

## **Trickle down mathematics: Adult pre-service elementary teachers gain confidence in mathematics – enough to pass it along?**

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### **Abstract**

Much research (Ma, 1999; Cohen & Leung, 2004; English, 2003) has been done on mathematics education and pre-service teachers with special emphasis on how the mathematics is taught and the psychology of the pre-service teachers. While there is concern among North American mathematicians that mathematics instruction in K-12 grades needs to be improved (Ma, 1999), how that can be achieved is an ongoing debate. This study, while recognizing the need for significant changes to the preparation of our elementary teachers seeks to look at a subgroup of pre-service teacher candidates – adult learners who are coming to the profession after accumulating several years of life experiences. Are their experiences similar to non-adults preparing for the same vocation? In what areas are they lacking? In what areas are they more superior? How should a teacher education program be designed to prepare these adult learners to teach mathematics effectively? In this study, we will compare these adult learners to non adult learners in the same class and discuss aspects of the pre-service program that succeeded in affecting their beliefs, confidence and mathematical competency.

Key words: mathematics; pre-service; adult; teach; practicum; teacher

### **Introduction**

Teachers in Ontario can be certified in two main ways: by obtaining a Bachelor of Education (B.Ed.) in a concurrent program that normally takes five years, or by completing a degree in any specialty and then continuing on to a one or two year consecutive B.Ed. degree through a faculty of education. As a requirement of certification, students must choose a division: Primary-Junior (PJ) refers to those who are generalists teaching from Kindergarten to grade 6, Junior-Intermediate (JI) refers to those with one teachable subject (for which they have satisfied a certain number of hours of coursework in their undergraduate degree) who will teach grades 4 - 10 and Intermediate-Senior (IS) refers to those who have two teachable areas and can teach from grades 7 – 12 in a secondary school. After receiving initial certification, teachers are able to augment their credentials by enrolling in Additional Basic Qualifications which will allow them to move from one division to another. There are currently 18 faculties of education in Ontario with most of them offering one degree leading to PJ, JI and IS certification by the Ontario College of Teachers.

For the purposes of this paper, adult learners are defined as those who have had extensive life experiences or other training prior to enrolling in the bachelor of education program. Casual

conversations with these adults reveal that many do not fondly recall learning mathematics when they were younger. Many of these adults are now choosing to start second careers as elementary teachers who must, by virtue of the Ontario classroom system, teach mathematics as part of their core curriculum. Whereas faculties of education the world over recognize the need to demand some mathematical competency prior to admission into a teaching program (Burton, 1987), the reality is that the need for teachers in many rural and inner city schools requires that Education faculties recruit the teachers first and then bring them up to an acceptable level of mathematics competency while they are in the pre-service program. This acceptable level of mathematics competency has been cause for concern in the past decade and Liping Ma's comparative work on math education of pre-service teachers in the USA and China highlighted in no uncertain terms that something major was lacking in how North American teachers are trained to teach elementary mathematics (Ma, 1999). In June 1998, the Californian Conference Board of the Mathematical Sciences appointed a steering committee for the purposes of addressing the problem of teachers who were teaching mathematics without proper training. A conservative estimate of 50% middle school and high school teachers teaching mathematics without even a minor in mathematics was enough of a reason to convene such a meeting. The tension in today's mathematics classroom is testament to the fact that the teaching of mathematics, having already gone through much change in the past century is due for another overhaul (Wu, 2006). How we motivate our students to appreciate, enjoy, study and understand mathematics is now one of concern in the wake of results in the latest 'Trends In Mathematics and Science Studies' (Gonzales, Guzmán, Partelow & Pahlke, et al., 2004). Since there is no fundamental reason to think that today's students are incapable of comprehending mathematics compared to students a couple of decades ago, one must look to those who teach these students to try to understand the issue of below average mathematics performance. Who are these teachers, how are they being taught and most importantly, what is being done to support them to enable them to teach a cohort that learns differently, lives differently, thinks differently and tends to apply concepts differently from those teaching them? For, while adult pre-service teachers are very motivated in their newly chosen profession, there is no doubt that their inability to block out previously held (and inherently erroneous) beliefs in mathematics education is a contradiction in terms (Wedeg, 1999) since these learners bring a wealth of experience and common sense competence from their everyday lives. One of our adult students observed:

