Should (or Does) Mathematics Education Research Inform Our Mathematics Teaching Practices?

Est-ce que la recherche en didactique des mathématiques informe (ou devrait informer) notre enseignement des maths?

Chantal Buteau, Nadia Hardy and Joyce Mgombelo

Does (should) mathematics education research inform our mathematics teaching practices (Biesta 2010)? This remains a widespread debate among the mathematics education community; it stems from a perceived gap between research in mathematics education and its potential to change teaching practices. It is in this context that the theme of the one-day Canadian Mathematics Education Study Group (CMESG) preconference on "Mathematics Education Research and Mathematics Teaching: Illusions, Reality, and Opportunities," hosted at Brock University in May 2013, was framed. At the event, some 90 math educators, 47 CMESG delegates and 43 local community members came together to reflect on the gap between mathematics education research and the practices in mathematics classrooms.

La réflexion a eu lieu par le biais d'un exposé plénier par John Mason (Lerman 2010) et des groupes de travail pour chaque niveau d'enseignement. Elle a été guidée par les questions suivantes: Quelle recherche informe l'enseignement des mathematiques? Comment cette recherche vientelle à être mise en pratique? Quels sont les problèmes et les lacunes? Dans cet article. nous résumons les principales idées discutées à propos du niveau universitaire et l'exposé plénier. Nous concluons avec quelques questions et préoccupations au sujet des questions soulevées par le conférencier plénier et les participants.

A Summary of John Mason's Keynote: Responsive and Responsible Teaching (Lerman 2010)

Responsive teaching involves thoughtful response to learner behaviour, informed by principles and assumptions about learning. The teacher, however, may not have a discourse to justify actions or choices.

Responsible teaching is when the choices to act and the expected results, both during preparation and the minute-by-minute flow of the classroom, can be clearly articulated and justified through the use of technical terms, assumptions and values.

Mathematics education, as a research domain, has the responsibility to promote responsible teaching, stimulating teachers to bring assumptions, actions and other practices to articulation so that they can be compared and used to justify or challenge established practices. This claim is founded on the growing evidence that teaching practices are effective only when teachers understand the principles underpinning them. This understanding and the articulation and justification of choices require a certain degree of acquaintance with mathematics learning theories and their values and assumptions as they concern the lived experiences of mathematics learners.

En ce sens, de la recherche en didactique qui peut apporter quelque chose d'utile au développement curriculaires et aux pratiques en classe devrait mettre en évidence des actions et sensibilités a l'égard de ces actions, tout en montrant clairement comment elles s'alignent avec les hypothèses et les valeurs sur l'apprentissage des mathématiques (i.e., avec les théories de l'apprentissage). et la façon dont elles se déroulent dans des situations particulières, sans essayer de prétendre que ceci ou cela "fonctionne": voici pourquoi.

There are two major gaps in the research-practice domain of mathematics education: between researchers and policy-makers, and between researchers and teachers. The pragmatics of education means that policy-makers, leaders and teachers would like to know what works and what does not. But all attempts to turn theories into recipes for action will flounder because human beings are agentive organisms not machines, and trained behaviour may only work in local conditions. Certainly, training mechanical aspects of human behaviour can be successful, but only temporary; as soon as conditions change, trained behaviour becomes useless without educated awareness to guide it, which is why drill and practice can get learners through tests and even a few examinations, but leaves them feeling they don't understand, and vulnerable to changed conditions. This applies both to teachers and to learners. Cause and effect is not a dominant mechanism when human beings are involved. There are no practices that work independently of the context and conditions, and the variables involved cannot be specified sufficiently precisely, or perhaps even enumerated, so as to guarantee results. If research in mathematics education is taken as a tool for deciding between different teaching actions, then great care is needed to discern the relevant conditions and context that make those actions work.

From this perspective, valuable results in mathematics education research are, for example, those that reveal different

- ways in which learners reconstruct procedures from fragments of other procedures,
- ways that learner attention can be induced to shift toward what is mathematically significant and
- ways of inducing learners to encounter challenges they would not otherwise have considered.

But how does such research come to be put into practice? Effective mediation between research and practice involves the design of curricula and tasks clearly aligned with assumptions and values about learning, so teachers (and students) may articulate and justify their practices. This may lead to challenging assumptions, predispositions and perspectives about teaching and learning, but the goal is that this questioning takes place within a supportive and sustained environment so that changes in the discourse go hand in hand with changes in practices and changes in perspective. What matters are the learner experiences and the teacher in relation to both learners and mathematics. Mathematics education has a long history of looking for simple cause and effect, for silver bullets that will have an immediate and significant impact on learner performance. But teaching is a caring profession, and teaching mathematics is about caring passionately for learners and for mathematics, and for relationships between people and mathematics.

