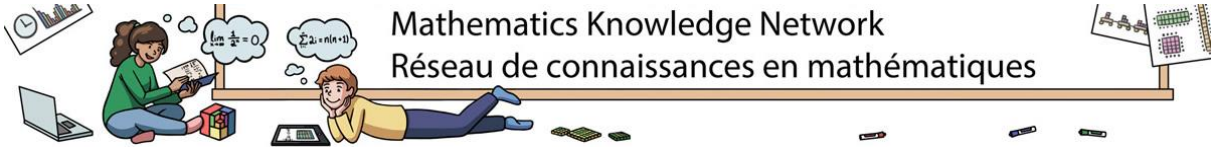


Notes from the Webinar: How to Utilize Online Technology in Increasing Pre-service Teachers' Readiness to Teach Mathematics Content?[1]

Organized on July 5, 2019, by the Mathematics Leadership CoP (Mathematics Knowledge Network) and Vretta

Agenda

- Brief introductions and overview of the webinar
- Challenges currently faced by faculties of education—how to ensure that preservice teachers receive the individual support they need?
- Practices followed to overcome the challenges—what seem to be the promising practices? How do we know?
- Suggestions to collaborate and create a common solution
- Final thoughts

Discussants

- Dr. Dragana Martinovic, University of Windsor, facilitator
- Dr. Daniel Jarvis, Nipissing University
- Dr. Ann Kajander, Lakehead University
- Anand Karat, Vretta
- Dr. Steven Khan, University of Alberta
- Dr. Anjali Khirwadkar, Brock University

Dragana M.: Good afternoon, I am Dragana Martinovic, Professor of Mathematics Education at University of Windsor. I will be facilitating discussion on ways to increase pre-service teachers' readiness to teach mathematics content. I have with me discussants from four other universities and a learning technologies company. (Introductions follow)

As mathematics confidence continues to be a prevalent issue in our society, preparation of future elementary school teachers has come into the spotlight. In an attempt to support the development of new teachers into knowledgeable and confident mathematics educators, Faculties of Education are increasingly exploring and implementing research-based teaching and learning, as well as digital tools and platforms. Today we will discuss our collective experiences as well as lessons learned from implementing different practices that assist with diagnosing, supporting, and assessing pre-service teachers' strengths and weaknesses in the kind of mathematics content knowledge needed for conceptually-based teaching. I will be posing some questions for discussion and posting them in the chat.

Q1: *Is mathematics difficult to teach? Is learning to teach mathematics difficult? How is teaching mathematics different from teaching other subjects at elementary school level?*

Ann K.: Teachers with appropriate background preparation do not generally find mathematics any more difficult to teach than other subjects. The issue is that, with the advances in technology among other things, what we need to students to know about mathematics is much deeper and more complex than ever before.

[1] These notes from the webinar are combined with notes from the personal communication with presenters. They have been checked and edited by the presenters.

So teachers are typically teaching a subject that they really didn't learn themselves, because it has changed so much from when they typically learned it. This is what makes teaching mathematics different from other subjects.

Steven K.: Any subject is difficult to teach. We need to be clear about what we think math is. We have also attached a lot of social pressure (and shame) to mathematics teaching and learning which we haven't necessarily done to different disciplines or to the same degree; keeping in mind the social dynamics.

Any subject matter in which one has insufficient knowledge, experience and awareness of the necessary distinctions, traditions, purposes, and developmental sequences related to content and learners will likely prove difficult to "teach". Teaching by analogy can only take you so far e.g., I could likely make some connections with cricket and soccer to hockey, but the probability of me being a good hockey teacher would be pretty low even if I took a few courses.

- It also depends on what one means and how one thinks about/conceptualizes mathematics. As Ann mentioned above, the school mathematics that teachers are required to work with now is much different from the school mathematics that many of them encountered or recall. In my experience many only recall their late Middle or High School (I/S) and University experiences with mathematics.
- A difference with teaching mathematics is the intense scrutiny that is placed upon the performance of diverse learners through provincial testing AND the ways the results of those tests are taken up and used to support arguments and claims that move far away from the purpose of the tests as indicators rather than measures.
- In terms of some specific aspects of mathematics we know are difficult: The move from individual cases to abstraction and generalizability; the move from studying discrete mathematical objects. phenomena to continuous objects/phenomena; the move from ordered/predictable systems to randomness and probabilistic systems; the places where mathematics stands in sharp contrast to human experience and 'intuition', the belief in epistemic closure with respect to mathematics that contrasts with a need for awareness of epistemic plurality in the teaching and learning of mathematics.
- Mathematics is less traditionally presented in the form of story/narrative than other disciplines. There can be a reduction of the story of mathematics to 'technique' within the narrative/metaphor of 'progress.'

