Australian Journal of Teacher Education

Volume 42 | Issue 11 Article 9

2017

Perceptions on the Role of a Pre-service Primary Teacher Education Program to Prepare Beginning Teachers to Teach Mathematics in Far North Queensland

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Abstract: This paper employs a collaborative auto-ethnographic method to reflect on perceptions and design of a pre-service primary teacher mathematics education program in a regional university and the role of that program to prepare beginning teachers for classroom mathematics practice in Far North Queensland. A four-phase analysis that reflected on: a primary teacher education program at a regional university, literature on primary mathematics education, reflections of two teacher educators and a pre-service teacher on Explicit Teaching, and the possible modifications to the practice of teaching and learning in the mathematics education subjects was conducted. Three challenges that emerged from the thematic analysis include: need for critical reflection in using a single teaching approach; need to bridge different priorities existing between schools and university; and optimism to change the approaches to assist students. The paper then discusses possible modifications to the practice of teaching and learning in the mathematics education subjects.

Introduction

Over the last three years a significant number of Far North Queensland (FNQ) schools have adopted Explicit Teaching (ET), a pedagogical approach that emphasizes teacher directed instruction as the most effective way to teach mathematics (Education Queensland, n.d.). In some of these schools ET is mandated for all lessons. All teachers, including pre-service teachers at the school are observed and their competency judged against their ability to demonstrate this approach to teaching. A recent job advertisement for a primary teacher in the region stated, "Our focus is very much on high-yield teaching approaches such as Explicit Teaching and Direct Instruction and the development of student literacy and numeracy through implementing highly structured Reading, Writing, Spelling and Mathematics programs." (Queensland Government, 2016). Our consideration of the mathematical education discourse within the pre-service teacher education program and these FNQ school classrooms reveals potentially significant differences between the faculty members' perception of effective mathematics education and pre-service teachers' lived experiences.

Another example that is illustrative of the potential difference between university and school system presentation of mathematical approaches is the pedagogical approach adopted by the Queensland Curriculum to Classroom (C2C) project to create curriculum materials based on the Australian Curriculum (ACARA, n.d.). In the context of the mathematics C2C, Kennedy, O'Neill and Devenish (2011) argued:

> *However the approach to content knowledge in C2C differs from ACARA's approach in a subtle, but important way. Factual knowledge, routine questions and efficiency dominate, frequently at the expense of flexibility. In a textual analysis of 57 lessons across grades 1–7 we found that 86% of the actions associated with teachers fit within a traditional teaching approach where teachers demonstrated, modelled or explained particular content to students, followed by time for practice questions that were very similar in nature to that which the teacher had just shown. (p. 10)*

The pedagogical issues raised by the differing perceptions between how mathematics teaching is presented at the university and how it is experienced by pre-service teachers while on professional placement poses difficulties for both academics and pre-service teachers. Adam and Chigeza (2014) provided a framework for engaging binary thinking within the teaching of mathematics (e.g., teacher-centred/ student-centred, transmission/discovery, explicit teaching/ inquiry lessons) and called for educators to avoid the binary teaching approaches that have historically proven divisive in mathematics education. The challenge for both academics and pre-service teachers is how to operate in an environment if the teaching of mathematics is not subject to critical analysis about the presence and impact of entrenched binaries, particularly binaries that have become part of the hidden curriculum.

This paper draws from an auto-ethnographic method to examine the participants' perceptions of the purpose and design of a pre-service mathematics teacher education program and classroom practice in FNQ. The approach challenges canonical ways of doing research and representing others and treats research as a political, socially-just and socially-conscious act. A researcher uses tenets of autobiography and ethnography to do and write auto-ethnography. Thus as a method, auto-ethnography is both process and product (Ellis, Adams, & Bochner, 2011). Our specific approach to auto-ethnography is collaborative. Root, Hargrove, Ngampornchai and Petrunia (2013) argue that one way to deal with teaching challenges and tensions is to share personal narratives with other teachers.

Methodology

The paper employs a collaborative auto-ethnographic approach to examine narratives of two teacher educators and a pre-service primary teacher on their experiences with mathematics education in FNQ. Auto-ethnography is an approach to research and writing that seeks to describe and systematically analyse personal experience (auto) in order to understand cultural experience (Ellis, Adams & Bochner, 2011). Chang, Ngunjiri and Hernandez (2013) describe collaborative auto-ethnography as "a qualitative research method that is simultaneously collaborative, autobiographical, and ethnographic" (p. 17). Some auto-ethnographers focus more on self, while others adopt a more analytical stance focused on the cultural interpretation of events involving self (Chang, Ngunjiri & Hernandez, 2013; Ngunjiri, Hernandez & Chang, 2010). This paper takes the form of an analytical approach to auto-ethnography. The research questions that guided our investigation were:

1. What are the perceptions of the purpose and design of a pre-service primary teacher education program and classroom mathematics practice in FNQ?
2. How can we implement strategies for pre-service teachers to navigate this interface?

