Response to H. Burkhardt
Panel II Report

Chair: France Caron – Université de Montréal

Panellists: Frédéric Gourdeau – Université Laval, QC
Philippe Labrosse – Commission scolaire Marguerite-Bourgeoys, QC
Katie Pirquet – SD 62 Sooke, (retired), BC
Eric Robert – Leo Hayes High School, Fredericton, NB

The chair started by thanking Hugh Burkhardt for his most relevant and provocative talk. Then, each of the panellists was invited to share his or her reaction to the talk, which can be read in its entirety as one of the appendices to this report. We thank all the panellists for the generosity and passion with which they shared their stories and reflections.

Teachers from the panel could relate to the view of "functional mathematics" presented by Dr. Burkhardt, either as a direction their provincial math curriculum is currently taking or as an option it once offered and marginally supported. Although all panellists recognized the value of including some functional mathematics into the curriculum, their responses (as well as comments from the audience) mainly addressed the difficulties, hurdles, issues and concerns about going in that direction. These can be regrouped into six major themes.

1. Representations and goals

When it becomes an official and separate curriculum stream (as was the Applications mathematics program in BC), functional mathematics is perceived by parents and counsellors to be the easier path, less rigorous, less representative of what math really is, and therefore less valued (if recognized at all) for entering university. In addition, some mathematicians may find that typical functional math problems do not have the attributes that they normally associate and value with mathematics: structure, rigor, generality, beauty or even fun, creativity, and imagination. Those representations come at odds with what teachers are trying to develop in such courses: mathematical modeling and deeper understanding through the tackling of complex real-life situations and open-ended problems. As such tasks are not considered part of the typical math class contract, teachers perceive great resistance, both from students and their parents, to go for this "risky" approach. The resistance is particularly strong if the course was initially perceived to be the easy one or if the approach is not shared by all teachers of the same course.

2. Tasks and resources

The problem of coming up with rich, significant, yet accessible modeling tasks is not an easy one. First of all, the word "significant" may mean different things to different people, and may even constitute an obstacle to the richness of the problem. Second of all, the skill levels of the students, combined with their specific cultural background, appear to call unavoidably for adaptations of the tasks taken from textbooks. Can a larger scale, more systematic design and validation process help reduce the need for adaptation? Some panellists expressed their doubts. If the institutional goal remains for the student to master a few techniques and concepts, then some teachers may find it more beneficial to "adapt" modeling tasks with "perfect data", so that they lead directly to the model that has just been taught. If developing modeling competencies is truly the goal of a program, then calculators and computers must be present as resources, as they play a major role in tackling the complexity of authentic real-life situations. Having these tools as resources opens the door to more exploration, manipulation and investigation, but this should be done jointly with the development students' critical attitude and judgment towards the use of the tools and the results that they produce. In any case, it is worth remembering that the tasks and resources alone, as good as they are, do not determine the quality of teaching and learning that take place in a class.

3. Students' knowledge and skills

If functional mathematics can be described as a sophisticated use of relatively simple mathematics, it can turn out to be really difficult for students who are already struggling with such simple mathematics. The Three-Year Gap (between the time students learn a new mathematical content and the time they reach autonomy in using it in a functional fashion) constitutes a real challenge for teachers who try to incorporate modeling tasks in the learning activities that they propose to their students.

4. Time issue

For both teachers and students, modeling projects take a lot of time. This may be partly due to the complexity of the situation involved and the time it takes to analyse and report on it. But it is also because conducting a mathematical modeling project represents a complete shift in the didactical contract that is implicitly set between a math teacher and his or her students. In addition to the time they spend looking for (and eventually adapting) good functional mathematics learning tasks, teachers that introduce modeling projects as assignments may end up spending many extra hours to provide the support and feedback their students need to progress in their projects. This observation seems to suggest that if modeling competency is to be considered one of the outcomes of the mathematics curriculum, then it has to be addressed much earlier in the school years than it is now; and teachers must be provided with better support.