Dan J.: Most anxiety or apprehension seems to be around math more than other subjects, for many of my BEd teacher candidates. There is a similar situation in the nursing program where perhaps students feel even more intimidated because of the importance of correct answers for things like dosage calculations. The amount of time for course delivery is important: when I began my career, I was delivering an 18-hour Math Methods course. For the past 13 years, I've had 36 hours for each PJ methods course at Nipissing. I'd like to see BEd teacher candidates receive 72 hours of mathematics preparation in all of the faculties, for the new 2-year program.

When I've asked my TCs if the reform-based methods that we model/experience in class line up with what they're seeing in practicum placements, I've found the responses have changed over the years, with more recent groups observing/implementing many of the same types of activities regarding modeling and problem-based learning. Further, is seems that an increased number of TCs had also experienced such activities as students themselves, when I ask them to reflect.

Anjali K.: Research has shown that students like mathematics as they do it and dislike it if they cannot do it. In mathematics, either you get it or you don't. It's due to the nature of mathematics (it is very abstract). Mathematics needs to be presented in relation to a real-world context. Because, it requires a lot of imagination from the students. When we talk of problem solving in mathematics, it requires a lot of time, effort, imagination and creativity. You can't just do it and get a quick solution. Students have to keep trying until they get their results. Practice, perseverance and patience are critical factors in learning mathematics. It is very well connected with other disciplines as well (chemistry, science in general). Bringing in connections to the real-world can make it more real / practical for our students.

Teaching mathematics is different from other subjects because:

1. Concepts of Mathematics are build based on the basic fundamental concepts. Difficulty in understanding one of the basic concepts will be carried forward leading to learning difficulty.
2. Solving mathematical problems involves critical thinking, imagination and creativity.
3. It requires lot of practice and patience to solve mathematical problems and hence time & effort.

Dragana M.: Maybe the problem is that it is easy to teach it inappropriately, but it is not easy to teach it well, so that it transfers properly to real learning.

Q2: *Let us talk about challenges currently faced by faculties of education, as well as how to ensure that preservice teachers, as future teachers of mathematics, receive the support they need in developing deep conceptual understanding of the mathematics they are to teach? What worries us in teacher education programmes?*

Ann K.: A major problem is that there is typically not yet a niche for the kinds of math courses teachers need that are specialized to teaching. These are not undergraduate math courses, but nor are they methods courses. I am talking about the kinds of specialized content knowledge (SCK) that involves such things as use of models and reasoning, as well as how topics evolve and link. This is a very particular kind of mathematics; but it is mathematics, not pedagogy.

For example, learning about the area model of multiplication allows teachers to link whole number multiplication, including commutativity, with fraction multiplication, and eventually with binomial products and so on. And it's not just the model teachers need, they really need to understand the reasoning behind using the model to help the mathematics emerge. It is absolutely NOT good enough to show them a procedure next to a picture of a model, with no reasoning. It is the explicit connection between the model and reasoning that is the mathematics that needs to be carefully developed in such courses.

Such specialized knowledge cannot be tested at the start of programs, as TCs don't have it yet. But once exposed to it, it is amazing how fast some can develop.

Steven K.: Time is the front-end challenge for all of the faculties – especially time to learn. One idea: time-shifting (think about how things have evolved with television viewing). The work at times needs to be presented more discretely before being connected. I see the discrete part as being analogous to the time-shifted viewing with the scarce time spent with pre-service teachers on making those connections explicit in actual practice before heading into a classroom. Equity: Physical, psychological, and financial concerns of teacher candidates. Quality of the mentoring experiences. Students sometimes (but not always) seeing the "strange things" from their methods course in the classroom with kids. Can't expect them to have more than the traditional experience. Need to make sense of it within the course and also in the classroom. To pick up on what Ann said the niche does not exist within Universities, I see the niche currently being constructed by individuals and groups who are delivering post-degree Professional Development covering much of what we ought to have covered in our teacher education programs. We should also mention curricula and curriculum documents that are poor information and pedagogical artefacts.