Auto-ethnography is systematic in its approach to data collection, analysis and interpretation, and the researcher is both subject and object of the research (Ngunjiri, Hernandez & Chang, 2010). Chang (2013) argues that when researchers work together to co-generate story, listen, stir memory, prompt action and reaction, examine and challenge assumptions, they produce rich, nuanced, and varied perspectives. The research data included

retrospective reflections of two teacher educators and a pre-service teacher, a review of the mathematics education subjects and literature on primary mathematics education. A four-phase analysis that reflected on an ET lesson sequence and the different perceptions between pre-service primary teacher education and primary classroom mathematics practice was implemented. In Phase 1 we reviewed and reflected on the Mathematics strand of a teacher education program at a regional university. In Phase 2, we reviewed literature on primary mathematics education and teaching practice. In Phase 3 we reviewed the reflections of two teacher educators and a pre-service teacher on mathematics education, particularly ET. In Phase 4, we reflected on the possible modifications to the practice of teaching and learning in the mathematics education subjects. The next section describes the Mathematics strand of a teacher education program and the authors' commentary on the challenges of teaching into the program.

The Mathematics Strand of a Teacher Education Program

The pre-service teacher education program at a regional Australian university consists of three Mathematics strand subjects. One subject is completed in the first year of the four year degree, one subject in second year, and the third subject in fourth year. The curriculum of these subjects is designed to connect vertically to the other mathematics subjects and horizontally to the key subjects in the program such as the Professional Studies subjects. The vertical design of these subjects aims to develop the mathematical content and pedagogical knowledge of pre-service teachers. Mathematical knowledge includes both content and proficiencies while the pedagogical knowledge builds towards pedagogical content knowledge (Shulman, 1986). In the Professional Studies subjects, pre-service teachers develop fluency in a comprehensive repertoire of lesson designs and pedagogies including both teacher-centered and student-centered approaches. Interwoven with the three Mathematics strand and three Professional Studies strand subjects, pre-service teachers undergo five professional experience placements in schools. The following is a conversation between the teacher educators.

> ***Philemon****: I have always felt that the focus of the program is more on meeting the Australian Professional Standards for Teachers (APST) (AITSL, 2014) and not necessarily the needs of the pre-service teachers or individual schools in FNQ. The Mathematics strand and Professional Studies strand subjects are obviously taught separately, how can we bring them together? How can we develop pedagogical fluidity with our pre-service teachers? How can we enables pre-service teachers to develop "the "why" as well as the "how" of mathematics" (National Curriculum Board, 2009, p. 6)?*
>
> ***Cliff****: Preparing our undergraduate teachers for the range of experiences they will encounter whilst on professional experience is challenging. How do we balance multiple agendas and simultaneously try to build the undergraduates mathematical confidence and positive disposition? Many of the agendas seem to compete rather than compliment. We have to ensure that the overall course meets the accreditation requirements and agendas of the Queensland College of Teachers (QCT) and the AITSL. We also need to develop and teach subjects that address the concerns of undergraduate students who need to be able to respond as teachers to the changeable agenda of local school systems.*

In the first year mathematics subject, pre-service teachers review mathematics from the Early Years Learning Framework and up to Year 9 level in the *Australian Curriculum: Mathematics* from a teacher's perspective. The subject introduces pre-service teachers to the

numeracy demands of professional life and to those of the learning areas that comprise the *Australian Curriculum*. The links between mathematics and numeracy are also explored. The following is a conversation between the teacher educators.

