PORTFOLIO COMMITTEE NO. 3 – EDUCATION

INQUIRY INTO MEASUREMENT AND OUTCOME-BASED FUNDING IN NEW SOUTH WALES SCHOOLS

29 November 2019

Question on Notice: Kim Beswick

QUESTION 1:

The CHAIR: Out-of-field teaching? Yes, what is that?

Professor BESWICK: It affects more low socio-economic status schools, which are often also rural schools. That clearly disadvantages the kids in those schools. It is a huge problem. I think to date we have tried to redress it with just fairly small, short-term professional learning programs, whereas what I believe is really needed is large-scale sustained retraining of teachers. It is because those out-of-field teachers who are not trained to teach mathematics and whatever are doing the best they can but they do not have the background. It is a big job to give it to them, which we cannot overlook.

The Hon. ANTHONY D'ADAM: Another inquiry, perhaps.

Professor BESWICK: I do not know that we need an inquiry. I could tell you how to fix it, but I just need the money.

The CHAIR: Send that through, too. We will take that on notice.

ANSWER 1:

I confine my answer to mathematics since this is my area of expertise.

There is consensus that teachers of secondary school mathematics teachers should have studied mathematics to at least second year university level AND should have studied one of more courses on teaching mathematics. Teachers in front of mathematics classes with less than this training are out-of-field. Up to 1 in 3 Australian secondary school mathematics classes are taught by a teacher who is out-of-field, that is a teacher who is not appropriately qualified to teach mathematics. Many teachers currently teaching mathematics in Australia have no university mathematics and no knowledge of how to teach the subject.

There is extensive research evidence of the problems caused out-of-field teaching. For example:

- Out-of-field teachers lack confidence due to lack of content and pedagogical knowledge (Hobbs, 2013)
- Out-of-field teaching places additional strain on subject coordinators and school administrators due to the extra support, mentoring and resources required (Hobbs, 2013)
- Short-term appointments (these teachers are often relatively new to teaching and accept out-of-field teaching roles because of a lack of alternatives), devotion to preferred subject area (not maths), lack of autonomy, lack of time or support, or simply lack of interest or motivation, can make it difficult for the out-of-field teacher to embrace this pedagogical imperative and thus cater to student learning needs (Hobbs, 2013)

- Highly qualified teachers have a greater impact on student achievement than other variables including student background and class sizes (Darling-Hammond, 2000, 2002; Hattie, 2003)
- Research consistently shows that there is a positive relationship between teacher academic proficiency and learner achievement (Goldhaber & Anthony, 2003:4; Ringstaff & Sandholtz, 2002)
- Learners whose teachers know their subjects perform better than learners whose educators lack core knowledge of the subject they teach. Further, out-of-field teaching has been associated with teaching practices of insufficient quality, resulting in the de-professionalising of educators and contributing to teacher attrition (Du Plessis 2005).
- Students learn more if their teachers hold productive beliefs both about mathematics and about learning mathematics (e.g., Philipp, 2007; Staub & Stern, 2002)
- Out-of- field teaching can mask the realities of teacher shortages (Thomas, 2000; Webster et al., 2006)
- Out-of-field teachers lack the foundational knowledge on which to build their knowledge and skills for teaching maths (Du Plessis, 2018)
- The ways in which schools are organised and operated, and how teachers get assigned within that system, contribute to out-of-field teaching as much as supply (Jerald & Ingersoll, 2002)
- Out-of-field teaching results from factors associated with teacher supply and demand, system-wide appointment processes and school-based decision-making. It is magnified in specialist curriculum areas and difficult-to-staff locations (Sharplin, 2014)
- Teachers hate to teach out-of-field (Jerald & Ingersoll, 2002)
- Out-of-field teaching makes lesson preparation much more time-consuming and classroom instruction more frustrating (Jerald & Ingersoll, 2002)
- Out-of-field teachers are more prevalent among high-poverty schools, and teacher assignment policies within schools often pair the least-experienced teachers with the most challenging students (Kalogrides, Loeb & Betelle 2011, cited by Hill & Dalton, 2013)

Solving out-of-field teaching will require sustained attention to recruitment, re-training and retention of well-qualified mathematics teachers.

