

Citation

For changing pre-service teachers' mindsets to enable effective and passionate teaching of mathematics in early childhood settings.

Overview

Australia continues to return poor results against global ratings for students' achievements in maths and science. Reports repeat the same message: "Australian performances in mathematics and science have stagnated over the past 20 years... In global terms, Australian educational levels are still what they were late in the last century" (Thomson, Wernert, O'Grady & Rodrigues, 2016). The Australian Curriculum, Assessment and Reporting Authority (ACARA) noted only 55 percent of students nationally were judged as being proficient in science (Robinson & Griffith, 2017). The problems have been identified as emerging as early as year 4: "Australia's average score [for year 4] was significantly lower than the average scores for 21 other countries, including Northern Ireland, Ireland, England and the United States, as well as the participating Asian countries Singapore, Hong Kong, Korea, Chinese Taipei and Japan" (Thomson et al., 2016). This year in a report released by the Office of the Chief Scientist it was noted: "A key step is to employ teachers who are genuinely enthusiastic about teaching mathematics. ... if a teacher was enthusiastic about teaching mathematics—not just the subject itself—then their students found learning mathematics easier" (Smith, Ladewig & Prinsley, 2018).

A number of problems have been identified as contributing to this 'disturbing picture' of Australia's global ranking. One is the lack of specially trained teachers (Timms, Moyle, Weldon, & Mitchell, 2018) and another is the way in which maths is taught (Hattie, 2016). Over recent years there have been tensions concerning the erosion of play and demise of experiential learning (Barblett, Knaus, & Barratt-Pugh, 2016). Therefore, my role in preparing pre-service teachers for employment is critical. It is essential to model appropriate pedagogies to equip students for their futures as effective maths teachers.

After graduating with a teaching degree in 1977 and working as a kindergarten teacher, I have continued with the philosophy to be the best teacher I possibly can and to have a positive impact on the students I teach. Forty years later, I may be teaching a different age group of students but I still have the same driving goal, to inspire and transform lives. For the last seven years, I have coordinated the mathematics teaching programs in undergraduate and postgraduate courses in the School of Education, Early Childhood program at Edith Cowan University (ECU). This includes teaching mathematics to an average of 470 pre-service teachers each year. During this period, I have written and coordinated learning and teaching of many units for both on-campus and online delivery, researched in the area of mathematics learning and teaching, and written a widely adopted text on Mathematics teaching.

During coordination of mathematics programs at Edith Cowan University (ECU) I have recognised several issues that impact on pre-service teachers and their learning. One of these concerns is the negative attitude towards mathematics. A positive attitude is imperative for the implementation of high quality teaching and learning yet many pre-service teachers suffer from mathematics anxiety - a feeling of fear, tension or apprehension. This is not uncommon and can be attributed to the students' own experiences of learning maths (Chen, McCray, Adams and Leow, 2013). Recent research I conducted (Knaus, 2017) found that of 21 practising teachers only four felt confident to teach mathematics in early childhood, mostly due to negative experiences they had experienced at school.

Category: 1. Approaches to teaching and the support of learning that influence, motivate and inspire students to learn.

Three major issues have been described; the negative perceptions of mathematics, alarm surrounding the lack of STEM trained teachers, and the threat to experiential learning for children. To meet the demands of these current issues I have adopted three key approaches to impact the learning of pre-service teachers destined to teach mathematics. They are the use of metacognitive reflective tasks, mindset theory and experiential learning.

Metacognitive reflective tasks

Metacognition is an important first step in recognising strengths and weaknesses in order to grow and learn. Pre-service teachers are asked to reflect on their previous experiences and what they feel and think about

mathematics. They write their reflections on a blog on Blackboard and it becomes a collaborative sharing experience where they begin to understand their own learning in relationship with other people's learning experiences. From one cohort of 59 pre-service teachers this semester only 17 reported positive experiences, 28 described negative experiences while 14 had mixed responses. Examples of these experiences include. "My feelings towards Mathematics in my primary school years is of fear, hate, and probably boredom. I was an 80s/90s primary student and back then the focus when teaching mathematics was definitely rote learning." "I unfortunately developed a strong dislike for my mathematics over my schooling years, however I am now looking forward to developing and strengthening my skills and knowledge in mathematics through this unit." "I liked mathematics as a young student. I strongly believe this was due to my teacher's teaching style who was equally supportive and challenging with her young students. I believe in the environment where mistakes are allowed and new opportunities for learning created from the mistakes made" (Year 3 Student Reflections 2018).