> ***Philemon:*** *While this is a noble agenda to reintroduce the mathematics and numeracy concepts to our pre-service teachers a large percentage who are not recent school leavers, I think the emphasis should be more on addressing the mathematics phobia most of these students have.*
>
> ***Cliff****: I agree with your sentiment Philemon. I taught into this subject a couple of years ago. Many of the students feel disempowered due to their previous experiences of mathematics, particularly at school. At that time, the first year subject strongly focused on mathematics content knowledge and covered a relatively large amount of that content. I found the role of lecturer in the first year subject to be personally challenging. Many students expressed concerns about what they perceived to be an overwhelming amount of mathematics content and I saw little evidence that the subject positively added to the student's self-conception as teachers of mathematics. Creating positive and energetic mathematics teachers from struggling mathematics students is a difficult metamorphosis. As academic staff, we need to ensure that our graduates' mathematical content knowledge and personal numeracy is at an appropriate level to be effective teachers. At the same time, I believe we need to nurture those students who have experienced a less than ideal mathematics education in prior settings and thus may feel anxious about doing mathematics. It is important that we help those students to develop a positive disposition towards mathematics and teaching mathematics.*

The second year mathematics subject introduces pre-service teachers to the knowledge and competencies to effectively and equitably teach mathematics to primary aged children from diverse backgrounds. The subject examines current national and state curriculum frameworks and policies in mathematics education. Pre-service teachers develop mathematical and pedagogical content knowledge, and contemporary approaches to teaching mathematics to primary classrooms. The following is a conversation between the teacher educators.

> ***Philemon****: Each time I teach this subject, I think to myself that there is something I am not addressing. I want the pre-service teachers to develop confidence with different pedagogical approaches. But the pre-service teachers are asking for the "quick-fix, one-size fits all" teaching framework that would help them survive the professional teaching practice. But we prepare teachers for the State, Catholic and Independent school sectors who can adopt different pedagogical approaches. I think I need to update the workshop content, and change particular assignments, but time always seems to slip past me.*
>
> ***Cliff*****:** *I find that students in the fourth year subject also look for a magical formula for the perfect mathematics lesson. In the last three years, students have observed the adherence of many local schools to a single type of pedagogy – explicit teaching (ET). This pedagogy is based on work by Hollingsworth and Ybarra (2009) and Archer and Hughes (2011) (Education Queensland, n.d.). I feel that many students want me to either (a) explain how to use ET to be an effective mathematics teacher, or (b) reinforce their self-belief based on their observations that ET alone is not an effective pedagogical approach. Whilst ET is certainly a pedagogical approach we examine in the fourth year subject I personally feel the fourth year subject's agenda is larger than a single lesson design and needs to look at larger issues in mathematics education such as the*

pre-service teachers developing their pedagogical content knowledge, knowledge of differentiation techniques and dealing with misconceptions.

The fourth year mathematics subject builds on pre-service teachers' growing understandings of how children learn mathematics, and explores mathematical and pedagogical issues and learning mathematics across the curriculum. The subject equips pre-service teachers as reflective practitioners, able to plan, implement and evaluate mathematical pedagogies that are informed by research and support contemporary approaches to children's learning.

Mathematics Education and Teaching Practice

According to Van de Walle, Karp and Bay-Williams (2013) the concept of understanding mathematics refers to the quality and quantity of connections created between a new mathematical idea and the person's existing mathematical framework. Hence the more varied the experiences students are given to think about, develop and test an emerging idea, the greater the chance the students will correctly form and integrate the new idea into their existing web of concepts and thus develop deeper mathematical understanding. Understanding mathematics involves building robust knowledge of adaptable and transferable mathematical concepts, the making of connections between related concepts, the confidence to use the familiar to develop new ideas, and the why as well as the how of mathematics (National Curriculum Board, 2009).

Skemp (1976) highlighted two distinct meanings of understanding an aspect of mathematics: instrumental and relational understanding. Instrumental understanding equates with knowing a fact or being able to perform a mathematical procedure. Skemp (1986) argued that it is not enough for students to understand how to perform various mathematical tasks; students must also appreciate why each of the mathematical ideas and relationships work the way that they do which he termed relational understanding. Skemp's (1976) preliminary notion was that well-constructed mathematical knowledge is interconnected, so that when one part of a network of ideas is recalled for use at some future time, the other parts are also recalled. More recently, researchers have used the term procedural understanding and conceptual understanding to refer to instrumental understanding and relational understanding respectively (Kipatrick, Swafford & Findell, 2001).

Booker, Bond, Sparrow and Swan (2014) suggest that the "development of conceptual understanding needs to be established prior to further development of a topic or content area, as it is critical to building up fluency and problem solving" (p. 13). Willingham (2010) argues that it does not make sense to teach for example, concepts first or teach procedure first; but that they should be taught in concert. As students gain knowledge and understanding of one, that knowledge supports comprehension of the other. However, Willingham highlights that of the mathematics knowledge systems, conceptual knowledge is the most difficult to acquire. Willingham suggests that a teacher cannot fill concepts in the students' heads, rather new concepts must build upon something that the students already know (constructivism). That is why examples are so useful when introducing a new concept. Learning in mathematics needs to target for conceptual understanding by building on meaningful ideas and multiple representations (Siemon, Beswick, Brady, Clark, Faragher, & Warren, 2015).