Anand K.: The student audience has changed over the past 30+ years. Traditionally, continuous drills were used by teachers to help students rely heavily on their memory. But in this day and age, there are various means of delivering learning content using technologies that students grow up with. We work with pre-service teachers and have noticed that some may not be comfortable with technology (even if their students are). So it has been an important part of our process to provide training to teachers for them to comfortably use technology with their students. We create professional learning communities for teachers to gain exposure on how best they can use technologies to effectively teach. They can also share their experiences and best practices with others through the training sessions.

Charles A.: Our experiences with Professional Learning Communities in Luxembourg have shown us some of the positive ways in which classroom interventions can be achieved using technologies such as ours, particularly without allowing the tools to take over the teaching. The PLC group (who were active

in the construction and customization of the materials) were sensitive to instances in which a teacher takes a "hands-off" approach to learning. The goal is for teachers to use some of the digital material (much of it containing embedded manipulatives) to spark discussion around methods and problem solving, and some of it as self-paced interactive remediation for students who are having trouble keeping up with the rest of the class. Through their PLC training, they made an explicit effort to contextualize the use of the digital tools and resources within larger conversations which maintained the connection between the teachers and the students. We continue to work out this aspect through practice, in providing a useful and powerful tool that keeps both the teachers and the students' in the driver's seat, helping them build connections between each other and between the ideas and methods they are covering in the classroom.

Dragana M.: One recent study sought to identify mathematics curriculum areas that the primary/junior pre-service teachers may have problems with. The mathematical competency test was created based on the five major strands within the elementary mathematics curriculum. It consisted of the five short-answer questions from previous Grade 6 Mathematics EQAO tests, which required the participants to show their work and thinking process. As a whole, the first and second year TCs struggled with two questions, one covering Measurement and the other, Geometry and Spatial Sense. Overall test results showed that:

> 7/28 (25%) of concurrent TCs consistently had 50% or less (on both pre- and post-course test); while 12/28 (43%) consistently had 70% or less
>
> 6/23 (26%) of consecutive Y1 TCs consistently had 50% or less; 10/23 (43%) consistently had 70% or less
>
> 3/24 (13%) of consecutive Y2 TCs consistently had 50% or less; 7/24 (29%) consistently had no more than 70% on both pre- and post-course test.

While we cannot generalize from the small samples, these results are concerning, and any school teacher would not be satisfied with such a performance of their Grade 6 students on the EQAO test.

Anjali K.: Our experience (in general) corresponds with this. Teacher candidate initiation and participation in problem solving activities; lack of confidence if they are not able to recall or recollect the basic facts; not able to relate the basic math concepts to solve the problem; don't want to come forward and participate to share their views; maybe it has been a long time since they have last studied mathematics. Planning lessons: if they cannot make the connections, they cannot link pedagogy/strategies to the problems.

Steven K.: Thinking about all of these things more developmentally than in the past (less programmatically). Sometimes you have lesson planning focused on one course, otherwise spread across many courses. Often not enough communication between the courses and the professors.

For example: not to develop content knowledge and methods at the same time.

Has a number of students of Anand's age who still prefer print and can manage it that way… focusing on learning to teach.

Time

Physical, psychological and financial (ecological) well-being of pre-service teacher candidates.

Equity, Diversity and Justice concerns.

Overly narrow, fragmented curricular experiences.

Connectivity.

Quality (including Professionalism).

Mentoring & Experiences: Pre-service teachers learn the most about teaching mathematics from being in actual classrooms with actual learners. However they may not get specific feedback on the mathematics content they are presenting but on their classroom management, preparedness and professionalism.

Ongoing mentoring and support for intentional professional growth.

Dragana M.: *Other worries?*

Dan J.: The structure of the math methods courses in faculties of education, beyond just the number of hours, is also significant. Spreading a 36-hour course across an entire year (i.e., Fall and Winter terms) allows teachers to implement ideas in their practicums and discuss strategies in an ongoing fashion as the year progresses; block scheduling (the full course within one term) can lead to a sense of rushing through material in just four months. Learning Management Systems like Blackboard Learn which we use here, serves as a useful tool to share print/web resources, organize assignments and feedback, and can also be used for online group work or synchronous whole class events. I've noted a changing landscape, in terms of the idea of digital versions now existing for nearly all of the main manipulatives that we use regularly in our workshops. Video-based resources are particularly helpful, as TCs can pause, rewind, and review concepts as needed.

