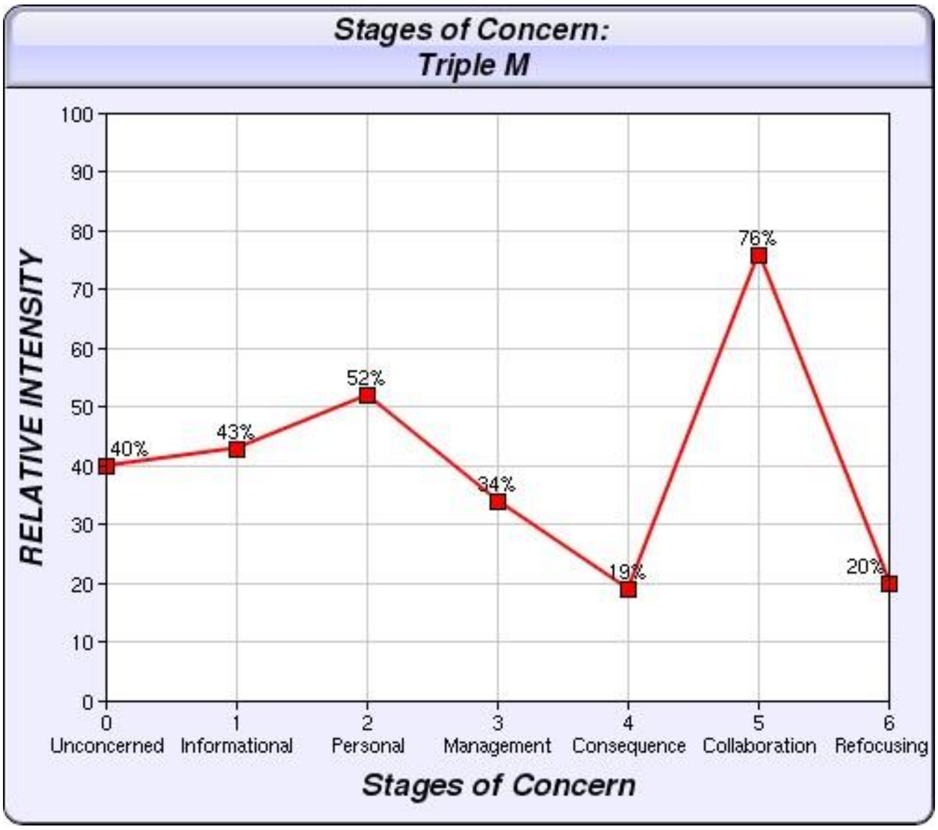

Figure 1. Stages of Concern - Triple M

Stage 0 score suggests that the team overall does have some concern for the project innovation but is somewhat more concerned about other things. A typical high score at this stage (hypothesised score of 82%) suggests that a nonuser's concerns are normally high on Stages 0, 1, and 2 and lowest on Stages 4, 5 and 6. Because Stages 1 and 2 are higher, it can be inferred that the team is interested in learning more about the project. The team does not have significant management concerns, signified by low intensity on Stage 3 and is not intensely concerned about the innovation's consequences for students but collaborating with others is high. The low tailing-off Stage 6 score suggests that the team does not have other ideas that would be potentially competitive with the innovation. The overall profile of the team suggests and reflects interested, not terribly overly concerned, positively disposed.

The relationship between Stage 1 and Stage 2 scores are important. A negative one-two split occurs when the Stage 2 score is higher than the Stage 1 score. These scores depict the team as having various degrees of doubt and potential resistance to the project. When Stage 2 concerns override Stage 1 concerns, the concerns about an innovation's effect on personal position or job security usually are greater than the desire to learn more about the project innovation. Experience suggests that when general, nonthreatening attempts are made to discuss an innovation with a person or team with this profile, the high Stage 2 concerns are intensified, and the Stage 1 concerns are further reduced. An individual or team with this kind of profile will not be able to consider an innovation objectively until her or his personal Stage 2 concerns are reduced.

Stage 5 provides information about how interested team members are in working with colleagues in coordinating the project. This concern is typical of people, such as team leaders, who spend a considerable amount of time coordinating the work of others. In contrast, high Stage 5 concerns tend to score lower in Stage 4, as is shown in the table below. These scores indicate a lack of concerns about the direct effects of the project on students. A breakdown of the individual team member responses could shed further light to determine whether they are team leaders, administrators or full-time classroom teachers. In any case, with the high Stage 5 score, the team's most intense concerns about the project are about coordinating with others in using it.

Stage 6 provides additional information about the attitude of the team towards to project innovation. When Stage 6 concerns tail off or down, the team does not have ideas that would potentially compete with the project. When Stage 6 tails up, it can be inferred that the team has ideas that they see as having more merit than the proposed innovation. Any tailing-up of Stage 6 concerns is a warning that the team may be resistant to the project. The Stage 6 tailing-down is detectable in terms of the overall concerns of the team.

Study 3: Professional learning workshops, classroom visits, resource development outcomes

The following activities were conducted with the school and teacher participants: a) professional learning workshops and reflections, b) in class lesson modelling to classroom teacher and with students, c) co- lesson modelling with classroom teacher and with students, d) observing teacher conduct focused lesson with students and e) reflection with teachers and PLC team. Resource development will now be discussed.

Multi-sensory Learning and Resource Development

Multisensory Learning (MSL) assists children to learn through the use of more than one sense. Considerable literature has been written about MSL and its benefits for the education of children (Aaron, 2017). Resource development plays a critical role in the project. More specifically resources were designed, created, trialled and modified to ensure that all children engaged actively in the teaching and learning process. Thus far in the project, several resources have been created by the PLC team and the project leader and team. Table two provides an example of this work.

Table 2. Resource development

Maths topic	Resource developed	Supporting image
Fractions: whole, half, quarter, eighth	Foam boards with sensory elements attached and connecting with real life experiences, e.g., pizzas and sandwiches. Planning template and ALD boards.	 

DISCUSSION AND CONCLUSION

This project has been positioned to strengthen the evidence pertaining to the teaching and learning of mathematics to students with intellectual disabiliy. Currently, there is limited research about students with intellectual disability, numeracy, multi-sensory and multimodal forms of learning mathematics and numeracy interconnect with improving instructional pedagogy. Intervention studies of mathematics have focused on explicit instruction and concrete, abstract sequences of instruction (Wizel, et al., 2008), but the literature is largely silent on the prior and existing knowledge and experiences of students with disability and how teachers can build on from that knowledge and experience and why this process is crucial to students' development and teachers' instructional strategies which includes appropriate resources.. As a consequence of the project there are several implications for consideration.

There is strong evidence to suggest that teachers (not all) lack sufficient numeracy and mathematics content knowledge. Whilst there is a strong commitment from teachers to support students with learning numeracy/mathematics, unfortunately, their preparation and capacity to teach it is of current concern. There is a need for special education teachers to have a repertoire of instructional strategies that they can use to assist students. By adopting a strong collaborative approach, it is likely that teachers will benefit from a focus on interpreting experiences during the implementation and maintenance phases of the program. The adoption of a professional learning community is commendable, however, when decisions, planning and resource making are left to a limited few or one member, it is difficult to see the benefits of such a community.

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