Five strands of mathematical actions are described by Kilpatrick and collegues (2001) and further elaborated by Watson and Sullivan (2008): Conceptual understanding; Procedural fluency; Strategic competence; Adaptive reasoning; and Productive disposition. Conceptual understanding includes the comprehension of mathematical concepts, operations and relations. Procedural fluency includes carrying out procedures flexibly, accurately,

efficiently, and appropriately and having factual knowledge and concepts that come to mind readily. Strategic competence includes the ability to formulate, represent and solve mathematical problems. Adaptive reasoning includes the capacity for logical thought, reflection, explanation and justification. Productive disposition includes a habitual inclination to see mathematics as sensible, useful and worthwhile, coupled with a belief in diligence and one's own efficacy (Kilpatrick et al., 2001; Watson & Sullivan, 2008).

Sullivan (2011) suggests that the first four of these mathematical actions are incorporated into The *Australian Curriculum: Mathematics* and described as 'proficiencies' (ACARA, 2013). The proficiency strands that describe the development and exploration of curriculum content are summarized as:

> *Understanding: Students build a robust knowledge of adaptable and transferable mathematical concepts. They make connections between related concepts and progressively apply the familiar to develop new ideas.*
> *Fluency: Students develop skills in choosing appropriate procedures, carrying out procedures flexibly, accurately, efficiently and appropriately, and recalling factual knowledge and concepts readily.*
> *Problem Solving: Students develop the ability to make choices, interpret, formulate, model and investigate problem situations, and communicate solutions effectively.*
> *Reasoning: Students develop an increasingly sophisticated capacity for logical thought and actions, such as analysing, proving, evaluating, explaining, inferring, justifying and generalising. (ACARA, 2013)*

The *Australian Curriculum: Mathematics* anticipates that schools will ensure all students benefit from access to the power of mathematical reasoning and learn to apply their mathematical understanding creatively and efficiently.

Sullivan (2011) argues that one of the challenges facing mathematics educators is to incorporate each of the mathematical actions (Kilpatrick et al., 2001; Watson & Sullivan, 2008) or the mathematics proficiencies (ACARA, 2013) into school-based mathematics activities and assessment to ensure that they are appropriately emphasised. Pre-service teacher education can be a space to emphasise a pedagogical dexterity that incorporates each of the proficiencies or mathematical actions when planning mathematics activities and assessment. Adam and Chigeza (2014) argued for teachers to develop a pedagogical dexterity that can evaluate and select one or more ways of teaching and knowing from a range of possibilities, with a differentiated knowledge of context, individual student needs and practical limitations. The selection should be appreciative of the relational nature of the mathematics proficiencies, and that context can demand particular choices, that can change over time for the most effective student learning. Such teaching is conscious of the abstract paradoxes between subjective and objective, concrete and abstract, student-centred and teacher-centred; and yet it is informed rather than paralysed by them, in contexts that require real pedagogical choices and actions.

Retrospective Reflections of Two Teacher Educators and a Pre-service Teacher

This section reports on the retrospective reflections of the teacher educators on the second year mathematics education subject and the pre-service teacher on his third year teaching practice.

Teacher Educators' Reflections on the Second Year Mathematics Education Subject

We develop pre-service teachers' competence to incorporate each of the mathematics proficiencies: Understanding, Fluency, Problem Solving and Reasoning (ACARA, 2013) when they plan a mathematics lesson in the second year mathematics subject. We draw from contemporary research and literature in mathematics education. We divide the subject into three phases.

In Phase 1 we introduce and develop: (a) the mathematics proficiency strands as described in the *Australian Curriculum: Mathematics* and their application in practice, (b) behavioral vs. constructivist approaches (explicit teaching vs. inquiry lessons), (c) learning needs of different groups of learners and implications for teaching mathematics, (d) an appreciation of ICT tools to facilitate learning. Pre-service teachers collaborate to investigate the four topics and present their application in practice when teaching mathematics.

In Phase 2 we introduce and develop planning for teaching and the application of the concrete to abstract teaching sequence. Pre-service teachers develop: (a) a unit plan and detailed explicit teaching and inquiry lessons, (b) differentiation strategies they can use, and (c) a formative and summative assessment tasks and associated grading rubric. Pre-service teachers specifically develop their application of enabling prompts and extending prompts for all the mathematics activities they plan.