'Some types of math have always been a struggle; however, I am strong in business math. I have a business minor - after I completed my first degree in English and Psychology, I began working on my business diploma, so there are some aspects of math I really enjoy. Our math text notes that education received before 1988 is considered "traditional" math. I graduated from high school in 1988 so all of my math experience is traditional. It was quite a struggle trying to get my mind wrapped around the constructivist theory, after have a rote education in math'

### **Format of study**

Participants in this study all came from one pre-service class, in one Education faculty and were all female. They were also all students in the final year of a B.Ed program as either consecutive or concurrent students. A number of these pre-service teachers began the B.Ed program after having held full time positions in other areas such as nursing, social work & hospitality. These students were those classified as adult students. Of the 30 students in the class, 22 were under non-adults (73%) and 8 were adult (27%).

The primary author was the instructor for the course on *Teaching Mathematics in Elementary School (EDU441 PJ)*, a semester course designed to be delivered face to face for 8 weeks (twice weekly; 90 minutes each session) with a 6 week practicum component. The

underlying purpose of this course, is to develop awareness and understanding of classroom theory and practice in mathematics. Education 441 PJ supports the learning expectations outlined in the Ontario Ministry of Education curriculum policy documents and the departmental mission statement of Redeemer University College. Students in the course are expected to:

- develop a strong foundation and understanding of the vision and underlying philosophy related to mathematics in the primary and junior divisions;
- explore topics and issues of relevance to the teaching of mathematics within the framework of the expectations set forth in the Ministry of Education curriculum policies and guidelines;
- gain an appreciation of the structures of creation, the intrigue and excitement of the mathematical relationships, the cultural changes in the approach to the role of mathematics, commitments to students and student learning;
- acquire knowledge of the mathematics curriculum; and
- become aware of the components of a positive learning environment for mathematics.

The course includes the exploration of:

- the current trends in the standards of school mathematics;
- how children learn mathematics with understanding;
- the role of the teacher in mathematics, planning and assessment;
- a study of the fundamentals of the five major strands of the primary/junior and junior/intermediate mathematics curriculum; and
- new approaches to mathematics, strategies for lesson planning, active learning, assessment and evaluation, the use and role of technology, and resources for teaching mathematics.

The theoretical perspective of the study was therefore based on the five key elements of the Ontario College of Teachers Standards of Practice for the Teaching Profession and provides the focus for the teaching of mathematics while the Ethical Standards for the Teaching Profession, also from the College of Teachers, provide the framework for student learning about the development of principles of the teaching profession. Education 441 PJ is part of the Redeemer University College program of teacher education that seeks to foster an attitude of continuing professional development so that the teaching of mathematics is not a static set of practices, but a commitment to personal and professional growth.

The course was delivered through five broad areas of (i) teaching methodologies, (ii) 6-week practicum in an Ontario classroom, (iii) one-on-one tutoring component with a student struggling in mathematics (iv) a series of reflections & papers looking at the history of mathematics, famous mathematicians and the relevance of mathematics in our lives and (v) whole class mathematics competency tutorials. The practicum and one-on-one tutoring were carried out during the same 6 week block of time for convenience. Most students reported that this arrangement worked well.

A pre-study survey (survey 1) was carried out in the first week of the course to establish answers to questions related to:

- age & mathematics background of participants [This was always asked in subsequent surveys];
- beliefs about who and what makes a good mathematics teacher;
- teacher's confidence in her own mathematical ability; and
- basic Mathematical competency of teachers.

A second survey was carried out midway through the course, when all students had passed the required competency test, worked on reflections and had experienced 4 weeks of methodologies. The main focus of that survey was to see if there were any changes in:

- beliefs about who and what makes a good mathematics teacher; and
- teacher's confidence in her own mathematics ability.

