Review to **Achieve Educational Excellence** in Australian Schools

Public submission made to the Review to Achieve Educational Excellence in Australian Schools

Submitter: Dr Stephen Norton

Submitting as a: Academic person or institution, lecturer in mathematics teacher education

State: Qld

Summary

Teacher preparation in Australia is in need of significant reform. The past few decades have seen us graduate teachers ill equipped to engage students and support their learning of mathematics. This has been particularly acute in primary teacher preparation, but significant reform is needed in middle and senior mathematics teacher preparation. The critical variable is that many graduates enter classroom practice with a poor understanding of the discipline, and thus cannot enact effective pedagogy. The problem has arisen from the evolving nature of teacher preparation programs away from a government supported and monitored "nation building" goal to that of an enterprise. Universities and individual academics have responded to market demands within the frameworks of accountability mandated by statutory bodies. Changes in academic governance are needed to ensure we are graduating teachers who can support the learning of our children.

Main submission

Introduction

This submission is concerned with only mathematics learning. The insights come from my 14 years of teaching mathematics in schools and 21 years of preparing teachers to teach mathematics in several schools of teacher education. I have remained classroom active during the past two decades. There are four areas to be addressed; culture, the nature of mathematics and its teaching, teacher preparation and academic governance. The focus is on the last three in this list since culture is the most resilient to alteration.

It needs to be recognized that there are cultural factors that support or inhibit student learning. Negative cultural factors are usually concentrated in economically disadvantaged or English as a second language communities. Positive cultural factors tend to be exemplified in economically advantage communities and in particular

cultures that have a high value for academic learning. In Australia these subcultures include students of East Asian and Eastern European migration as well as affluent professional citizens of diverse heritage. Negative dispositions towards learning can be manifested by the following behaviors; absenteeism, non-completion of homework, disengagement in class time and disruptive classroom behavior. Schools have a role in changing culture. Indeed schools are critical for cultural shift, but it is a long term project. The focus of this submission is upon what can be achieved in the short and medium term. The key is to have graduate teachers who are classroom ready. First, to give a better understanding of what is needed in teacher preparation, a brief background on what mathematics is will be discussed.

What is mathematics?

Mathematics is a hierarchical body of specialist knowledge. Almost every modern mathematics syllabus recognizes this. Mathematics is best learned in sequence. This sequence typically begins with whole number numeration, computation, and problem solving, followed by fraction naming and renaming, computation and problem solving. Subsequently, proportional reasoning across the strands (rate, ratio, scale etc.) is then followed by linear algebra (naming, renaming, computation, and problem solving) then moving onto calculus. The point is if children miss foundations at any stage, the next stage becomes very difficult. Mastery at each stage is critical, a fact well recognized by East Asian systems. This may seem an obvious factor, but the evidence from NAPLAN indicated that it is very poorly attended to across most of Australia.

A further very important factor in regard to learning mathematics is that a great deal of detail needs to be stored in long term memory. The Australian curriculum recognizes this and has an entire strand termed “fluency”. This means children have to have facts and processes stored in long term memory starting with addition and subtraction facts, multiplication facts, computation conventions, algebraic conventions and so on. Without this critical detail committed to long term memory for ready retrieval, students cannot compute let alone problem solve or become creative with their mathematical knowledge. There seems to be a bit of resistance to expecting children to remember a lot of facts and processes and this is related to the view that they are lower order aspects of thinking.

Failure to fully appreciate the hierarchical nature of mathematics and commit the foundations to long term memory largely explains why we have so few students in the top bands in international testing and so many falling behind basic standards. Importantly, very significant proportions of children graduate from primary school without the tools to cognitively engage with mathematics. In order to preserve some sense of self, the natural response is to call mathematics “boring” and or become disruptive. The answer is not to attempt to make mathematics entertaining and fun or even authentic. Making it fun and authentic is ok, but ultimately children need to

be able to understand mathematics. This means some hard work is needed. To a considerable degree the hard work aspect has been neglected in Australian schools and part of the lowering of expectations comes from a shift in epistemology in teacher training.

What is needed to be a good teacher of mathematics?

To be a good teacher the individual has to be able to communicate with and manage students effectively. Things like; ability to read body language, manage people, show empathy to children, problem solve in human interaction situations and situational awareness are essentially primary skills. To a very considerable degree these are forms of primary knowledge that do not need to be taught at university. In most instances in most classrooms, without these primary abilities and skills a teacher will find it hard to engage and manage students. Unfortunately, primary skills alone are not enough to be a competent classroom teacher of mathematics and this becomes increasingly apparent the further up the grades the teacher is teaching. In addition to primary communication and management skills teachers need knowledge of their discipline. They need to have a very deep and connected knowledge of the mathematics they are teaching and a few years beyond this. This is called mathematics content knowledge for teaching (MCKT). They also need to know how to unpack the various mathematical structures with a range of specific models and language. This is called mathematics pedagogical content knowledge (MPCK). Finally they have to be able to assess mathematics effectively so they can plan remediation; this is called mathematics assessment and planning (MAP). Needless to say, no amount of primary communication skills can compensate for a deficit in any of these three key attributes and all depend on a deep knowledge of mathematics. Here lies the problem and the solution, at least as far as teacher training.