In Phase 3 we introduce and develop knowledge and understanding of students' data and using the data to inform planning and learning. Pre-service teachers develop their skills to collect and present data; and infer meaning from a range of data collected from previous students. Pre-service teachers develop competence to infer meaning from data collected from previous students to modify and inform pedagogical decisions. The following is a conversation between the teacher educators.

> ***Philemon****: The response from most pre-service teachers is "just show me the steps to teach". But I want them to engage with the concepts and materials at a deeper level and develop as reflective practitioners. I want them to make the contemporary mathematics education research concepts we develop in the workshops their own rather than to simply regurgitate back a set of teaching steps. I want them to understand the cyclic, almost pendulum-like motion about the pedagogical and curricular swings and tug-of-wars that manifest in academia, education departments, school administrations and classrooms (Adam and Chigeza, 2014).*
>
> ***Cliff****: It is certainly challenging to engage students in deep reflection on the teaching process. I find that many students are more focused on their overall grade than the comments and feedback I provide. One of the aspects of ET that may explain its rise to prominence in local schools is that the local educational program developers have proposed ET as a one size fits all teaching approach. The simple structure of ET will likely appeal to teachers just starting in the professional, particularly if they have low confidence in their ability to teach mathematics. In addition, schools in the FNQ region have linked the use of the teacher directed pedagogy to improved results on state and national tests. In Australia, successive governments have used NAPLAN to interrogate state and school systems. Little attention seems to be given to connecting the results on national tests to long term effective learning. Thus I see ET as an attempt by local schools to improve their overall NAPLAN results. The assumption of this approach is that good NAPLAN results mean that students have developed good abilities in mathematics.*

Pre-Service Teacher's Reflection on his Third Year Teaching Practice Using ET

In this section, the pre-service teacher Aaron describes his third year teaching practice in a school that mandated the use of a version of explicit instruction, which is referred to as the 'Fleming Model' (Fleming & Kleinhenz, 2007). In recent years in FNQ, there has been a move away from student-centred, cooperative or inquiry-based learning and towards teacher-centred, direct instruction and explicit teaching (Torzillo, 2015). The lesson sequence in the school followed a four step format: orientation, framing, instructional sequence, and plough back revision.

Orientation: A consolidation activity was used to 'kick-start' the lessons. This activity was a teacher directed fast paced rote learning activity where necessary facts and terminology were revised through the use of flash cards. The teacher would initiate the activity with a question such as "Subtraction means?" and the students would answer in chorus "take-away". This activity gave the teacher the necessary feedback on student participation and provided the teacher with an opportunity to re-direct learners to the task at hand.

> ***Aaron's reflection****: Although students were often able to reach success during the consolidation phase using the flash cards, these same students had difficulty applying this knowledge to a new situation during the Checking for Understanding (CFU) phase. Most students were engaged, actively listening and participating during the flash cards yet often students would disengage as their confidence diminished during the CFU phase.*

Framing: The lesson was then introduced to the students by framing explicitly what students were going to be doing during the activity and how they would be able to identify if they had reached success. This framing procedure followed the model proposed by Archer and Hughes (2011). Lesson intentions and success criteria were placed on display. I would initiate by stating, "Today we will be learning …", and the students would respond by checking the intentions on the wall and responding with the intention. For example the students might reply, "Parts and wholes". This procedure was then followed for the success criteria and was repeated until all students were engaged and was followed by a CFU phase which acted as a 'hook'. During this activity, student knowledge of specific skills required to reach success in the activity could be assessed and retaught if necessary.

> ***Aaron's reflection****: Framing of the lesson worked well yet lesson intentions were often parroted back with little understanding of the actual requirements. This rote learning style again engaged the students as they could reach success and knew the requirements.*

Instructional sequence (I Do/We Do/You Do): In the instructional sequence the teacher introduced the sequence by saying, "Now it's time for an I Do. I Do means …", and the students responding, "The teacher does it". During this time I would provide specific examples of how the task is to be structured and how to reach success. I used the think-aloud strategy during this time to provide students with an audible link between the skills I am mentally using and how this can be reproduced. During the We Do phase, I encouraged the students to participate in the activity and the skills required to reach success were scaffolded through a series of steps. This scaffolding was slowly removed as students became comfortable taking on more steps. This was repeated using a slow release of responsibility style pedagogy until the majority of students had gained the skills and knowledge required to reach success. During the You Do phase the students were given the opportunity to independently complete a set of similar tasks. Students who had yet to reach a stage where they could reach success independently were grouped and additional scaffolding was provided by the teacher.