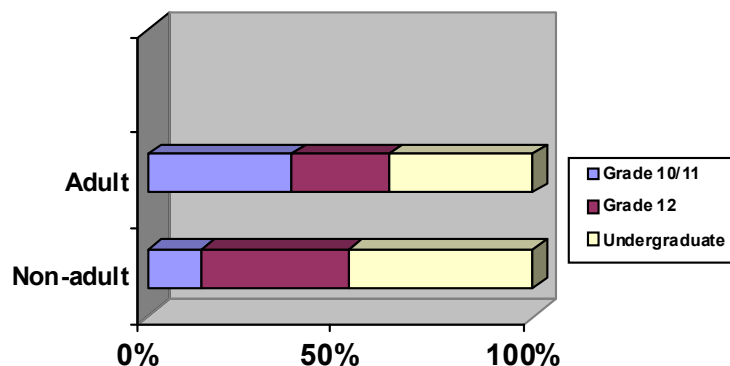
The third survey was carried out at the end of the 14 week course, asking questions about:

- beliefs about who and what makes a good mathematics teacher;
- the teacher's confidence in her own mathematical ability;
- whether the practicum changed the pre-service teacher's perception about beliefs and confidence in mathematics; and
- whether various activities (e.g. tutoring a student) during the practicum changed teacher perception of beliefs and confidence?

The authors recognize that there are obvious limitations to this type of study: using only one faculty of education, a study involving the author's own class, one-gender participant pool and a small statistical sample. However, the one-gender participant pool helped clarify some of our results and through this study, the authors hope to shed light on the emerging trend of adult students and hopefully glean some insight into the various components of an elementary mathematics education program that will best help them to be most effective in their future classrooms.

### Survey results

The response rate for survey one was 100%, survey two was 81% and the third was also 81% with approximately 6 weeks between each survey. Analysis of the sample population showed that the education level differed by age. Only 62% of the adult learners completed upper level high school mathematics courses (Grade 12 or higher) while over 85% of the rest completed that same level of mathematics education. Further, we noticed that only 38% of adult learners completed some university-level mathematics courses while nearly 50% of non-adult learners completed the same. It is evident therefore that adult learners in this sample size have had less tuition in mathematics than non-adult learners in the class.



*Figure 1.* This figure is an expression of the highest level of mathematics education the students completed. A much larger percentage of students under 25 years (non-adult) completed post-secondary studies in mathematics than the adult learners.

When we asked respondents at the time of the first survey, to agree or disagree (i.e. is the statement true or false?) with the statement: ‘You’re either good in mathematics or you are not’ (i.e. is it an innate ability?), 37.5% of adult learners agreed with the statement, while 27.3% of non-adults agreed. By the second survey, the adult learners who agreed were still at 37.5%, and the non-adults who agreed with this statement had dropped to 11.8%. By the third survey, at which time the practicum was over, we observed that 42.9% of the adults agreed with this statement while 5.6% of non-adults agreed. Although the entire class believed overwhelmingly that mathematical ability was not innate, our results indicate that proportionately more adult learners agreed with this statement.

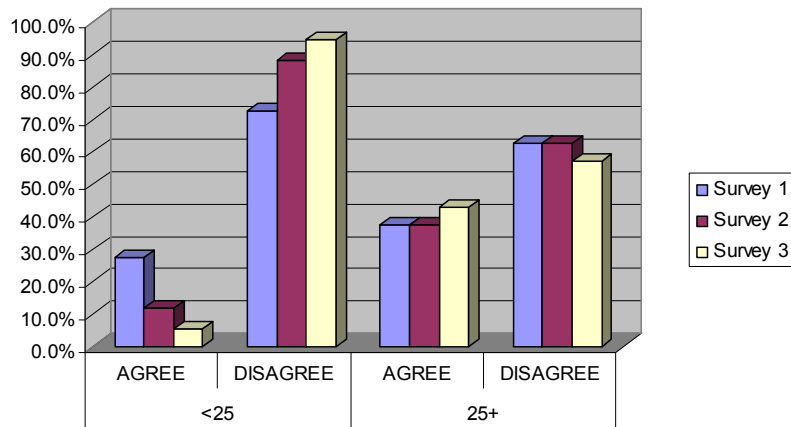


Figure 2. This graph shows the variation in beliefs about the innateness of mathematics ability by students who are less than (non-adult) or older than 25 years (adult). Surveys 1 to 3 are compared.

In response to the statement: ‘All elementary teachers must like mathematics to teach it well’, 62.5% of adult learners believed this to be true while only 36.4% of non-adults believed this to be true at the time of the first survey. At the time of the third and final survey, adult learners who agreed with this statement decreased to 28.6% while non-adult learners dropped to 27.8%.