Q3: *What seem to be the promising practices to overcome these challenges? How do we know that they may work (or are working)?*

Ann K.: First of all, in answering this question, I want to be clear that I speak based on a database of over 1000 PSTs, gathered over a ten year period, about their specialized content knowledge for teaching (SCK), and its support and development.

Number one, is that we need more stand-alone courses in SCK, as part of teacher preparation. In a brief that was submitted a few years ago to OCT and MOE, which Dragana was involved in as well, we argued for 100 hours of learning in such courses. The content and pedagogy of such courses must parallel the kinds of classroom learning experiences that we want for students. For example courses need to include small group explorations with hands-on materials, and the exploration of multiple solutions and how they make sense.

I'd like to provide a specific example. When exploring patterning, children tend to see patterns, and pattern rules, in multiple ways. The growth happens when children share and co-construct understanding of these multiple ways, which enriches their capacity in solving the next problem. As an alternative to that, asking children (or teachers!) to use a sort of "fill in the blank" template such as 'multiplyier plus constant' is a step backwards. Instead of supporting multiple understandings, such a method imposes a sort of rote, one-right-way method, which is exactly what the research on children's learning tells us we need to get away from. We don't need software or supports to make people more fluent in filling in the blanks. A good patterning problem can have 6 different ways of looking at the problem and of solving the rule. Teachers have to get their heads around the different approaches. This requires small group work, talking about it, "how did you do it". It's thick and messy, not just something that can be done on a worksheet or screen – it needs to be co-constructed. We have a thousand surveys of how people change over the course of these kinds of experiences.

Teachers need experiences that parallel what they should be doing in the classroom – sharing and deconstructing multiple methods, exploring misconceptions, and so on, not filling in blanks without understanding. The hard part for teachers is not just understanding a pattern rule (or other mathematical idea) *themselves*, but being able to support a student who is thinking about it in a totally different – but equally valid – way.

As a second example, teachers need a deep understanding of fundamental concepts such as operations, and their development. For example, teaching division of fractions, without students having a deep understanding of the measurement model of whole number division, is not helpful.

The examples I just gave are illustrations of the kinds of teacher math knowledge that makes a *measureable* difference in both teacher capacity and student learning and achievement, and this is supported by both my own research as well as that of others. On the other hand, our data also show, that teachers' increased fluency and procedural skill alone, do *not* support student learning in a measureable way.

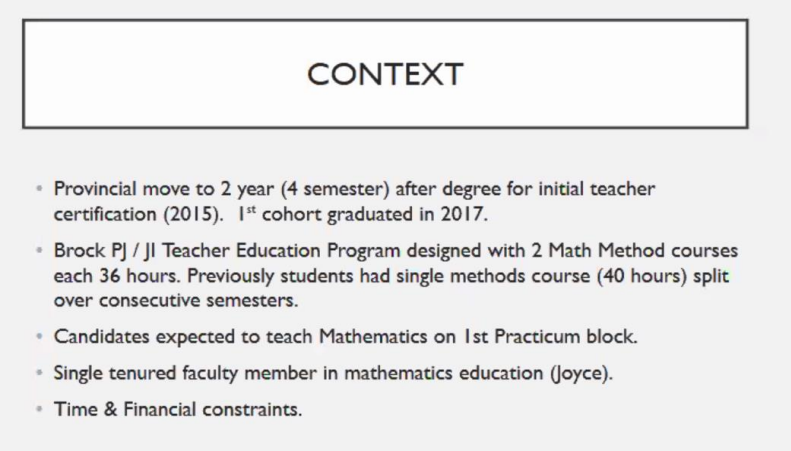
If there is going to be a test of teachers' mathematics knowledge, it needs to test the kinds of deep and specialized understandings described above. This cannot be done prior to acceptance to a preservice program, because prospective teachers simply DO NOT have this kind of knowledge at that point. I can

provide data from over 1000 PSTs entering the program who had no idea why some of the standard procedures worked, but developed quite quickly once exposed to the underlying ideas.