Improvements in Primary Teacher Discipline Preparation.

Primary teachers:

In the past we have accepted into primary teachers training significant portions of candidates with very significant deficits in personal mathematics knowledge and often this is associated with low confidence and self-efficacy, and this continues to be the case. The recent move to insist on a pass at year 12 will have minimal effect. The vast majority of our intake have already completed 12 years of high school maths, but only a small portion have good grades in higher level mathematics such as mathematical methods or specialist mathematics. Good grades in subjects like Mathematics B, or Specialist Mathematics or Mathematical Methods that have considerable portions of calculus are a much better predictor than a pass in general mathematics. Not because calculus is necessary to teach counting, but because it is a good indicator or mathematical knowledge and mathematical aptitude. Further, the basic numeracy test for teachers (from what we can see) is a very low bar. In fact,

while children are expected to be fluent with and without a calculator, trainee teachers can use a calculator for nearly all the problems. From what we can see of the test it looks more like a general numeracy test rather than a test to see if the pre-service teachers have the necessary content, understanding and fluency expected of the children they will soon teach. In summary the current test looks like a non-event, a political stunt.

In my refereed papers since 2011 I have set out the evidence that the current models of teacher preparation are not effective. At intake, and frequently at exit, primary pre-service teachers are particularly weak in multiplication, division, fraction work of all forms, proportional reasoning and any algebraic reasoning. Without a deep and connected knowledge of this content, teachers are unable to apply the pedagogical theories they learn in tertiary settings. The evidence suggests that about a third graduate with a satisfactory level of upper primary content, about a third have the aptitude to learn this readily if given the opportunity and about a third would probably rather not teach upper or middle primary mathematics and would need considerable learning support to understand the material that has eluded them for their entire academic careers to date. My data comes mostly from one University. However, this institution has a very good reputation and is in full compliance with the regulatory body of the State Queensland College of Teachers (QCT). It is not creditable that the data is unique to the institution, further; other academics have published similar concerns based upon data from other institutions in other States.

It is worth examining the structure of teacher education at both a program and course level. Bar a few exceptions, review of program structures indicates that, at best, primary teachers have three mathematics related courses where any deficit might be remediated. The delivery mode (face to face vs online) is variable as is the time allocated. This semester I delivered a mathematics 10 credit point course over 20 hours in 5 weeks. Some courses are completely online. If students have not understood this material after 12 years of schooling it is very optimistic to think they can be transformed in a few weeks of online engagement, particularly if knowing the mathematics is not a focus of the course. A review of assessment protocols across Australian institutions suggests that in the main pre-service teachers can pass on the basis of essay writing and construction of a limited number of teaching resources.

Middle and senior secondary teachers

The situation with respect to enrollment of middle school teachers is less critical, since in order to teach middle school the trainee teacher needs to have shown completion of between four and six mathematics courses. Still, because these courses were completed so long ago (many in the graduate or masters pathway), either the material has been forgotten or was never understood deeply. In addition, much of the mathematics content taught in the university courses completed by our

entering middle and senior trainee teachers is beyond or irrelevant to the teaching of senior high school mathematics. Thus, I am finding significant portions of the intake having shallow understanding in the mathematics they will soon be teaching (mostly; fractions, basic algebra, quadratics, surds, calculus and statistics). Unfortunately, a review of teacher education courses across the nation indicates that there is little or no attempt to account for this deficit during teacher preparation. As above, you can see the evidence in course profiles and assessment schema that focus on essay writing and preparing specific resources. Trainee teachers are not required to demonstrate that they know the mathematics they are expected to each without access to Wi-Fi. Further, for the graduate entry the only preparation opportunity for trainee teachers to learn middle years curriculum is one or two mathematics curriculum course of limited duration. The undergraduate pathway is better placed as far as knowing the mathematics.

Academic governance

This section looks at the governance factors that have facilitated short cuts in teacher preparation. This is a complex question that involves both institutional and individual academic considerations. From the institutional side, various authors point to the political ideology of neo-liberalism and the retreat of government from interfering and closely managing teacher training. The theory goes that the market will sort out the quality issues. Well, the market is not working to do so. As enterprises the universities are in competition with each other to attract clients, and part of that process is to offer cheap and convenient courses. Further, schools of education are seen as a cash cow for the university with up to 60% of student fees and government allocated support for trainee teachers being taken by the university for overheads and to support of projects and research that is seen as more likely to enhance the reputation of the institution. Schools of education are under pressure to cut costs and one response is to increasingly truncate lecture and workshop time. In addition, the increases in student fees and truncated courses have motivated most of my students to take on part-time and even full- time jobs while studying. These commitments impact on the attention they can devote to leaning to teach. It is not unexpected that you have to lower expectations if the pre-service teachers are working, and have limited time to allocate to learning mathematics or how to teach it. Universities are operating predictably within the market and governance constraints set by government.