5. Assessment

Making modeling an official outcome of the mathematics curriculum can only happen if there is a consistent assessment policy that shares that goal and that provides clear guidelines and some practical ways of implementing them. From a lack of tradition in this area, teachers may not feel comfortable in assessing students' productions on open problem situations, particularly when students have yet to learn to document their mathematical reasoning. However, the time and effort dedicated both by teachers and students in developing modeling and communicating skills may not "pay off" at official assessment time, as most provincial standard examinations include almost no "functional mathematics" problems, and are still very much designed around multiple choice questions. If these tests continue to determine what is considered to be mathematical competency and what study programs a student can enter upon graduating, there may be very little motivation and support for a teacher to go beyond "teaching to the test".

6. Collaboration and support

Many panellists expressed the lack of support and feeling of isolation experienced by teachers who try to (or have had to) include more functional mathematics and modeling into their teaching. Besides a clearer direction from ministries of education, which would provide greater coherence between stated goals and assessment practices, it is felt that support, both in terms of direction and resources, should also come from a variety of sources. These include universities, research centers and scientific societies. Such a concerted action could be facilitated if, as a mathematical community that includes both teachers and researchers, we would aim at becoming a more inclusive and stimulating learning community.

A step in this direction, as was suggested at the end of this very engaging panel session, could be to move beyond this sterile opposition between pure mathematics and applied mathematics, starting with the recognition that both can be "useful" and "beautiful", and that both should receive equal attention at every school level.

Response to Hugh Burkhardt: making school mathematics functional

Katie Pirquet
SD 62 Sooke BC

I am a recently retired teacher. I taught Mathematics and Science in small-town middle and high schools on southern Vancouver Island, near Victoria. The area is typical of many small BC communities, that is, formerly resource-based economies that underwent a period of economic collapse and upheaval in the '70s and '80s. Recently, however, at a time when many other communities in BC are shrinking and having schools closed, the last ten years or so have seen rapid development west and north of Victoria. A few communities have undergone a dramatic reinvention of themselves over the last 10 to 15 years. Our school populations are steady or even growing.

During the last 9 years in my secondary school, I implemented, among other things, an Applications of Math program (10 and 11 – we never did offer Apps Math 12). With few exceptions, I was largely on my own because nobody else wanted to teach it. Too messy and no glory. Despite enormous effort, this program never did manage to escape an unfortunate "Twilight Zone" of expectations. We just could not dispel persistent notions, abetted by unrepentant counsellors and misinformed parents, that Apps was "the easier course" and "you can't go to university with Apps Math". Neither of these was fully true. We also had trouble with parents who wanted their kids to follow the "easier" Applications path, and then switch to Principles for Math 11 so they could "go to university", a strategy that virtually never led to success.

So the first thing I observed about our venture into more 'functional' mathematics was a cultural bias toward belief that Math which is functional is not "real" or rigorous math. It is "easier" math and it doesn't get you anywhere you really want to go, because only abstraction and computational skills are valued when the goal is to get into college or university.

Nevertheless, we pressed on. Eventually, I believe that we did manage to get perhaps 30% of the way to a truly functional mathematics program. Over the years my students gained experience with modeling lots of different systems mathematically, asking and answering questions that were complex, open-ended, political, ambiguous, and occasionally impenetrable. A partial list follows:

- Maximum possible profits in a retail or restaurant venture
- Oil field test holes and proposed drilling programs to optimize or maximize yields
- Ski slope and roller coaster design (transformations between potential and kinetic energy!)
- Investigating losses and costs over time from leaking water pipes (very messy and fun!)
- Optimizing profits in manufacturing and retailing
- Optimizing prices and ingredients for fruit/nut/candy trail mixes
- Estimating populations of fish, M&M colours, wild animals, etc. (note: ANYTHING with M&Ms was very popular)
- Money management: major purchases (car, home), credit schemes, budgeting, investments, strategic planning, pay schemes and commissions, taxes, setting and achieving financial goals
- Practical problems using indirect measurement in navigation, architecture, orienteering, and forest management
- Interior decoration and construction design tasks
- Analyzing social issues within the school, such as bullying, drugs, alcohol, product preferences, racism, homophobia, etc.
- Modeling skydiving, artillery, falling objects, prediction of race winners
- Improving basketball free throws, hockey shots, other athletic activities
- Designing of games of chance and strategies for playing same
- Lying with graphs and statistics: how to lie, how to detect lies (I used a lot of Provincial government PR ads from the local daily papers for this – wonderful stuff!!)
- Predicting world population growth by comparing different models, examining assumptions, factors, strengths, weaknesses, and coming up with a "best guess"