It was common to read that student attitudes were shaped by their school experiences and often it was teachers who had the most impact. Knowing this helps them to realise the important role they will have when teaching and how their attitudes and practices will affect the children they teach. A meta-analysis of 26 studies across primary and secondary pre-service teachers showed the relationship between fear of mathematics and achievement (Ma, 1999). It is my aim to minimise this influence by transforming fear into confidence to reduce the anxiety of pre-service teachers.

Metacognitive reflective practice fosters development by stimulating curiosity and independence in learning. Reflections written towards the end of their study reflected this development. "Thank you for making maths into such a positive engaging experience for me. I have really enjoyed this unit 😊 I am becoming confident in my abilities to teach mathematics" (Year 2 Student Reflections 2018). "I know this is a bit out of the blue, but I just wanted to e-mail you to show my appreciation for the 2 maths units that I have participated in in the last two years. I myself never had maths anxiety as a student in primary school or high school, but I was very concerned and nervous about how to teach maths to students in an effective way because there is so much content and so many different ways of teaching it. Especially after the maths unit this semester, I went into my 3rd year practicum in a Year 2 classroom 2 weeks ago feeling confident and very excited to teach maths and it has shown - my mentor teacher has given me such good feedback about all the maths ideas I want to implement in the upcoming weeks, and was very impressed that I was able to independently unpack curriculum content descriptors and make a range of hands-on activities when all she gave me was a topic" (Year 2 and 3 student feedback email, 2017).

Mindset theory

My next approach to guide learning and to implement a change in negative perceptions of mathematics is to adopt the theoretical model of mindset introduced by Carol Dweck (2016). Growth mindset is a social cognitive approach to motivation, achievement and success. The theory proposes that those with a fixed mindset believe their intelligence and abilities are fixed and cannot be changed. Those with a growth mindset (or incremental view) see intelligence as malleable, view mistakes as fundamental to the learning process and will accept and persevere when faced with challenges and adversity. Throughout lectures and tutorials mindset theory has been explained and modelled with particular emphasis on: understanding theories of intelligence, realising that there is no such thing as a mathematics person, everyone can learn mathematics; believing in yourself and applying hard work as it is a growth subject and takes time to learn; providing positive affirmation and environmental cues while engaged in hands on mathematics tasks; knowing that mistakes are valuable and help to grow your brain and awareness that mathematics is about creativity and creating solutions. Mindset theory is promoted for pre-service teachers, not only for their own personal development but also to implement this theory with children in their classrooms after graduation.

In 2017, I undertook a personal teaching evaluation with a cohort of 44 mathematics pre-service teachers. While all agreed that mathematics is important for life, over half of the participants reported they did not previously enjoy mathematics. The results indicated that introducing mindset theory encouraged engagement and enthusiasm for learning. "I was never someone who felt good about their mathematics skills and I always dreaded maths and Marianne has really changed that mindset in myself and I really like the way she fostered the mathematical mindset, that's really important with children" (Year 3 formal student survey, 2017).

Experiential learning

Another strategy I use is to model the pedagogy of experiential learning (Kolb and Kolb, 2017). Every tutorial in my maths units are based on hands-on practical experiences using concrete materials demonstrating and modelling how to teach mathematics in an early childhood setting. This is combined with using the relevant language of mathematics making the links to the concepts and matched to a developmental progression through practical experiences. Student feedback has always been positive using this teaching strategy, providing guidance, motivating others and developing enthusiasm for learning demonstrated in these two examples. "LOVED THIS UNIT!! I have walked away with so many practical and hands-on ways to teach different mathematical concepts to children of different ages. I learnt so much and really built up my confidence with maths. Thank you!!" and "The broad experience of the lecturer made the content delivery of this unit so easy to understand. All fear and barriers in relation to mathematics were broken down as we

were exposed lecture by lecture to the real world of mathematics and how we can apply to real life situations and experiences at all times" (Year 2 formal student survey, 2018).

I have consistently gained high scores from student responses in the Unit and Teaching Evaluation Instrument (UTEI) as shown in Figure 1. Since 2014, analytics of UTEI scores demonstrate a much higher lecturer and tutor Mean compared to ECU and School of Education (SED) results. In addition, when I introduced growth mindset practices in 2017, I received letters of congratulation from the Dean and Associate Dean (Teaching and Learning) for all units taught.