> ***Aaron's reflection****: During the I Do phase the students were discouraged from asking questions. Although some students were happy to use their whole body listening skills during this time, many students became disengaged and the behaviour of some students began to decline. During the We Do phase students were encouraged to participate and this active engagement helped to refocus students on the task at hand. There was little room for differentiation here and often the more capable students wanted to move on while others still required additional scaffolding. This again caused the behaviour of some students to decline. During the You Do phase, and regardless of student ability to complete the task during the We Do phase, most students were often requiring additional support. To assist students to reach success the We Do phase was often revisited.*

Plough back revision: To finalise the lesson, the lesson intent and success criteria were recapped. Students were encouraged to demonstrate their understanding through a fast paced series of questions relating to the lesson intent and targeted the success criteria required through a 'Thumbs up/down display' where examples and non-examples were provided by the teacher. Student work was collected as evidence of learning.

> ***Aaron's reflection****: Students were often much more confident during the revision phase when the teacher scaffolding had not been completely removed than during the You Do phase.*

Aaron identified three areas of mathematical practice that presented a disconnection between the practice of mathematics presented in the pre-service teacher education program and the mathematics practice experienced in the classroom: pedagogical practice, implementation of the proficiency strands and his conceptualization of himself as a mathematics teacher.

The first area of mathematical teaching practice where there was an identifiable difference was the emphasis on researching and critically analysing different pedagogical approaches in the second year mathematics education subject compared with the one size fits all explicit pedagogical practice (ET) expected within the public FNQ classroom.

> ***Aaron's reflection:*** *As a third year pre-service teacher I have come to the realisation that there is a large disconnect between the pedagogical practices researched and used in the hypothetical classroom and the explicit pedagogical practices expected within a public FNQ classroom. The explicit teaching model used is quite prescriptive for pre-service teachers and modifications outside of these practices often lead to student behaviour issues. The routine nature of the sequence provides students with exactly what is required to reach success and this appears to be the focal point of the practice. It is almost algorithmic in nature as students are instructed to reproduce a specific target. Even a slight change to the wording of an instructional phase can cause confusion amongst the class. The fast paced nature of the lessons seems specifically designed to limit student questioning as outcomes are produced as specified.*

The second area of difference was the impact of the mandated ET lesson sequence on the implementation of the proficiency strands: Understanding, Fluency, Problem Solving and Reasoning (ACARA, 2013). In the second year subject, pre-service teachers were encouraged to plan for all proficiency strands while the school mandated lesson sequence privileged fluency and to a lesser extent understanding at the expense of problem solving and reasoning.

> ***Aaron's reflection:*** *Due to the fast paced and compressed nature of the explicit teaching model, as a preservice teacher, I do not feel confident that the proficiency strands had been addressed. Fluency appeared to be the main strand targeted using this model. Although the 'think aloud' strategy used during the I*

Do phase of the lesson had the potential to assist students in building an understanding of concepts, often students were disengaged during this time. During my teaching practice I was advised to remove choices for students during my teaching to avoid confusion and assist lesson flow. It was my experience that problem solving and reasoning were limited to being able to reproduce the strategy as demonstrated by the teacher. Perhaps given the flexibility to include these within lessons could have assisted students to make connections between content and generate a more robust understanding of concepts. With this understanding a more individual and concrete base for student reasoning could have been established and presented by the students. The nature of the short practicum, inadequate time to pre-assess student learning and build additional skills, and a pre structured and explicit curriculum/pedagogy provided limited capacity to restructure lessons that targeted the strands in a more cohesive manner.

The third and final area of difference between the two contexts was the emphasis in the pre-service teacher education program of developing as a teacher of mathematics who encourages the children to become the leaders of tomorrow. The monosyllabic approach to pedagogy in the school seems to actively discourage students from becoming independent learners and thinkers.

Aaron's reflection: *Within these pre-established classrooms it appears to be effective as students engage quickly through the various lesson sequences in order and achieve results. Fluency seems to be achieved and confidence is boosted yet this is not how I envisaged the classroom of the 21st century. I envisaged the classroom of the 21st century as an environment that encouraged students to question the teacher, question the practices, and take risks. I envisaged a classroom where these questions gave rise to teacher modelling of the how and why this information could be used within the real world. I envisaged connections between content in context being generated and yet, through my experience in the classroom, a production line mentality is still in effect. Within the confines of the classroom, the routine success is being achieved, yet I struggle to understand how this teaching model (used in this specific way) is assisting to build the critical and creative thinkers of tomorrow.*

In response to this uncertainty Aaron felt that he needed to develop a deeper understanding of the ET pedagogical approach used in the school. Aaron applied to be part of the 2017 intake into the Mount Stewart Cluster Teacher Education Centre of Excellence (MSCTECE) (n.d.). The stated purpose of the MSCTECE is to provide high quality field experiences for pre-service teachers, and professional development for existing teachers.