Recruitment: Out-of-field teaching, and other factors, has contributed to uninspiring teaching of mathematics in schools and hence the pipeline of students studying demanding mathematics in senior secondary schools and then at university has been declining for years. Prospective mathematics teachers are also affected by the ambient negativity about teachers and teaching in general, but arguable to a greater extent than prospective teachers of other subjects they have options – most of which are more prestigious and financially rewarding. Consideration of scholarships, employment guarantees etc would help. Addressing the general status of teaching would also help to recruit mathematics teachers.

Re-training: This needs to be much more than professional learning that provides out-of-field maths teachers with pedagogies for teaching mathematics. What is needed is fulsome re-training that includes the study of university mathematics to year 2 and courses in mathematics pedagogy. Many out-of-field mathematics teachers would not be able to succeed in first year university maths without support (I have heard this used as an argument that re-training should not include university mathematics. On the contrary it is a further indictment of the situation in which these teachers have been placed) so preparatory programs and intensive support would also be needed. There is a model of the sort of thing needed in Ireland (Goos, Riordain, Lane & Faulkner, 2019).

Retention: Well-qualified graduate maths teachers readily find employment; schools able to recruit most quickly (often independent schools) attract these teachers more easily. When well-qualified teachers of mathematics experience situations that are common in the early years of a teaching career (e.g., short term contracts, less desirable class assignments, lack pf permanence) they may be better placed to find alternative work than many other teachers and hence less likely to persist with teaching. Being the only qualified teacher in a school can add to both workload and a sense of professional isolation. Fast-tracked permanence for well-qualified maths teachers would be sensible.

Teachers being re-trained would need substantial time off class (approximately 0.5 FTE for at least 2 years). Immediately employing satisfactory well-qualified graduates, even if they are 'surplus' at the time and pairing them with one of two re-training teachers could be useful strategy to support retraining and retention.

I include with this answer the short analysis from the Australian Mathematical Sciences Institute by (Prince & O'Connor, 2018) of what would be needed to address out-of-field teaching in maths in 5 years or 10 years.

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AMSI Occasional Paper 1

CRUNCHING THE NUMBERS ON OUT-OF-FIELD TEACHING

Professor Geoff Prince & Michael O'Connor
Australian Mathematical Sciences Institute | November 2018

Crunching the numbers on out-of-field teaching in maths

Out-of-field teaching in mathematics is a deep and difficult problem in Australian secondary schools. It is estimated that between 21 percent and 38 percent of Year 7-10 maths classes are taught by out-of-field teachers, depending on the definition[1]. Combined with the subject's other endemic problems, such as the 20 year decline in the proportion of students taking intermediate and advanced maths at Year 12 and the wholesale retreat from prerequisites by the universities, the future for the mathematics teaching workforce looks grim[23].

The modelling presented here indicates the depth and scale of out-of-field teaching in secondary mathematics. Seen through the lens of remediation, the problem will clearly take at least 10 years to fix even with a united approach from the Commonwealth, the States, the non-government sector and universities. Re-training current out-of-field teachers must be a large part of the solution and new thinking is needed to attract mathematical sciences graduates to teaching. This won't be cheap but the return on investment is priceless, while the consequences of avoidance are dire.

Out-of-field teaching in mathematics not only affects the learning outcomes of students, it limits our schools' ability to mount the intermediate and advanced subjects at Years 10 through 12 which lead to degrees in science, engineering, medicine and so on. It is worst in regional, remote and mid to low SES communities and is therefore an equity issue, not only limiting educational access but driving down adult numeracy. From an economic viewpoint it chokes the supply of mathematically and statistically capable professionals in an era of increasing demand.