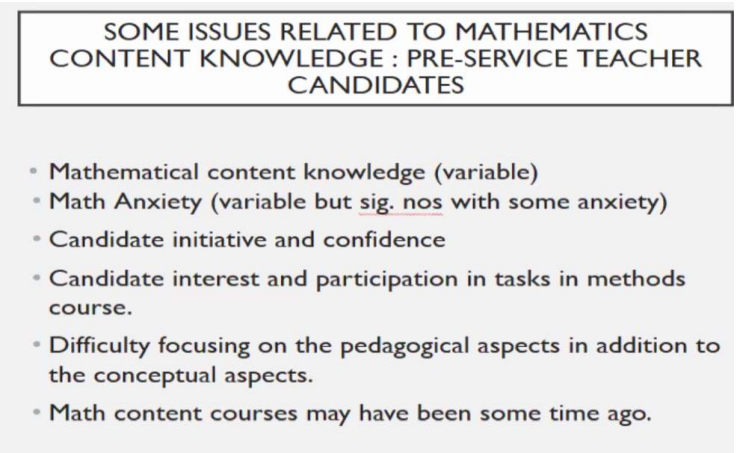
Steven K. (via chat): Here is an example of an Open Lesson Plan with some multiple solutions to a patterning problem. I use this every term as my capstone problem with patterning and number after the pre-service teachers have the sorts of experience that Ann mentioned: https://docs.google.com/document/d/1em1-FCIQ4azicgLH0QjhFXy55DUqe8e7HgMLGmUgMqM/edit?usp=sharing

Steven shared screen with slides: "How to utilize online technology in increasing pre-service teachers' readiness to teach mathematics content".

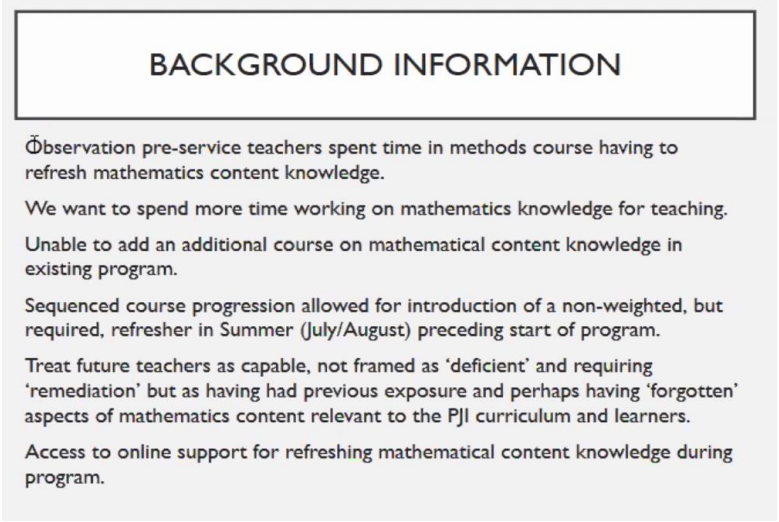
Anjali K.: Talked over the slides.



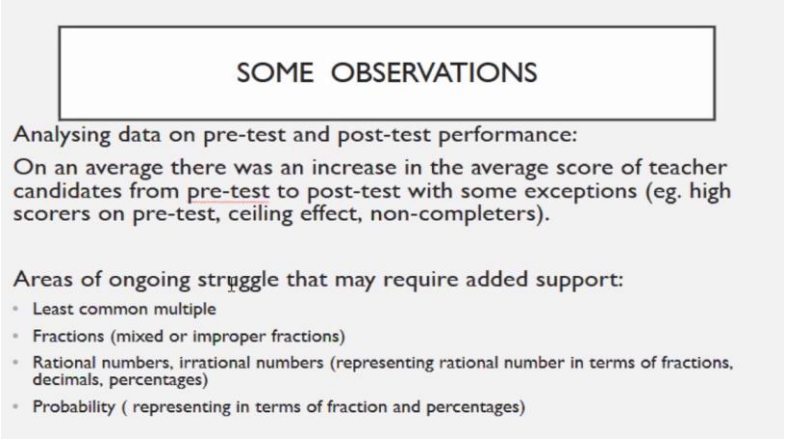
Difficulty with the conceptual understanding can be why they cannot focus on the pedagogical content.