Aaron's reflection: *I have taken the opportunity to learn more about this model by accepting an offer to participate in the MSCTECE program. Through this program I hope to learn more about how to alter the structure of the explicit teaching models I have been exposed to. If I am to use this model in the classroom I would like clear direction on how I can encourage the kind of critical thinking and questioning that can assist students in developing the problem solving, reasoning, and understanding they will require when the routine of the classroom is replaced by the challenges faced in society. I am concerned that a fast paced, results driven model used in this way will not provide our future citizens with the skills and how to use those skills in new and novel ways.*

As we had surmised at the start of this process of writing this paper there are clear and perhaps significant differences between the approaches presented in our undergraduate pre-

service mathematics education program and some pre-service teachers' experience whilst on professional experience. The data gathered from conversations between the authors has highlighted a number of areas worthy of deeper reflection. The following section will analyse the authors' reflections with a view to identify possible modifications to the practice of teaching and learning in the mathematics education subjects.

Modifications to the Practice

Three challenges emerged from a thematic analysis of the authors' reflections: the need for critical reflection in using a single teaching approach; the need to bridge different priorities existing between schools and university; and the authors' optimism that change to their respective approaches will assist students.

The Need for Critical Reflection in Using a Single Teaching Approach

Siemon and colleagues (2015) argued that meaningful learning in mathematics needs to target for conceptual understanding by building on meaningful ideas and multiple representations. Explicit Teaching, while it can look efficient in terms of delivery of material and achieving fluency as experienced by Aaron, it might not be efficient in terms of development of conceptual understanding which needs to be established (Booker et al., 2014). There is need for teaching approaches that target the proficiency strands: understanding, fluency, problem-solving and reasoning to become parts of the same whole that can be temporarily coordinated or separated for the most adaptable result. Our position is to develop teaching approaches that are more responsive to the needs of all learners, and these approaches need to have several layers and pathways of support. This position is echoed by Adam and Chigeza (2014) who suggested teachers develop the competence to be more responsive to the stability and dynamism of the classroom contexts, gauging and differentiating students' pedagogical needs within a relatively stable scaffold, even within a single lesson.

Our resolve is that it is not enough for students to understand how to perform various mathematical tasks, they must also appreciate why each of the mathematics ideas and relationships work the way they do (Skemp, 1986). The development of conceptual and procedural knowledge should be done in concert since the comprehension of one supports the other as suggested by Willingham (2010). The weakness of using a single approach or one-size-fits-all model of teaching mathematics results in the neglect of that particular model's weakness and the relative strengths and co-dependence of other models. Aaron suggested that procedural understanding appeared to be the main target using ET. Our experience is that teaching models that represent a more or less one-size-fits-all approach like the ET model that Aaron was mandated to use does not necessarily enhance student inquiry and active participation in problem solving and mathematics investigations in challenging and engaging ways. We intend to build on a recent *Mathematics by Inquiry* (n.d.) program funded by the Australian Government Department of Education and Training that amplifies existing approaches to teaching mathematics through structured and purposeful investigations of mathematical and realistic contexts. Our approach will also need to reflect Adam and Chigeza (2014) who propose for developing of pedagogic dexterity with pre-service teachers that is characterised by (a) an understanding of the interdependent and relational nature of different pedagogies, and (b) the relational, contextual, and evaluative application of these pedagogies for effective learning.

The Need to Bridge Different Priorities Existing between Schools and University

There is need to build a bridge and align the learning processes that pre-service teachers experience in teacher education programs with the learning outcomes they achieve in the practicum spaces in the different sectors of the education system. While a teacher education institutional focus can be on designing of subjects that draw from research literature in mathematics teacher education and meet the QCT and APST standards for accreditation, we suggest that alignment between the pre-service teacher education program and practicum schools' specific pedagogical practices is paramount. This alignment should target contemporary pedagogical approaches in State, Catholic and Independent school sectors.