Linda Hobbs has recently written of the complexity of the out-of-field problem[4], partly in response to recent comments by the former Minister of Education, Simon Birmingham, urging the universities to graduate more in-field teachers in mathematics and the sciences. Senator Birmingham wanted the problem solved in five to 10 years.

What is missing to date is a quantitative analysis of the issue, answering questions such as:

"What is the likelihood that your child will have at least one, two or three out-of-field teachers between Years 7 to 10?"

"What fraction of Year 7 to 10 students have an in-field maths teacher every year?"

"How long would it take to halve the out-of-field problem if recruitment of freshly trained graduates matched retirement of in-field and out-of-field maths teachers?".

"How many new, in-field teachers would be required to reduce out-of-field teaching to, say, 10 percent in five years? 10 years?"

"Can we solve the out-of-field teaching problem with new graduates alone?"

Our work at AMSI indicates that the supply of new graduates alone cannot solve the out-of-field problem on any acceptable time scale. Retraining of out-of-field teachers must be a major part of any approach. It is possible to estimate the scale of this retraining operation at the same time as we work towards graduating enough new teachers to match retirements.

SOME ASSUMPTIONS

The analysis here is based on some simplifying assumptions. It is intended to establish the scale of the problem and not provide the most definitive predictions.

First of all, we will assume that the retirement rate of out-of-field and in-field maths teachers is the same at approximately five percent[5]. It is, however, known that early career teachers do more out-of-field teaching than their older peers[6].

Secondly, we assume that the out-of-field rate in mathematics is constant across years and all jurisdictions at an indicative 30 percent. This corresponds to a definition of in-field teaching requiring one semester of study in the subject at second year[7]. As an aside, AMSI regards this level of preparation as inadequate, especially for teaching at Year 10 and above. Of course, these assumptions are only valid on limited geographic or socio-economic scales. And it may be that out-of-field teaching is more prevalent in Year 7 than in Year 10; more on this later.

Third, we will assume that maths takes up 18 percent of Year 7 to 12 class hours[8], so that teachers of mathematics, both in and out-of-field, make up 18 percent of the secondary teacher workforce. In 2017 the ABS[9] reported a full-time equivalent workforce of 135,526, meaning that the maths teacher workforce was 29,395 of which 7318 (30%) are out-of-field. We will assume that the total

1 Weldon, Paul R., "Out-of-Field Teaching in Australian Secondary Schools". ACER Policy Insights Issue 6, June 2016.

2 Wienk, M., "Discipline Profile of the Mathematical Sciences". Australian Mathematical Sciences Institute 2017.

3 "Improving Australia's Maths Grades". Australian Mathematical Sciences Institute 2017.

4 Hobbs, Linda, "Universities can help recruit more science and maths teachers, but they can't do it alone". The Conversation, July 20, 2018.

5 Willet, Mike, Segal, Daniel and Walford, Will. "National Teaching Workforce Dataset Data Analysis Report 2014" Commonwealth of Australia 2014.

6 Weldon, op. cit.

7 Weldon, op. cit.

8 Around 20% of class hours in Years 7 to 10 and around 16% in Years 11 & 12. This is less than the 20.9% estimated in the 2014 ACER Report "Staff in Australia's Schools 2013: Main Report of the Survey"

9 Australian Bureau of Statistics 2017 http://www.abs.gov.au/ausstats/abs@.nsf/0/9448F2F814FA0311CA2579C700118E2D?Opendocument

workforce size is constant, at least on the time scales considered here. The assumed 5 percent retirement/attrition rate means 1220 teachers of mathematics leave the system each year.

There are some critical facts that are not known (to us or anyone else, including the Commonwealth): the current national or State graduation rates of in-field mathematics teachers, and the percentage of new graduates who don't reach the classroom.

Finally, our thesis is that we should aim to match new, in-field teacher recruitment with in-field and out-of-field retirement/attrition. This is because our schools are fully staffed. So, if there is an under supply of recruits then out-of-field teaching will increase. Conversely, if there is an oversupply then new graduates and existing teachers will be out of work.

