



FIELDS

## MATHEMATICS PRE-SERVICE TEACHER EDUCATION IN ONTARIO Consultation Brief Regarding the Extended Pre-Service Program

Contribution of the Sub-Committee of the Mathematics Education Forum of  
The Fields Institute for Research in Mathematical Sciences

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### **Executive Summary of Recommendations**

1. Future models of pre-service teacher education in Ontario should ensure that candidates receive instruction in (a) mathematics content knowledge, (b) mathematics pedagogy knowledge, and (c) the integration of both mathematics content knowledge and mathematics pedagogy. Candidates in the Primary/Junior/Intermediate/Senior divisions should have a minimum of 72-100 hours of instruction which includes all of components (a), (b), and (c) above. The current average in Ontario is approximately 36 hours.
2. Both the practicum and the university component should be extended, well-coordinated, and balanced. Teacher educators, associate teachers, and pre-service teacher supervisors should have ongoing and sustained engagement throughout the duration of the extended practicum. While this recommendation is specific to mathematics instruction, this format is applicable to multiple subjects, as well as grade groupings.
3. Teachers admitted to Primary/Junior/Intermediate teacher education must have at least one undergraduate course in mathematics, but preferably two. Currently, there is no such requirement.

4. Mathematics teaching in the secondary panel should be designated as a “protected subject” whereby only individuals with mathematics qualifications are eligible to teach mathematics courses. The preparation of such teachers should include courses in (a) mathematics content knowledge, and
5. (b) mathematics pedagogy knowledge, and (c) integrated courses of the types (a) and (b); with the courses of type (a) and (b) being before or in parallel to the completion of the Bachelor of Education with a total of 6 full courses. Currently, any teacher with generalist secondary qualifications can be assigned to teach mathematics, and ‘second teachable math’ is only 3 full courses.

### **Context**

Mathematics teaching and learning world-wide have dramatically and fundamentally changed as a result of a wealth of research about students’ mathematical development and best practices in education. Large-scale research directly links student success in mathematics to teacher knowledge of mathematics content and pedagogy (Baumert et al., 2010). Consistently high achieving countries in international testing (i.e., Taiwan and Korea), and those that have shown dramatic improvement (i.e., Finland), have the following in common: a balanced approach in providing mathematics, mathematics pedagogy, and general pedagogy in the preparation of teachers (Schmidt et al., 2007).

Currently, there is much variability in the level of preparation teachers in elementary and secondary panels receive during their teacher education program and prior to it. For example, while it is recommended that future elementary teachers have some undergraduate mathematics courses, it is not presently a mandated requirement in the Province of Ontario. Additionally, some pre-service programs in Ontario provide as little as 30 hours of instruction in mathematics education (see Appendix A). Evidence across numerous sources suggests that this is well below what is recommended by researchers and practitioners for the preparation of teachers, and that 100 hours or more of specific instruction are required for P/J/I teachers (see, for example, National Council on Teacher Quality, 2008; Kajander & Jarvis, 2009).

While elementary teachers are typically prepared as generalists, research convincingly demonstrates the measurable impact of teaching-specific teacher mathematics knowledge on student achievement (Baumert et al., 2010; Ball, Hill, & Bass, 2005). Kajander (2010) and Wu (2009) examined the adequacy of current teacher preparation in mathematics and came to the conclusion that much more is needed. Teachers need to have a “profound understanding of fundamental mathematics” (Ma, 1999) in order to make sound pedagogical decisions to support learning (Ball, Hill, & Bass, 2005).

Despite the fact that standardized test results in mathematics for Ontario are showing promising results, these results remain somewhat stagnant over time and continue to point to a vast number of students still being left behind. While we have some exceptional teachers of mathematics at the P/J/I levels, there is no consistency in their depth of understanding of the material they teach – the depth needed for students to achieve at the highest levels. The “achievement gap” and the challenges facing teachers, students, and parents were recently highlighted in a Maclean’s article that asked, “Why is it your job to teach your kid math?” (Reynold, 2012). Important indicators from top-ranking countries on international standardized testing can be utilized to improve practice but are currently underutilized. Top-ranking countries in international standardized testing

in mathematics use data acquired through these comparisons to improve policies and practices as a means of improving student outcomes. This includes improving teacher preparation, as well as professional development. Finland and Shanghai, for example, are currently doing this follow-up from PISA 2009. The proposed changes to teacher education in Ontario are a prime opportunity to ensure that future teachers in Ontario are well prepared to teach mathematics.

### **Recommendations for Pre-service Teacher Education**

Substantial studies describe the nature of teacher mathematics learning and appropriate courses in teaching specific mathematics content (Hart & Swars, 2009; Hill, 2010; Kajander, 2010), and other work further clarifies the specialised nature of such learning and thus also has implications for appropriate content as well as faculty qualifications (Ball, Thames, & Phelps, 2008; Oesterle & Liljedahl, 2009; Swars et al., 2011). Therefore, in line with the understanding that professional learning of mathematics should be “focused on mathematics knowledge for teaching, including content knowledge, pedagogy and pedagogical content knowledge” (Ontario Ministry of Education, 2011, p. 7), and also that in a recent Ontario Ministry of Education study nearly 50% of Ontario grade 7 and 8 teachers said they wanted more opportunities to learn “content knowledge for teaching” (Suurtamm & Graves, 2007, p. 149), it is the strong recommendation of this committee that any future model of pre-service teacher education in Ontario ensure that candidates receive appropriate instruction through:

- a) Course work in teaching-specific mathematics content knowledge (i.e., mathematical content and mathematical processes);
- b) Course work in mathematics pedagogy knowledge (i.e., problem-solving; developing and connecting conceptual and procedural understanding; mathematical learning theories; culturally sensitive mathematics approaches, including Aboriginal ways of knowing; appropriate uses of technology to support learning and teaching processes);
- c) Course work that integrates both of the above.