Aaron highlighted the mismatch between the pedagogical practices researched and used in the hypothetical classroom at university and the explicit pedagogical practices expected within a public FNQ classroom. There is need to develop strategies for pre-service teachers that shape their thinking about the roles of mathematics research literature, the QCT and APST standards, and the needs of the different school sectors. Our approach as teacher educators needs to optimise the need for complementary aims when designing teacher-centred/ student-centred, transmission/ discovery, explicit teaching/ inquiry lessons that align with the needs of schools in FNQ. A new set of pathways need to be developed with our pre-service teacher so they can opt into teaching models that suit the needs of schools in FNQ. Teacher educators and pre-service teachers need to work through these spaces and develop critical and evaluative skills so as to interrogate and navigate the seemingly different priorities between QCT and APST standards, teacher education programs and needs of particular schools in FNQ.

Teacher education needs to articulate more clearly frameworks that enhance pedagogical fluidity so that pre-service teachers can draw on to maximise classroom mathematics practice that enhance mathematics understanding. Such pedagogical frameworks can position the mathematical actions or proficiency strands as parts of the same whole and enables pre-service teachers to help their students during teaching practice to develop "the confidence to use the familiar to develop new ideas, and the "why" as well as the "how" of mathematics" (National Curriculum Board, 2009, p. 6). Our position is that pre-service teacher education programs can explicitly enhance pre-service teachers' ability to incorporate, draw on and draw out each of the mathematical actions or proficiency strands and thrive in a mathematics lesson.

Optimism to Change the Approaches to Assist Students

Pre-service teacher education can better prepare future teachers to develop the knowledge and competence to incorporating each of the proficiencies or mathematical actions (Kilpatrick et al., 2001; Watson & Sullivan, 2008) successfully in mathematics lessons. The *Australian Curriculum: Mathematics* makes the point that:

> *Mathematics provides students with essential mathematical skills and knowledge in Number and Algebra, Measurement and Geometry, and Statistics and Probability … It encourages teachers to help students become self-motivated, confident learners through inquiry and active participation in challenging and engaging experiences. (ACARA, 2013).*

Sullivan (2011) suggests that incorporating the proficiencies into school-based mathematics activities is a challenge facing many mathematics educators. Our experience is that designing teaching models that addressed all the proficiency strands and also address the explicit pedagogical practices expected within some public FNQ classrooms is not a straight

forward process. The explicit teaching model as experienced by Aaron limited the development of some of the proficiency strands. Our position aligns with Willingham (2010) who argues that mathematics concepts and procedure should be taught in concert; as well as Adam and Chigeza (2014) who propose for pre-service teachers to develop the understanding of the fluidity of the classroom context, with an adaptive ability to change pedagogical approaches accordingly to maximise learning.

The fourth year mathematics education subject pushes pre-service teachers to explore the different types of mathematics teaching approaches. However, the subject also needs to address issues raised by Aaron and other pre-service teachers in a similar position who have focused on a dominant pedagogical approach from their third year professional experience. The optimism is for teacher educators to acknowledge the pre-service teachers' imperative to be work ready within the broader philosophical underpinnings of the subject. The challenge is to balance that the pre-service teachers are seeking to be employable in the local setting using a dominant pedagogical approach with the need to prepare teachers who will address all aspects of the *Australian curriculum: Mathematics.* The motivation is for pre-service teachers to develop pedagogic dexterity that enhance mathematics understanding as indicated by the quality and quantity of connections that their students will make between new and existing mathematical ideas within the school's mandated teaching model.

Conclusion

The auto-ethnography process has enabled us to reflect on our practice for future implications in three areas. The first involves the need for critical reflection in using a single teaching approach. There is need to interrogate teaching models that represent a one-size-fits-all approach like the ET model and how they do not necessarily enhance inquiry and active participation of students in challenging and engaging ways. The second involves the need to bridge different priorities existing between schools and university. There is need to articulate frameworks that enhance pedagogical fluidity in our practice with pre-service teachers to maximise their classroom readiness that enhance mathematics understanding of their students. Thirdly is the optimism to change the approaches to assist students. We have explored the need for curriculum models to be more responsive through several layers and pathways of support. There is need to align the learning processes that pre-service teacher experience in our teacher education program with the learning outcomes they achieve in the practicum spaces in different sectors of the education systems. The auto-ethnography process has highlighted the importance of placing the needs of practicum schools at the heart of our mathematics education subject designs. Our hope is to encourage further research that aligns the learning processes that pre-service teacher experience in teacher education programs with the learning outcomes they achieve in the practicum spaces in different sectors of the education system.

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