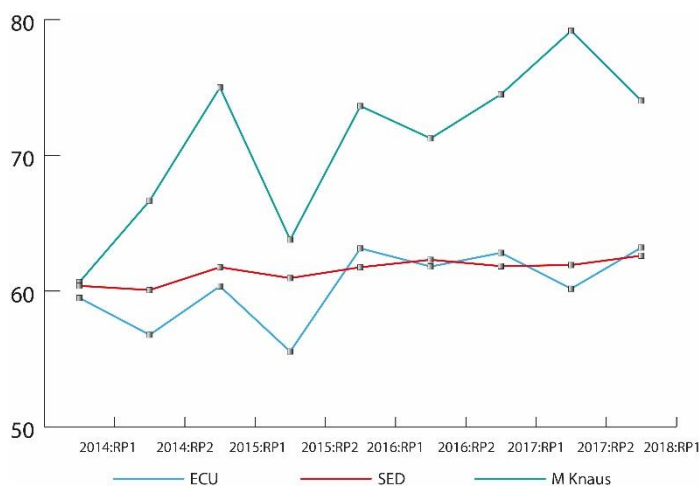


Figure 1: Student satisfaction ratings 2014-2018

Local, national and international Impact on pre-service teacher learning and on practicing teachers now working in the field

The strategies I employ work in an integrated way to enhance the learning of the students and help develop the quality maths teachers so desperately needed. I am recognised as a discipline expert in early childhood mathematics. I have been invited as a keynote speaker at conferences nationally and internationally speaking on both mathematics and STEM. I also have a solid record of peer reviewed journal articles. I have written a

maths textbook (Knaus, 2013) to align with the Early Years Learning Framework which is a prescribed text for 15 universities across Australia, as well as TAFE students and many early childhood practitioners. On request I have written a corresponding text that aligns with the UK curriculum (Knaus, 2015) which is widely used in Britain and have been asked to produce a NZ based equivalent text. I have a solid record of peer reviewed journal articles.

Apart from the numerous self-reported positive student experiences, the enhanced learning is clearly indicated by the improved distribution of marks over the years since the strategies have been introduced as shown in Figure 2.

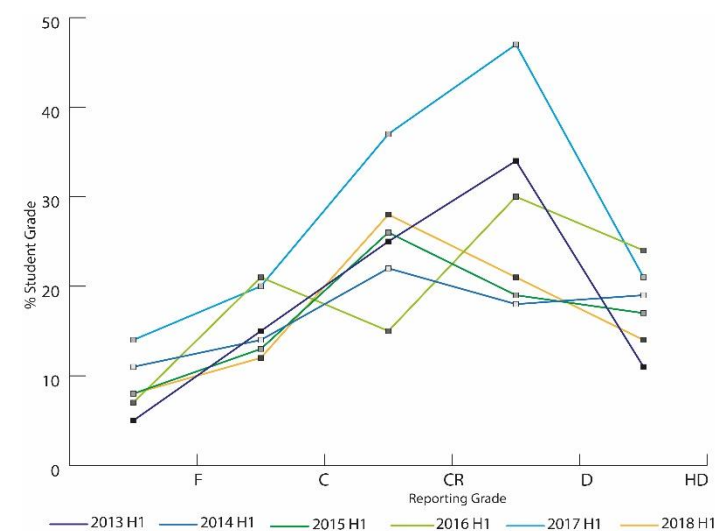


Figure 2: Grading curves 2013 - 2018

In summary, introducing metacognitive reflective thinking combined with knowledge of growth mindset and experiential learning has made an impact on pre-service teacher learning in early childhood mathematics education. The following quote is one example: "Well it has been six years in the making and I have finally made it through, I am actually a teacher! I just wanted to thank you for your guidance throughout my journey.

You are the teacher I will remember as having the greatest impact on my learning. Your help has been greatly appreciated.” (Student email 2015) This is overlaid by my own passion for teaching which I believe inspires pre-service teachers to like mathematics and to become effective teachers, evidenced in this email: “I had my first supervisor visit this week on my ATP and it was for a numeracy block. The feedback from my supervisor was so incredible and honestly I just wanted to thank you for helping me and teaching me everything! Who would have thought I would love teaching maths this much” (Student email 2015).

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