In my courses, calculators and computers had a major role in doing a lot of the computation, recording, tabulating, graphing, etc. They allowed us to explore, display, manipulate and investigate our data to make discoveries, find possibilities and construct meaning. I tried to give students some insight into the nature of the machine-human interface, and to convince them of the absolute necessity of a habit of estimating and constantly questioning the reasonableness or sensibleness of results. The tool is of no use without the prepared, agile and critical brain.

Many of the modeling tasks were not mine, but were adapted and enriched from the curriculum and the Addison-Wesley texts we were using. Hardly anything could be done "from the book", because around half to two-thirds of my students just did not have the prerequisite skills or conceptual underpinnings to do "more sophisticated things with relatively simple mathematics". The Three-Year Gap remains alive and well!

Most of my students simply were not ready to use their math for interesting and authentic problems because they had never really hoisted the basics on board. I had kids tell me they had no idea what I was talking about; I used words that were too big (like numerator, equation, coordinate…); what's wrong with 3+8=11+5=16+4=20??? I had students who could not measure a line with a ruler in inches and parts of inches, some who couldn't use basic drawing tools for making simple diagrams without difficulty. Visualization and spatial reasoning were very problematic for my students, as were fraction operations, decimals, percents, algebra, polynomial operations and solving equations. To get anywhere, I had to spend a lot of time on remediation.

Students generally came into AppsMath because they had not done well in PMath 9 or 10. Instead of having weak students repeat Math 9 or 10, the "solution" was just to "drop down" to the Applications stream, where it would all be "easier". The fallacy of this should be obvious. It was to me, but not to parents, students or guidance counsellors.

In addition, there was enormous resistance to a deeper type of learning and to completing projects. They LOVED the hands-on, "Math Lab" activities, but just wouldn't, or couldn't, manage the paper work. I had to give them the whole semester to complete projects, and did not deduct "late marks". Students seemed to need that long, at a MINIMUM, to integrate and consolidate their new skills and understandings, and to figure out how to put it all together as a presentation. They needed a LOT of help with everything, all the time, every little step. I had students in my room at lunch and after school every day, most days until about 6. A lot of them failed anyway. It was heartbreaking and infuriating, when it should have been great fun and a rich learning experience for them.

The bottom line is this: Grade 10 is TOO LATE! If we really are serious about getting the system to focus on Functional Mathematics, it needs to be introduced and nurtured in the early years. By grade 10, this was a radical change of approach for students who had long ago cased the system and made a very different kind of contract with Math classes: listen somewhat in class, crank out answers to the pages of problems, do the tests with all the same kind of problems as the homework, write a bunch of practice provincial exams, pass the course. Too often, this led to a miserable pattern of barely passing, failing the next course, repeating, barely passing, failing the next course, etc., until the system finally let them stop taking any Math at all.

Two issues arise. One is a confusion of goals. Is the goal to be able to do powerful things with Math, or is it strictly to get into university with the prerequisites for Calculus? The requirements are actually quite different.

The second issue revolves around what students, parents, indeed most people think Math competence really is. Pages of repetitive homework, easy-to-mark tests and quizzes, averaged course marking schemes, provincial exams full of multiple choice questions all teach students and the general public, administrators and politicians to believe that high marks are equivalent to Math competence, or that computation and facility with algorithms ARE what Math really is.