The underlying metaphor of education as a factory based on the mechanism of simple cause and effect needs to be challenged at every level. Maintaining complexity, respecting human beings as agentive, desirous and value directed, and respecting mathematics as a mode of enquiry and world perspective requires ongoing elaboration and support.

For more details, see Mason's various writings and publications at his website: http://mcs.open.ac.uk/jhm3/.

Mathematics Teaching at University Level: How Big of a Gap Is There Between Mathematics Education Research and Teaching Practices?

The focus of the working group (WG) was on the teaching of introductory mathematics courses (mostly calculus and linear algebra) as it was claimed that the issues around teaching these courses are significantly different than those around the teaching of advanced mathematics courses (such as abstract algebra or measure theory), and time was insufficient to address all. The WG participants (a group of 12 professors, researchers and graduate students) stressed several aspects of a perceived gap between research and the realities of the everyday teaching of these courses. In particular, they pointed out that related research often constrains its own capability of being put into practice since it considers ideal situations that are far from the realities of classrooms and students, and of teachers and their constrained practices. For example, research seldom takes into account students' diverse backgrounds, class size and time, and other institutional constraints such as how powerless instructors of

introductory courses are to alter or influence curriculum design and everything it involves. (They don't choose content, often not even the order in which content is presented, and they have little or no control at all over assessment, textbook choice and so on.)

À la question de quelle recherche pourrait être "utile" pour l'enseignement. un groupe de participants a plaidé pour la recherche normative, i.e .. qui prescrit une approche pédagogique qui "fonctionne": "si on enseigne de telle ou tells façon les élèves apprendront/comprendront." Une discussion s'en est suivie, à partir des critiques formulae, lors de la présentation plénière. á l'endroit du paradigme de recherche "cause et effet." Les didacticiens en mathématiques qui participaient au groupe de travail (qui étaient pour la plupart également professeurs d'université de mathématiques) ont reconnu la frustration des professeurs d'université qui sentent leur liberté académique—qui devrait inclure la liberté d'explorer et de remettre en question les hypothèses institutionnelles et personnelles, les prédispositions et les perspectives sur l'enseignement et l'apprentissage—plus souvent qu'autrement bafouée par les pratiques institutionnelles actuelles.

Further Comment by the Authors

The view that research in mathematics education should be of prescriptive nature, providing scientific evidence that such and such teaching approach works or doesn't work seems to have gained popularity among the many educational stakeholders. The keynote speaker argued against a cause-and-effect approach to research in (mathematics) education, emphasizing its humanistic and social nature. Other researchers have expressed further worries with this approach (for example, Biesta 2010; Lerman 2010): the question of what works and what doesn't assumes that the ends of education are given, and that the only relevant questions to be asked are about the most effective and efficient ways of achieving those ends. Focusing on what works makes it difficult, if not impossible, to ask questions of what it should work for and who should have a say in determining the latter.

References

Biesta, J J G. 2010. "Why 'What Works' Still Won't Work: From Evidence-Based Education to Value-Based Education." *Studies in Philosophy and Education* 29: 491–503.

Lerman, S. 2010. "Theories of Mathematics Education: Is Plurality a Problem?" In *Theories of Mathematics Education*, ed B Sriraman and L English, 99–109. Springer-Verlag: Berlin, Heidelberg.

Note: The preconference was supported by the Fields Institute, Brock University and Pearson Publishing Company. The working group was led by Nadia Hardy (Concordia University). The summary presented here is based on notes taken during interactions in the working group.

Chantal Buteau and Joyce Mgombelo are associate professors from Brock University, Saint Catharines, Ont; and Nadia Hardy is an associate professor from Concordia University, Montréal, QC.

Reprinted with the permission of the Canadian Mathematical Society; this article was originally published in CMS Notes, *December 2014. Minor changes have been made to conform to ATA style.*

Comments from Your Executive

I found this to be an interesting article as I have been one to sit on the fence regarding best teaching practices based on research and/or on education personnel experiences to use in a high school mathematics classroom. For me, whether from presentations, discussions or reading, I evaluate how one or maybe more ideas can or will improve my teaching practice for my students in a whole class or for one student. From the phrase "what works for one does not always work for another" is what I think all teachers, parents, tutors, administrators, curriculum developers, government education departments and so on need to keep in mind.

To be the most effective in teaching mathematics to others is being knowledgeable in the subject of mathematics first. Next, one must become very familiar with the student's abilities in mathematical concepts as well in how a student learns. As one is exposed to research and other mathematical resources, one will include and/or adapt the ideas in one's teaching practice. To improve one's teaching practice, the best resource is the student's written work, whether presented in written form or orally.

Donna Chanasyk is the secretary of MCATA and department head of Special Programs at Paul Kane High School in St Albert.