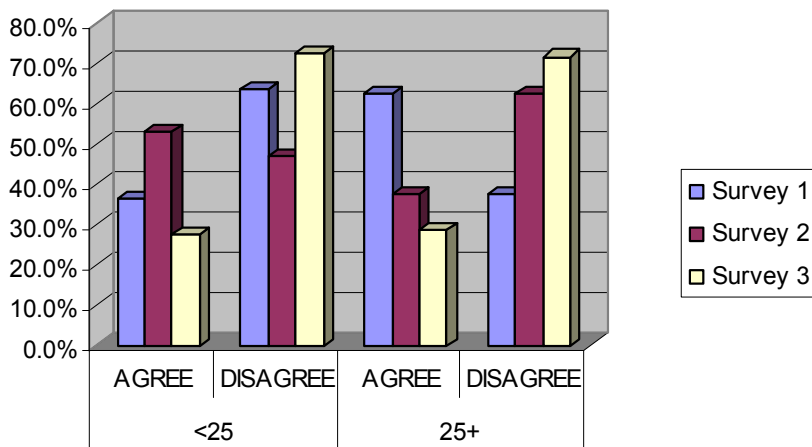


Figure 3. This graph describes what students who are less than (non-adult) or older than 25 years (adult) think about the direct correlation between liking math and being able to teach it well.

Using a Likert Scale of 0 to 5 with 0 being ‘strongly disagree’ and 5 being ‘strongly agree’, we asked what helped the students most in their preparation to teach elementary mathematics. There was a general consensus that the most helpful aspects of the course were the professor (knowledge, experience, teaching style and support), peer group support, and the children’s mathematics literature discussed in class (these were the categories that received an average rating of 2 out of 3 or better). When asked to rate their ability to understand mathematics at the first survey, adult learners responded with an average of 2.5 on the 5-point Likert scale. This number increased to 2.75 at the second survey and at the third and final survey had increased to an average of 3.3. In terms of self confidence with regards to mathematics, adult learners’ response went from an average of 1.6 in the first survey to 3.0 in the second to 3.4 in the third and final survey (Figure 4).

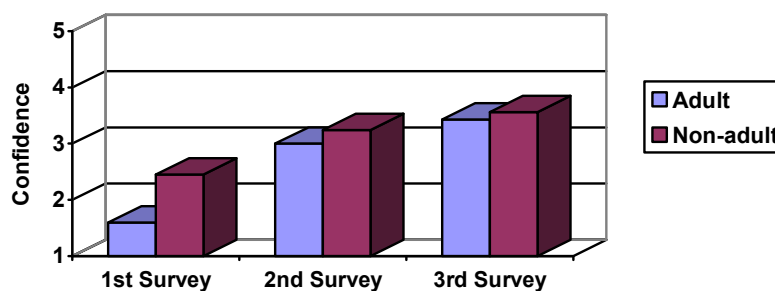


Figure 4. This graph shows the increase in confidence, where 1 is least confident and 5 is most confident, during the course of the semester.

The observed higher increase in confidence of adult learners when compared to the non-adult learners is an interesting one. As one adult student who previously worked as a teaching assistant said,

‘To be honest... I never thought I would be able to teach a math class as my own skills are so weak, but through perseverance and a little guidance, I taught an entire math unit successfully. I think it had a lot to do with looking at math differently than my own childhood experiences which had been so rote and so negative’

The third and final survey (taken after the 6-week practicum section of the course) introduced a new question regarding how various components of the practicum helped each student understand and appreciate mathematics more. Overall, on a Likert scale of 0 to 3 (with 0 being ‘not effective’ and 3 being ‘very effective’), the most frequent rating given to each one of: Observing a teacher, designing a lesson, reflection with classroom teacher and teaching a class was 3, whereas tutoring a student one on one in mathematics was frequently rated a 2. Adult students rated these different aspects of the practicum lower in terms of value than the non-adult students. As one adult student reflectedz:

Designing a math lesson and teaching it was great because I needed to take what I learned, make sense of it and try to determine how I would teach it. One thing that I ran into when I went into my placement was that I was not able to use constructivist methods and the materials I had collected from my resource folder within my new classroom because the associate teacher used a different approach to math, a more traditional approach. I had to fall into his mold for continuity of the class.

This highlights one of the issues our newly trained teachers are going to face in their schools: ‘seasoned’ teachers who have always done it the ‘old’ way and who believe that it is still the best way despite mounting evidence that the three significant aspects of mathematics education: coherence, reasoning and precision are woefully missing from the standard math textbooks and curricula that teachers are using everyday (Wu, 2007).