QUESTIONS AND ANSWERS

Let's start off with the questions requiring fewest assumptions:

"What is the likelihood that your child will have at least one, two or three out-of-field teachers between Years 7 to 10?"

"What fraction of Year 7 to 10 students have an in-field maths teacher every year?"

Assuming a conservative, uniform, national out-of-field rate of 30 per cent across Years 7 to 10, this question requires the use of the binomial distribution, well known to Year 12 students, with n=4 (the four 7 to 10 years thought of as trials) and p=0.3 (the probability of having an out-of-field teacher in any one year).

The answers are: there is a 76 per cent chance of at least one out-of-field teacher, 35 per cent for at least two and 8 per cent for at least three years of out-of-field teaching.

Less than one in four Year 7 to 10 students have an in-field maths teacher every year.

This is alarming – on average three quarters of Australian students are taught by an out-of-field maths teacher at least once in these important years and a third of them have at most two years with an in-field teacher. The flip side, that less than one in four students have a qualified maths teacher in each of Years 7 to 10, is a particularly stark reality, especially given the nonuniformity of out of field teaching.

Now, for reasons of pedagogy it may be better to get this out-of-field experience out of the way in Year 7 and 8 rather than in Years 9 and 10. Would this change the likelihood that a student would experience at least two years of out-of-field teaching? This is a harder mathematical problem, but it turns out that having equal likelihood at each year level minimises the overall likelihood of at least two (or three or four) years of out-of-field teaching. So, strategies like localising the out-of-field experience to earlier years will make the overall problem worse.

Now to the other questions. Firstly,

"How long would it take to halve the out-of-field problem if recruitment of freshly trained graduates matched retirement of in-field and out-of-field maths teachers?".

The answer to this is 13.5 years.

This calculation requires some undergraduate maths and we have assumed that out-of-field teaching is at 30 percent and the retirement/attrition rate of all teachers, both in-field and out-of-field, is 5 percent.

The result is also alarming, especially since we are clearly not now recruiting in-field teachers at anywhere near the rate of retirement. It would take 13.5 years of healthy graduations to bring out-of-field teaching to 15 percent, still a far from acceptable rate. And if we aimed to reduce out-of-field teaching to 10 percent it would take 21 years! If the rate is worse than 30% or fewer out-of-field teachers retire, then this half-life blows out even further. Both 13.5 and 21 years are outside the aspirational five to 10 year range!

So, what can we do to deal with the problem in five to 10 years?

"How many new, in-field teachers would be required to reduce out-of-field teaching to 10 percent in five years? 10 years?"

Our analysis shows

Answer 1: in relative terms we would have to recruit these teachers at 160% and 120% of the retirement rate per year respectively.

Answer 2: in absolute terms we need to recruit around 1900 and 1500 in-field teachers per year respectively.

The answer in relative terms is important for planning because it does not require the estimated current numbers of maths teachers in the system.

Given that recruitment of new graduates should match attrition and retirements, the conclusion is clear. We should retrain existing out-of-field teachers to make up the shortfall. This means for every thousand new graduates per annum we need to retrain an additional 600 out-of-field teachers for a five year solution and 200 out-of-field teachers per year for a 10 year solution. Of course, if the new graduate supply doesn't match retirements then we must retrain more out-of-field teachers.

But we really need some hard numbers because our universities and employers need to know the challenge they will face. The figures in Table 1 are based on the assumptions about the workforce size, etcetera, identified above. All estimates are rounded to two significant figures. In our view reduction of the out-of-field rate to 10 percent, even in 10 years, will be challenging.