Steven K.: Continued to talk over these slides.

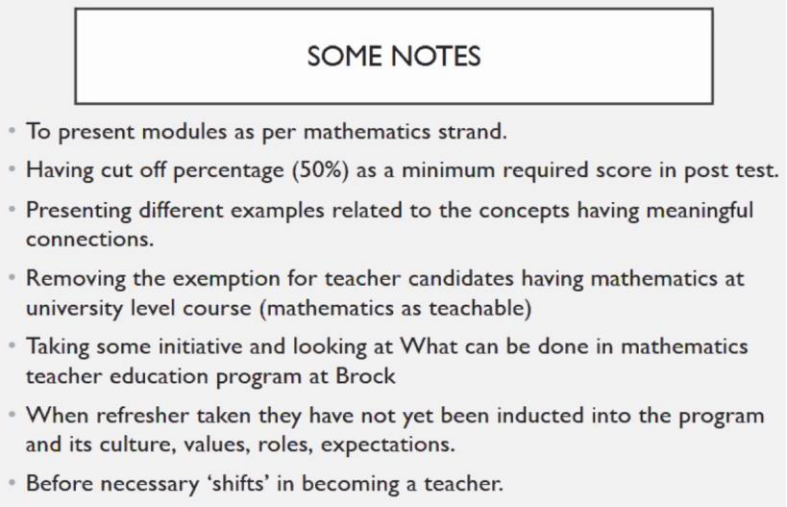


Talked about EMM intervention provided to students; interesting findings.



Breaking it up by strands.

Anjali K.: Talked over the slides.



Currently informal (no cut off).

Ann K.: Is mathematical knowledge specific to teaching left to the methods course?

Steven K.: Yes. In first version, we experimented with methods questions, and this was not helpful because they are not expected to know. Doubled-down on refreshing existing knowledge. In the context of Brock at the time, there was no funding available to run a full course or money for any instructor to run it.

Ann K.: If they learned it procedurally before, and do not remember, then we need a different experience now, not just review. For example, if a student says they don't remember long division, I used it as an opportunity for in depth experiences and discussion around division and not going straight back into the "steps" of one (poor) procedure. I would suggest digging right into the specialized knowledge of mathematics, even right at this early stage. The beauty is, once the underlying concepts are understood (often for the first time), the procedures emerge in parallel – but this time they stick, because they are grounded in understanding.

Steven K.: It's grounded in understandings of how people learn. Anything we are not using at a high level of fluency or proficiency could be forgotten. This has been a stumbling block for students. The main purpose is to say: this mathematics is not something to be scared of. The material in the Vretta modules are not all procedural. It is possible to develop connections between the pedagogies. I am agreed that students need a different experience, but do note that the context here is prior to program start and the intention is a refreshing of content knowledge that they likely encountered in school so that that having to recall at the same time as they are unpacking/unraveling and learning to re-pack / ravel for teaching is less encumbered. Also note that this was introduced at a period when there was only 1 tenured faculty member with responsibility for mathematics education.

Dan J.: I was not aware that Elevate My Math was actually used prior to the Fall term with students at Brock U, as a content review experience. When I informally piloted the resource last year with my PJ classes, it took place during the term. I think there may be better value added if the EMM is self-directed, and occurs during the term while TCs have an opportunity to seek help. I have my students look at Ontario's CLIPS (especially fractions), LearnAlberta online resources for Grade 3, 4, 5; Ontario mathIES tools, etc. They are working quietly at their own pace on this material. I would like to see something like this happen with the new Ontario math entry test, i.e., some form of pre-test, then remediation and practice, and then a self-administered post-test that can be repeated until an acceptable competency/mark is achieved.

Steven K.: Meant to be low stakes, to get them to think about assessments differently.

Dan J.: For example, nursing students use an online resource here that is self-directed, and which they must repeat until they reach a certain level of competency, before entering their annual hospital placements.

Steven K.: Medical school is doing some fantastic stuff regarding just-in-time training. They are wrestling with the issue of privacy around that data (if you know how doctors performed in their preparation, that may tell you something about their future performance as professionals). Just in time: Oh, I've got a gap… I need to fill it.

