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1. What have you learned about teaching/learning in your research?

I have had the pleasure and the privilege of following classroom teachers in their natural environment. Over the years, I have been able to follow dozens of French-language teachers from Kindergarten to Grade 12 as they attempt to steer away from the traditional ways of teaching mathematics. My research has been a combination of qualitative and quantitative methodologies, and has spanned most of the province.

Over the past five years, I have followed 10 separate French-language initiatives in their implementation of the collaborative inquiry model (Bruce, Ross, Demers, Duquette, and Esmonde, 2009; Demers, 2012, 2013a, 2013b). Each project involved between four and twelve teachers ranging from Grade 3 to Grade 10. Throughout those projects, a number of findings emerged consistently. In particular, where the greatest gains in student self-efficacy were consistently identified were contexts where teachers felt they had support from a competent third party – in these cases either an outside consultant or an in-board consultant – and enough latitude to experiment and push their own comfort levels without being judged. Most participants found the collaborative inquiry model to be highly engaging and effective in moving their approach to teaching mathematics from a traditional view of knowledge transfer to a focus on students learning through the use of various pedagogical strategies such as bansho, manipulatives, and problem-solving. As in many schools and boards, teachers have consistently said that they have very few opportunities to share practices. French-language schools are typically very small and seldom have more than one teacher at each grade level, and more often than not, multi-year classrooms. These initiatives have given teachers the opportunity to meet, discuss, share and learn as a group, truly creating a professional learning community.

Studies over the years have looked at how boys and girls learn mathematics. One of the assumptions is that there is a biological difference between boys and girls that make boys predisposed to do better in mathematics. Most school boards are interested in investigating this aspect in order to ensure that all their initiatives ensure the success of both genders. Some studies (Vezeau, Bouffard and Chouinard, 2000) identified mathematics as the subject area where girls would most benefit from a single-sex environment. In one research project I lead (Demers and Bennett, 2007), a school decided to have an all-boys and all-girls Grade 6 class, with a man teaching the boys and a woman teaching the girls. This was a particularly interesting situation which accentuated the differences that often times go unnoticed in a mixed environment. This particular project showed that boys had a greater success rate at understanding mathematical concepts with the use of manipulatives than did the girls. Boys were also more engaged, as a group, in their learning in the mathematics classroom than did the girls.

Two consecutive studies on Francophone students' performance on EQAO testing (Radford and Demers, 2010; 2013) helped shed both some qualitative and quantitative light on the system. In the first instance six, and in the second eight school boards participated in these studies tracking two distinct cohorts of students as they went from Grade 3 to Grade 9. We found that up until Grade 6, students have very stable results on both their report cards and EQAO scores. Results then started to decrease as the mathematical concepts became increasingly more complex and abstract. Our analysis of open response and multiple choice questions of the Grade 9 EQAO test showed that students had difficulty in building algebraic models of the situation, both in setting an accurate equation, and in solving it. Using a Generalized Hierarchical Linear Modeling approach, our analysis showed that the Grade 6 EQAO score was the best indicator of meeting the provincial standard in Grade 9 in our 2010 study (our data was for Grade 6 to Grade 9) whereas our follow up study of another cohort showed that reaching the provincial standard on the Grade 3 EQAO Reading test, along with reaching the standard on the Grade 6 EQAO mathematics test were the best predictors of a student's chances of reaching the standard on the Grade 9 EQAO mathematics test.

The collective knowledge gained from these studies lead me to conclude that the following strategies or behaviours have the best chance of leading to student success in mathematics, and come mostly from studies looking at students in the Junior and Intermediate levels. Firstly, from our initial study that looked at communication (Radford and Demers, 2004), and later on at abstraction (Radford and Demers, 2009), we found that students had the most success when they worked on problems as a group rather than individually. This permitted them to have meaningful discussions on mathematical concepts. Meaningful discussions by students are the second common ingredient to successful teaching and learning in mathematics classes. These discussions occur both between the teacher and students, but more importantly space and time is given for students to discuss between themselves. In order for the students to carry on meaningful discussions, teachers need to give students open-ended questions, or questions that can be solved in a number of different ways. Beautiful discussions between students have been witnessed when they struggled with a new concept and had to work collaboratively to solve the problem. The type of problem presented to the student should be open, but should also permit the use of manipulatives. We observed students creating meaning by utilizing manipulatives and then teachers taking this new found understanding and converting it to a more abstract, algebraic, understanding. Such a transition between abstract and concrete, and between concrete and abstract, is a necessary condition to a fulsome understanding of mathematical concepts. The use of technology, in particular calculators, was shown in our various studies as being a very helpful tool to visualize mathematical concepts. These powerful tools permit students to concentrate more on their problem solving abilities and less on computational abilities which are already mastered. Finally, we have found that optimal learning occurs in an environment where the teacher lets students discover concepts, but also know when to intervene and teach the concept. With all of the above, the most important aspect to consider is that of balance. Teachers must vary their teaching strategies so as to touch a maximum number of students. In that context, some days students should be asked to discover a concept, but on other occasions, there should be more formal teaching of the concept. Teachers need to use their professional judgement and their experience to determine which strategies work best in which contexts.

