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A More Evidence-Based Proposal to Support Teachers' Mathematics Teaching Competencies*

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In 2011 a large number of Manitoba professors in the areas of mathematics and the applied and pure natural sciences have signed a petition (see Martin, 2011) in which the undersigned ask the current Manitoba Premier and the current Minister of Education “to introduce, in addition to the existing requirement of 3 credit hours in mathematics or statistics at the university level, the following requirement for teacher certification in the elementary or middle years stream in Manitoba: A minimum of Grade 12 Pre-Calculus Mathematics 40S (strongly recommended) or Grade 12 Applied Mathematics 40S, or equivalent, from high school.” In this article I would like to unpack the core arguments provided in the preamble of the petition and suggest a more evidence-based approach to addressing the underlying issue the petitioners are concerned with.

The underlying concern of the petitioners with early and middle years teachers’ “weak math skills” and “math anxiety” is that both contribute to poor mathematics learning experiences for their students. Canadian students “perform[ed] significantly above the OECD average in mathematics” in the 2009 PISA study (OECD, 2010, p. 14). While on the 2010 Pan-Canadian Assessment Program testing Manitoba students ended up second last among eleven Canadian provinces and territories and a bit lower than in the 2007 assessment, Manitoba students are still relatively close to the average Canadian mean score. There is *overall* simply no problem with the mathematics learning and, thus, the mathematics teaching in Manitoba schools. That, however, does not mean that in specific school and classroom contexts, the mathematics teaching competencies of teachers do not need to be improved. The appropriate concern, then, is how to best support current and future teachers with the development of their mathematics teaching competencies (and that includes the issue of “math anxiety”, i.e., a teacher’s attitudinal relationship with mathematics).

The petitioners write that “university math professors have found that students with this minimum requirement [Grade 12 Consumer Mathematics course] often have *alarmingly weak mathematics skills* and *high levels of math anxiety*” and that “university professors cannot make up for years of neglect caused by taking inadequate math courses at the high school level in a 3 credit hour university course”. The petitioners, thus, suggest that requiring a more academic mathematics course at the high-school level can help mathematics professors in their preparation of future early and middle years teachers’ mathematics knowledge that then will prepare them better for the teaching of mathematics in early and middle years classrooms. The research I will be drawing on, however, will provide evidence that this approach generally will *not* be supporting the development of future teachers’ mathematics teaching competencies while a more integrated approach of pre- and in-service education of teachers will.

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In the academic field of mathematics teacher education – which is one of the two fields of study relevant for the concern addressed here and in the petition – one insight about the mathematical knowledge needed for teachers to teach mathematics well has emerged:

- (*) The way teachers need to know mathematics for teaching is qualitatively different than the way in which other professions (like research mathematicians, engineers, etc.) need to know mathematics.

Based on this insight the scholars have been suggesting that taking university-level mathematics courses is not the way to help future early and middle years teachers to develop the mathematics teaching competencies, which include the way they need to understand the mathematics they teach. (For research and scholarship relevant here, see the work by Deborah Loewenberg Ball (University of Michigan) and her colleagues, e.g., Ball, Lubienski, & Mewborn, 2001; Ball, Thames & Phelps, 2008; as well as the 2009 special issue 29(3) of the Canadian-based international journal of mathematics education “For the Learning of Mathematics”.) While it is true that one cannot teach what one does not know, the insights from the field of mathematics teacher education research suggest that one needs to ask what it is that one needs to know to teach mathematics well in schools – and the answer the research suggests for the case of early and middle years teachers is that it is *not* pre-calculus high school mathematics or university-level mathematics.

The other field of study that can provide evidence for how to best support current and future teachers with the development of their mathematics teaching competencies is the research field of teacher professional development. The best pre-service teacher education can provide is to prepare good *beginning* teachers. Teaching is a profession that requires on-going professional development, and the research in the field of teacher professional development provides us with good evidence for approaches that work well (see, for instance, the overview in Falkenberg, 2010).

The evidence from this line of scholarship together with the evidence from the mathematics teacher education scholarship suggests to me that a well-developed pre- and in-service teacher education program provides the most effective approach to helping pre- and in-service teachers with the development of their mathematics teaching competencies. Most pre-service teacher education programs in Manitoba are after-degree programs, meaning that all those entering these programs have a bachelor’s degree of some kind. While I do not want to deny that many of them have difficulties with university-based mathematics as described in the petition, my own experience from teaching future early and middle-years teacher candidates is that *all* of them are intelligent enough to develop the mathematical understanding relevant to the teaching of mathematics at the early and middle years level as well as being able to overcome their anxiety teaching mathematics. The issue of their ability to successfully take university-based mathematics courses is, thus, irrelevant to the underlying concern of this article – and of the petitioners.

There are a number of other aspects that would need to be considered for the question of what experiences and qualities should be required for teacher certification than those concerning mathematics education. But even up to this point I hope to have made the case that in order to address the concern that gave rise to the petition and to this article – the concern of how to best support current and future teachers with the development of their mathematics teaching competencies – the petition should read quite differently than it currently does. The evidence

referenced in this article suggests that in order to adequately address the concern raised, the Minister of Education should:

- (1) *remove the 3-credit university-mathematics breadth requirement for teacher certification.*

The evidence referenced in this article suggests very strongly that a university-mathematics course requirement has no direct relevance to developing mathematics competencies relevant to early and middle-years mathematics teaching; it might actually be that this requirement – as anecdotal evidence from my courses suggests – has the potential to worsen or create the mathematics anxiety that the petitioners are rightly concerned about.

- (2) *do not make any changes to the current teacher certification requirements (at least not for reasons concerning mathematics education).*

There is currently no evidence that changes of the type suggested by the petitioners will make any difference where it really counts to address the concern raised, namely in the development of early and middle-years teachers' development of mathematics teaching competencies. Quite to the contrary, the evidence drawn upon in this article suggests that high school mathematics is not relevant to how early and middle-years teachers need to know mathematics to help their students successfully learn mathematics.

- (3) *support school divisions with resources to develop and implement effective in-service programs that support teachers with the development of their mathematics teaching competencies.*

What “effective in-service programs” are should be based in the findings of scholarly literature on teacher professional development. What relevant “mathematics teaching competencies” are should be based in the findings of the scholarly literature on mathematics teacher education. In this article I have referred to evidence from both fields of study.

A last, but important, point for the government to consider is the following. These evidence-based recommendations concerning mathematics education have to be seen in the light of multiple needs of teachers in the K-12 school system. For instance, the 2010 graduation rate in Manitoba was 82.7% (Government of Manitoba, n.d.), which means that about 17% of grade nine students do not graduate from high school within four years. 17% is also roughly the rate of high school graduates who enter university degree programs which require university mathematics courses as part of the program (mathematics, science, engineering, etc.). There are ample resource needs in the K-12 education system, and the government needs to consider and weigh all those needs in light of its responsibility toward all students.

References

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