## Discussion

While some education programs have called their program of mathematics competency training an intervention (Simon & Schifter, 1991), there is some indication that an education program that combines mathematics competency with mathematics teaching methodologies and confidence boosting approaches in the form of constructivist teaching methods may be successful at producing teachers who are not afraid to teach mathematics. These teachers may teach differently (and yet better) from how they were taught. Research has shown that there is a direct correlation between performance attributions, self efficacy and achievement in mathematics and this is even more profound in girls (Lloyd, Walsh & Yailagh, 2005). When girls underestimate their capabilities, they tend to avoid mathematics courses and careers because their attribution pattern is one of internalising failure and externalising success (Pajares, 1996). Despite the fact that one of the perceived weaknesses of this study was the all-female pool of participants, this allowed us to remove any gender variability so that the result of confidence boosting approaches to mathematics study was easily observed.

Simon and Schifter indicate that their methods resulted in teachers being more confident and most importantly, being able to use more hands-on methods in their own classrooms. Prior to initiating this study, the authors were aware that adult learners bring a wealth of experience to their new careers as teachers but this experience, although significant, can be crushed by an overwhelming sense of ineptitude when it comes to mathematical competency. Through a carefully designed syllabus that sought to recall and in many cases re-teach basic mathematics concepts, previously math-anxious adult elementary pre-service teachers experienced an increase in confidence and a change in beliefs regarding who could teach mathematics well. This confidence was palpable. By going out into the field to teach mathematics to a whole class, as well as one on one with a struggling student, participants in this study were able to augment their learning with practical experience producing an overall sense of accomplishment. Although the adult learners started out with the lowest confidence in their abilities (Figure 4), they experienced a larger increase in confidence over the course of the fourteen week program than non-adult students. It was also evident that along with an increase in confidence came a change in beliefs about who could understand and teach mathematics. The results indicate that adult learners especially had grown to believe that they could teach mathematics well even if mathematics was not their favourite subject. One adult student said:

‘My overall experience was good. It helped me understand that I don’t have to be a mathematics genius to be able to teach it (by the way, this was not what I thought when I first started taking the course), but now I understand that you can learn it while learning how to teach, it just needs an open mind and willingness to try to learn it’

Also noteworthy was the finding that although all student teachers benefit tremendously from a practicum experience, adult learners seemed to gain less overall from the experience than their younger counterparts. The only aspect in which the adult learners made significant gains, higher than those of the non-adult learners was an increase in confidence. It would seem that the practicum period seemed to be a return to the ‘workplace’ and was used as a time to build confidence facilitated changes in perception about who can understand and teach mathematics.

There is little doubt that an individual’s life chances for employment and income in

contemporary societies worldwide is strongly related to their level of literacy (Wagner & Venezky, 1999), in mathematics (also referred in some studies as numeracy) as in other subjects. A student's ability to comprehend mathematics and to use it effectively depends in large part on the teacher's ability to teach mathematics (Kaplan, & Owings, 2002). Ontario's teaching landscape (like many parts of the world) has shifted dramatically over the past few years. In the late 1990s and early 2000s, new graduates were in strong demand because of higher than expected retirements. In 2000, for example, 7100 teachers retired and 8800 new educators graduated. Despite a reported surplus of English language teachers in the province of Ontario (McIntyre, 2007), all the faculties of education continue to report record numbers of applicants to both concurrent and consecutive programs, with more than half of the applicants applying for elementary teaching. Of this number, an increasing number identify themselves as adult learners (personal observation). What remains to be seen is how our adult pre-service teachers hold up in the classroom over the long term: by how much does their pre-service confidence improve? Do they continue to be lifelong learners? Are they motivated to learn more mathematics? Do they see a correlation between their ability to teach mathematics and any in-service mathematics education they may have taken advantage of?

If the goal of the elementary mathematics curriculum is to provide children with a solid foundation in mathematics, it makes sense to equip elementary teachers with the necessary content knowledge so that confidence is not only boosted but sustained. Our preliminary study showed that the likelihood of a teacher 'teaching for understanding' will be greater when she knows and understands mathematics and is confident enough to let this knowledge 'trickle down' to her students.

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