Iain (from the chat): Medical training idiom: See one, do one, teach one. It works well with other subjects, too.

Anand K.: Working with professors at the faculties of education at Brock University, for about 3 to 4 years, we have developed a platform called Elevate My Math that is used as a math refresher for students at the beginning of their course. The platform has three components – a diagnostic assessment, upgrading modules, and a summative assessment. Students start by completing the diagnostic which helps to identify the areas that they should improve. The results on the diagnostic provide students with focussed upgrading using interactive, voice-enabled modules, after which they complete a summative assessment to see their gains from the diagnostic. They can also download a certificate of achievement based on their performance and submit this to their professor. This platform is also being piloted and customized by the faculties of education at the Nipissing University where it is being used throughout the school year to support students through their learning experience.

Over the past year, we have customized and aligned the platform to the Australian National Literacy and Numeracy Test and it is being piloted at the University of Western Australia to provide the required maths support to students. Similarly, it has been aligned to the math curriculum in England and teacher education curriculum. It is being reviewed and introduced to train teacher candidates at the University of Derby in the UK.

In the UK, teachers are trained in two separate ways. One is, just like in Canada, where they take a two-year program after a degree (in Canada this is usually called a B.Ed. in England it's called a Postgraduate Certificate in Education - PGCE). More recently, a new model has been introduced - called School Centred Initial Teacher Training (SCITT), where a teacher obtains a job in a school as a teacher trainee on a reduced workload and receives their teacher training "on the job" under the supervision and coaching of school based teacher trainers. The training is coordinated by regional SCITT providers which have the authority to recommend certification for new teachers. NASBTT is the national association of all those involved in school-based teacher training.

We are working with SCITT and NASBTT to develop a custom version of Elevate My Math to be made available to their trainees. The plan is to use the platform in three distinct ways:

- For applicants for teacher training whose math background is weak prior to their taking the numeracy component of the (government) professional skills test which they must pass before beginning training
- For teacher trainees as part of their training
- For regular teachers whose maths background is weak as part of their professional development.

Q4: *In which ways could we utilize online technology in increasing pre-service teachers' readiness to teach mathematics content? Is learning with technology sufficient to support to the kind of learning? What else would be required? Could online surveys and learning modules be an efficient approach in this regard? What are your suggestions for the next steps? Any advice for our institutions and groups of educators who would wish to collaborate and create a common solution?*

Dragana M.: Is it possible to go beyond piloting and piecemeal fixes, and go towards a common solution?

Steven K.: It is possible. There is no pan-Canadian education framework, maybe start with this. Create learning trajectories around mathematics knowledge for teaching. Re-establish connections with math departments (they face a similar struggle, not with content knowledge but pedagogical challenges). Flexible platform or framework that is not so tightly bound to time. Clarify what we expect teachers to be able to do at different levels.

Anjali K.: Taking the views of schools and community: What they expect teachers to be? Collaboration across institutions and planning an ongoing research to find out what works? Which areas need attention? Developing online resources for students (asynchronous and synchronous).

Finding and analysing the causes for the learning difficulties/problem areas in understanding mathematical concepts by the teacher candidates at PJ and JI level. Implementing a strategy/ solution for bridging the gaps.

Gaging standards of expectations (provincial standard for mathematics teachers at PJ or JI level) with the teacher preparation program in place.

Dan J.: Again, I would like to perhaps see 72 hours of math content/methods courses be mandated for BEd TCs across Ontario, just to provide them with more time to become competent. I was particularly impressed with the "Upgrade My Skills" section of the Vretta EMM resource—they developed some really neat drag-and-drop features during the content explanations. My advice would be for Vretta to try to address conceptual issues/difficulties within those Upgrade My Skills sections (check some of the LearnAlberta and CLIPS resources for that kind of an idea, if you have not already done so). New mathematics curriculum is coming out soon in Ontario, and so we look forward to seeing what that will entail—hopefully some good online connections, along with further helpful teaching strategies throughout the strands.