2. Specific question regarding your research

The following identifies some of the most prevalent research questions dealt with in the last 10 years of my research on mathematics teaching and learning in French-language schools in Ontario. There is no particular order to the questions listed as they are all part and parcel of a complete understanding of a very complex issue:

- To what extent can the collaborative inquiry model be modified to meet local needs yet maintain its efficiency?
- Can teachers correctly identify strategies to bring students currently at Level 2 to perform at Level 3?
- How can descriptive retroaction in a mathematics classroom help the student to build a better understanding of concepts?
- Can we produce a statistical model to identify variables that affect a student's performance on the Grade 9 EQAO mathematics test?
- Can we identify variables that would permit an early screening of students who later display difficulties in mathematics?
- Can we identify strands that give students the most difficulty, and can we identify the nature of those difficulties?
- Can we identify learning opportunities for teachers?
- What are the characteristics and qualifications of the teachers at the Junior and Intermediate levels in Francophone schools?
- How is mathematics learning occurring in French-language schools in Ontario?
- What are the factors evoked to explain the important reduction in the number of students attaining the provincial standard in Grade 9 versus in Grade 6?
- What are the factors evoked to explain the important reduction in the number of students attaining the provincial standard in the Applied stream versus the Academic?
- What are the most popular classroom evaluation strategies?
- What strategies do students use to communicate their understanding of mathematical concepts?
- Do students have the ability to listen to mathematical discourse, interpret the arguments and critically evaluate others' arguments?
- What are the characteristics of a lesson that encourages the passage from concrete to abstract?

3. What further questions about mathematics teaching and learning are you now beginning to examine?

Despite the large number of studies on mathematics teaching and learning, there are still many questions that remain unanswered.

1. Engagement is a critical attribute in any classroom, but particularly in intermediate mathematics classrooms. How can mathematics be made more engaging for students, and does the engagement then produce an increase in their mathematical abilities?
2. We have looked at the academic trajectory of two French-language cohorts. Such an analysis should continue particularly because of the much improved performance of Francophone students on the 2012-13 EQAO Grade 9 mathematics test. It will also be interesting to see if this performance will continue or if it was a one year aberration.
3. A recurring question is with respect to the permanence of the changes that are seen in the collaborative inquiry projects. Are the changes in teaching strategies still present once the consultants are removed from the school, and do the progresses made by students continue through their academic career?
4. Technology is ubiquitous in the world outside of the classroom. How do teachers currently use technology and what is it the best manner of going forward with these powerful tools as many teachers contend that students must learn mathematics in the same way as they have done themselves?
5. Manipulatives have been shown to help students better understand complex mathematical concepts. Teachers have, for the most part, learned mathematics without their use. How can these two worlds be reconciled so as to give the best possible chance for all students to learn mathematics?
6. How has the use of the *Réseau de conseillers pédagogiques en numéracie* helped improve the performance of students?
7. How can student and teacher self-efficacy be improved and maintained through regular, day-to-day activities (as opposed to special initiatives)?
8. What are the best practices to promote a better transition between the concrete and the abstract?

References

Bruce, C., Ross, J., Demers, S., Duquette, S. and Esmonde, I.(2009). *Literacy and Numeracy Secretariat Mathematics Professional Development Program Evaluation* (CIL-M). Research Report.

Demers, S. (2012). *Interventions en numératie aux cycles moyen et intermédiaire – Projet mené par le Conseil scolaire catholique de district des Grandes Rivières – Phase 2*. Research Report.

Demers, S. (2013a). *Projet d'enquête collaborative en numératie de la 6^e^ à la 10^e^ année - Projet mené par le Conseil scolaire catholique Franco-Nord*. Research Report.

Demers, S. (2013b). *Projet d'enquête collaborative en numératie de la 6^e^ à la 10^e^ année - Projet mené par le Conseil scolaire catholique Franco-Nord.* Research Report.

Demers, S. and Bennett, C. (2007). *L'effet d'une classe homogène de garçons et de filles sur la performance et la motivation de ces derniers.* Research Report.

Radford, L. and Demers, S. (2013). *Étude du rendement des élèves aux tests provinciaux de mathématiques de l'OQRE.* Research Report.

Radford, L. and Demers, S. (2010). *Pratiques pédagogiques et rendement des élèves au Test Provincial des Mathématiques de l'Ontario.* Research Report.

Radford, L. and Demers, S. (2004). *Communication et apprentissage. Repères conceptuels et pratiques pour la salle de classe de mathématiques*. Ottawa : Centre franco-ontarien des ressources pédagogiques. 206 pages.

Radford, L., Demers, S., and Miranda, I. (2009). *Processus d'abstraction mathématique* (with DVD). CFORP. 162 pages.

Vezeau, C., Bouffard, T., and Chouinard, R. (2000). The impact of single-sex versus coeducational school environment on girls' general attitudes, self-perceptions and performance in mathematics*. Journal of Research and Development in Education, 34*(1), 49-59.