Individual teaching academics are motivated to do what is in their best interests. The typical teaching academic has a load split 40% teaching, 40% research, and 20% service. As far as promotions and job security are concerned, the latter two are the critical. You must publish and be seen to be working on committees and so on, but frequently these activities have little relevance to developing classroom ready teachers. The least important variable is quality teaching, in part because of the way

it is measured. The only reported measure of any teaching is Student Evaluation of Course (SEC) or its equivalent. This is voluntary and occurs around assessment time. If students are happy, positive evaluations are returned and no questions are asked. Academics soon learn there is a strong relationship between the grades they hand out and the SEC. It is not uncommon for the average assignment mark to be 50/60 and for there to be a dominance of high distinctions and distinctions even if the trainee teachers cannot do the mathematics they will soon be teaching. A further consideration is that administrative protocols make failing any student an unwanted burden for the individual academic. Re-mediating any discovered deficit would be costly for the institution. A good way to avoid finding out if your students are lacking in basic knowledge is to avoid testing them to a reasonable level during their courses. I think this is almost the uniform practice across mathematics curriculum courses across Australia. In fact, as far as middle school and senior school courses go, I think my courses are an anomaly in testing the pre-service teachers for a reasonable level of mathematics knowledge and using it as a part of their grade.

A further variable is accountability mechanisms related to academic standards. Internal audits are “tick the box”, as are external audits. Just about anything and any spread of marks is accepted, and actual tests or samples of student work are not evaluated. Internally, the task description, marking criteria and spread of marks are given a quick look over usually by someone who knows little about mathematics education. In 21 years of lecturing in mathematics teacher education I have never had to submit a test or sample of student work to the accrediting body (QCT), nor am I aware of any other academic who has had their assessment audited effectively. Rather, course profiles are carefully analyzed. These are a promise note, but a very poor indicator of actual standards. So, without any effective oversight of quality, SEC considerations take further priority.

Fixing accountability

The problems above are not easily fixed. At the tertiary institution level, the ground rules need changing. Voluntary SEC needs to be decoupled from academic advancement. It would help if completing SEC’s were compulsory since we could at least be assured the data was representative. I cannot think of a plan or pathway that would encourage academics to work together to expect more from trainee teachers since, at present, it is not rewarded. There is just no incentive to the individual academic at this time, and there is no perceived need for the school administration to intervene. My discussions with academics in other institutions suggest the situation is endemic across Australia.

Currently accrediting bodies such as QCT do not have the resources nor the skill set to adequately audit mathematics teacher preparation courses. You would probably have to replace the governing bodies and current staff and reconsider funding in-order to effect change. Bringing in reputable mathematics heads of departments

from high schools to audit teacher education programs might be a more constructive approach. A few selected university based mathematics academics and a few selected mathematics teacher educators could provide some balance. The problem is that if you draft in teacher education academics from the current system you are drawing from the same pool that have enacted the current standards. However, if you do make structural changes in regard to course and program accountability mechanisms, this might filter down and motivate teaching academics to re-focus.

Fixing primary mathematics teacher preparation

The most efficient way to fix primary teacher preparation is to make primary teaching of mathematics a teaching speciality. Six or so 10 credit point courses focused on developing mathematical understanding and specific pedagogy would go a long way to improving our graduate preparedness. Of course you need to ensure the focus is on mathematics and its teaching and not less substantial side issues. You will need measures of quality control that encourage this focus. An added incentive is to pay primary mathematics specialists a bonus. This of course has to get past the teacher's unions. China has primary mathematics specialists and I can assure you they go into classrooms very well prepared to teach structure. In fact, graduating Vietnamese teachers have, on average, much stronger discipline knowledge when they enter classrooms and they are generalist primary teachers. The argument that we need generalist primary teachers to account for the emotional welling of the child is not backed by evidence.

Fixing secondary mathematics teacher preparation

The current selection mechanisms are reasonable. However, the value adding of tertiary mathematics curriculum courses is questionable, especially related to knowing the mathematics to be taught. I would like 80 hrs as a minimum for middle school mathematics teacher preparation. Mathematics curriculum courses need to account for the teacher's mathematics knowledge and, to facilitate this, changes in accountability need to occur. We are also facing a challenge in attracting quality teachers into mathematics. Increases in status, work conditions and pay will assist in this process.

Concluding comments

I have spoken little about guiding neither epistemology, classroom behaviors and curriculum structure. I have focused on improving Australian children's learning opportunity by preparing and graduating more effective teachers. We have many brilliant teachers in classrooms, but the role of teacher preparation has not been as effective as it could and should be. Evidence for the assertions above is well evidenced in my refereed publications or is in press.