Ann K.: Touching back – there was a recent conversation with Ontario College of Teachers regarding the mandated test for teachers in Ontario. We need more than content knowledge, we need to focus on what is going to help students, and that includes deep and specialized knowledge on the part of teachers. Lynda Colgan and Ann K. have some ideas, and a small group can put things together. If at some point if there is going to be a test, we need teachers to be ready. The book: "Mathematical Models for Teaching" (Kajander & Boland, 2014) was designed as such a support. We can use these materials as a starting point. We need a curriculum or outline that defines the structures and competencies, something that goes beyond the refreshers and reviews.

Steven K.: AMTE has some draft standard documents for teacher education in the U.S.

Iain (via chat): How about starting not from the bottom and moving up, but starting at the top. Start with the '*why*' the beauty, the ideas. Continue with the '*how*' the problem solving the thinking. Finish with the *what*. Use *the what* to learn and explore *the why* and *the how*.

Steven K.: Starting with the *why* is great. When the course starts and throughout as there is no human physical body or additional resource from the University prior to the start of the program. In this stage they have not yet been exposed to the culture of teacher education and its expectations.

Jennifer (via chat): I totally disagree with that. It can come before the course. The work Ann was talking about and what I am seeing in my research is that those models change the way they see the math. It can and should come before, not just in the methods course.

Iain (via chat): Hi, Jennifer. The *why*, *how*, and *what* of math itself. Not the '*why*' of mathematics pedagogy. Pedagogy has to come after.

Jennifer (via chat): I wasn't talking about pedagogy.

Steven K.: I do have an objection here about readiness to teach mathematics content. I would prefer the framing of readiness to teach mathematics for flourishing which puts the content and pedagogy in the service of a broader goal (in this case a construct which is defined in the psychology literature). If it were only about readiness to teach content, then a strong UG math degree would be all, we know from the decades of research on MKT/M4T this is insufficient.

- The approach to learning mathematics content for teaching for flourishing needs to be chunked differently and distributed over a longer period of time and designed around ideas from the Learning Sciences e.g., spaced practice in addition to blocked practice. I am thinking here more in terms of micro-credentials.
- For future teachers technology also needs to help them understand and visualize where they are in a learning trajectory as an adult and where kids are in learning trajectories, that the mapping of their experience and that of children who are at different developmental stage.

- Critical Curation and creation practices need to be valued and enabled. Technology can be used here.
- Use of Open Education Resources to create a level starting point with freedom to remix and share.
- Creating communities that connect mentor teachers with pre-service teachers.
- Learning with technology is not sufficient. Human-human and human-community interactions are necessary. Surveys and learning modules get at one part very broadly in a relatively cost-effective manner.
- Well-articulated, clear, differentiated statement regarding what a well-prepared beginning teacher of mathematics looks like and can do at P, J, I and S levels.
- A set of sensible learning trajectories for pre-service mathematics teacher education that is linked to future flourishing.
- A set of provincial or Pan-Canadian standards for initial/pre-service mathematics teacher education.
- A much closer relationship between faculties of education teacher education programs and mathematics departments to co-design learning opportunities that extend beyond required coursework and practica.
- Systems that move us from conceptualizing our initial preparation of teachers within a time-based program/paradigm to more of a competency/proficiency based program/paradigm in terms of knowledges for teaching (including mathematics but not limited to mathematics) AND which can provide useful evidence to inform policy initiatives.

Q7: *Final thoughts?*

Anjali: Promoting importance of perseverance and efforts in teaching and learning of mathematics among preservice teachers.
Having an opportunity for preservice candidates to revise & relearn the concepts of mathematics (before beginning of a program) from the perspective of teaching and learning. Helping them to make a strong foundation in mathematics which will build a positive relation with the subject and motivation for learning mathematics.

Steven: The idea of annual testing of teachers' broad mathematics content knowledge is ridiculous. Content knowledge is only 1 piece of effective teaching.
The better place for such any such test is PRIOR to entering teacher education and with a goal of improvement in mathematics literacy for a much broader population (than those who will eventually enter teacher education programs). As with the Vretta solution, such a pre-test should be linked with resources for refreshing or re-learning mathematics content knowledge. To reiterate what Ann said, additional hours and more clarity around course that develop mathematical knowledge for teaching.
A searchable repository of curated mathematical pedagogical content knowledge cases/reflections from teachers.

Dragana M.: Thank you for participating in this webinar. It was recorded and the notes and the link to video and audio will be provided at the MKN website. This will be the first in the series of webinars and I am looking forward to continuing this discussion.

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