A Bachelor of Education Program should include a minimum of two 36 hour courses that incorporate a combination of those areas outlined above, although ideally the Program should include three such courses for a minimum of 100 hours (Conference Board of the Mathematical Sciences, 2012; Schmidt et al., 2007). In particular, it should be noted that general undergraduate courses in mathematics are not a replacement for the teaching-specific mathematics courses described here and may, if not accompanied with teaching-specific mathematics courses, be at odds with the development of deep teacher knowledge and appropriate teaching-related beliefs (Moreira & David, 2008).

### **Recommendations for the Education Act**

Teachers admitted to Primary/Junior/Intermediate teacher education must have at least one undergraduate course in mathematics, but preferably two in the areas of curriculum-related mathematics concepts and “profound understanding of elementary mathematics” (Ma, 1999). Teachers need to learn the underlying concepts, models and connections supporting each developmental stage of mathematics knowledge.

All teachers admitted to Intermediate/Senior teacher education must have a minimum of 5 undergraduate math courses, whether mathematics is considered a ‘first’ or ‘second’ teaching subject. Similar to other important and valued subjects such as French, and protected subjects,

teachers admitted to I/S teacher education should have the benefit of a consistent number of mathematics undergraduate course prerequisites.

Mathematics teaching in the secondary panel should be designated as a “protected subject,” whereby only individuals with mathematics qualifications are able to teach mathematics courses. Currently, it may be the case that the teacher assigned to teach a secondary school class in mathematics may not have qualifications to do so. This is not a case of shortage of qualified mathematics teachers. Since 2007, the Ontario College of Teachers have reported that an undersupply of teachers of secondary mathematics is no longer the case ([http://www.oct.ca/publications/PDF/transitions07\\_e.pdf](http://www.oct.ca/publications/PDF/transitions07_e.pdf)); yet, in the absence of stronger regulatory guidelines, teachers without mathematics qualifications continue to teach secondary-level mathematics, while new, qualified mathematics teachers are experiencing a shortage of employment.

### **Recommendations for the Practicum**

Mathematics course and fieldwork experiences should be mutually reinforcing in teacher preparation (Philipp et al., 2007), with Faculties of Education, Associate Teachers, and pre-service teachers having ongoing and sustained engagement throughout the practicum. In addition to traditional face-to-face opportunities, other options, such as: (a) using Information and Communication Technologies, (b) another integrated course-based experience between the programs (AQ course for Associate Teachers supporting mathematics learning), (c) summer mathematics workshops with Associate Teachers and pre-service teachers, and (d) cross-curricular sessions or seminars that mirror professional development workshops, are suggested.

### **Conclusion**

It is clear that mathematics education has long term implications for the well-being of a society. Pre-service teachers need more preparation in mathematics education. The extension of pre-service teacher education in Ontario provides the ideal opportunity to ensure through policy that every teacher graduating from an Ontario program is exceptionally prepared to meet the demands of teaching mathematics, and enhancing student learning experiences and outcomes.

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**Appendix A: SUMMARY OF PROVINCIAL HOURS FOR MATHEMATICS  
METHODS/TEACHABLE COURSES AND ADMISSION REQUIREMENTS**

**March 2012**

**(Consecutive Education – only)**

<b>Institution</b>	<b>PJ Mathematics Methods Course Hours</b>	<b>JI Mathematics Methods Course Hours</b>	<b>IS Mathematics Methods Course Hours</b>	<b>Number of Full Courses Required for First Teachable in Mathematics</b>	<b>Number of Courses Required for Second Teachable in Mathematics</b>	<b>Do <u>non- mathematics</u> teachable applicants require any undergraduate courses in mathematics for admission?</b>
Brock	40	40	40	5 (IS), 3 (JI)	3	No
Lakehead	36	36	72	5 (IS), 3 (JI)	3	No
Laurentian (French)	18	24	24	5 (IS), 3 (JI)	3	No
Laurier	45	36	NA	3	NA	No
Nipissing	36	24	72	5 (IS), 3 (JI)	3	No
OISE	36	36	72	3 (IS and JI)	3	No
Ottawa	36	36	72	5 (IS), 3 (JI)	2	No
Queen's	36	NA	72	5	3	No
Trent	36	NA	73	5	3	No
UOIT	36	NA	72	5	3	No
Western	36	36	72	5 (IS), 4 (JI)	3	No
Windsor	32	16	48	5 (IS), 3 (JI)	3	No
York	36	36	72	6 (IS), 4 (JI)	3	No

**Notes:**

Data Collected from faculty members at each Faculty of Education during the month of March 2012.