Target out-of-field rate *(currently 30%)*	**Total recruitments** *required per annum including retrainees*	**New graduates** *required per annum to match retirements*	**Retrained teachers** *required per annum (% of current out-of-field workforce)*	**Total retrainees required over the time period** *(% of current out-of-field workforce)*
15% in 5 years	1700	1200	440 (6.1%)	2200 (30%)
15% in 10 years	1300	1200	90 (1.2%)	900 (12%)
10% in 5 years	1900	1200	710 (9.7%)	3600 (49%)
10% in 10 years	1500	1200	240 (3.3%)	2400 (33%)

The supply of out-of-field teachers wishing to retrain is far more certain than the supply of new graduates needed to match retirements. A more sophisticated and realistic model, easily built once the data is to hand, would begin with the current graduation rate of new in-field teachers and then grow to match retirements on some viable time scale. This model would also, of course, predict the corresponding increased extent of retraining required.

One last question: ***how big is the current pool of students graduating in the mathematical sciences each year?***

AMSI surveys its member university departments each year and our current estimate of the total number of full-time equivalent students in third year mathematics is around 1500[10]. A small proportion of these will undertake teacher training with many more heading into further study or lucrative employment in an economy hungry for data science, optimisation and algorithms. Clearly, our universities must increase undergraduate numbers in mathematics and statistics to restock the teacher workforce. We leave the reader to ponder how this might be done when the social demographic which produces school teachers is so poorly supplied with in-field teachers of mathematics!

Australia is not alone in having a severe out-of-field problem in mathematics. However, the combination of multiple jurisdictions and institutions which train, employ and register teachers has made our problem almost intractable. The time for shouting at the issue has long passed, what we need now is leadership.

10 This does not include all students taking a mathematics specialisation in a Faculty of Education.

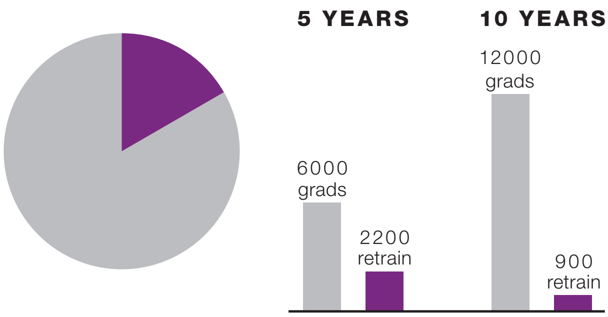
Number crunching our maths teacher shortfall

1 in 3

secondary maths classes are taught by out-of-field teachers

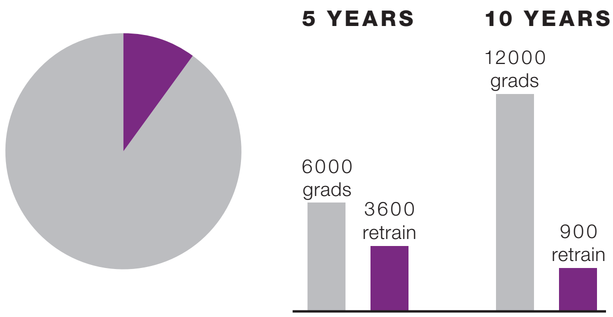
AMSI has crunched the numbers to reverse the out-of-field teacher shortfall in Australian schools

1 in 6 classes

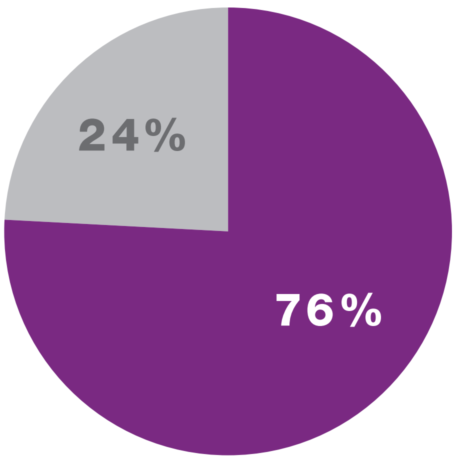


*This **optimistically** assumes that graduate numbers **will** match retirements at 1200 **per annum**

1 in 10 classes



Secondary students taught by an out-of-field teacher from 1–4 years.



76% of secondary students will be taught maths by an out-of-field teacher for 1 or up to all years from Years 7-10

Only 24% are taught by a qualified maths teacher every year