Provincial exams provide NO meaningful feedback to students, parents or teachers. In a 2-hour or 3-hour test there are no truly functional math problems to work on. The FSA (fundamental skill assessment) tests, given in grades 4 and 7, serve only to give the Fraser Institute some bogus statistics to promote their deeply right-wing, conservative agenda through their published yearly school rankings. These are based largely on FSA and Provincial exam results; they routinely rank most of the private schools in the top 10%;

they rank ALL schools with no regard to location, entrance requirements, % of ESL students, % of First Nations students, socioeconomic factors or school population (small schools can only offer some courses like Calculus or Physics 12 every two years, or not at all, and cannot offer a wide range of electives, for example).

These rankings are statistically and conceptually invalid, but districts and schools are VERY sensitive about them because politicians and school boards, in their ignorance, give the rankings far more credence than they merit. Districts have to sign Performance Contracts and meet targets for graduation rates and Provincial exam score improvement, or ELSE.

This nonsense has redefined the meaning of "competence" for the public, and has turned math education into an environment where important meanings are being defined by math-ignorant politics. We are enveloped within a creeping corporate model of management that places low value on activities that create real understanding and excellence, and high value on optics, kid-sitting and contact hours, to the neglect of preparation, professional consultation, collaboration, and deeper, more functional learning.

In the corporate world the focus is always on the money, as it must be in business. The only valued expenditures are those that improve the optics, or at least keep them acceptable in the short-term. It is also highly valued to spend less, period. Corporate models of management are being increasingly and inappropriately used by politicians and administrators. In education, money is a limiting factor, but cannot be the focus if you want quality results.

It is a difficult conundrum. Money spent on education has a very long pay-back time, 15 to 30 years or more. Political organizations operate in a much shorter time frame of 4 to 8 years. The focus is not on more powerful learning, more functional education or even on real performance. The aim is to get elected and please your power base by reducing taxes, spending less and handing the business sector more business.

For all of these reasons, the pressures on teachers are enormous to "cover curriculum" and teach exactly and rigorously to the tests. And they are doing it, if they know what's good for them. Strategic administrators are increasingly putting the optics at the centre of their management of their schools, and exam prep is key. It has reached a profoundly dysfunctional, lunatic extreme down south in the USA, where underperforming schools are required to spend huge amounts of federal money hiring private consulting companies, buying expensive materials and devoting significant class time to commercial exam prep programs, in order to "improve" performance. It is a huge business, but it is not really about education.

Recent research showed that schools in BC are increasingly making major changes in course delivery and timing, discouraging poorer candidates, devoting large amounts of out-of-school time to test prep, and using a host of other strategies to increase their test scores and claw their way up the FI rankings. None of these strategies actually improve functional learning or make students more powerful lifelong learners. In terms of benefit to young people, they are a waste of time and money. Functional Mathematics is taking it in the chops.

The system will change only when there are within it, at every level, significant numbers of people who consistently exert pressure approximately in the right direction, and who draw others onto the path. They will need support from the outside – people like Dr. Burkhardt and others – who will continue to shed light, spread the word, teach teachers, provide materials and set examples. Even in business, it is understood that innovation, adoption, and general acceptance of a useful paradigm can eventually make the few diehard holdouts irrelevant. Part of the strategy must be convincing corporate culture of the overwhelming benefits of investing in people who can use mathematics more powerfully.

Epilogue: the new BC Math curriculum has eliminated Applications of Math as a course stream, and now features an academic stream, a workplace and technical math stream and a basic essentials stream. Where will Functional Mathematics fit in now? How will teachers implement these new courses? How will teachers try to address the ongoing problem of the Three-Year Gap? And will organizations like CMS, PIMS and the CMEF, among others, be able to redirect the juggernaut of corporate culture enough to get Functional Mathematics and deeper learning onto to the political agenda?

Réaction à la conférence de Hugh Burkhardt

Philippe Labrosse
Commission scolaire Marguerite-Bourgeoys, QC

Bonjour à tous,

Permettez-moi tout d'abord de remercier l'organisation du Forum Canadien sur l'enseignement des mathématiques de me donner la chance de réagir à la conférence de Hugh Burkhardt. Un merci plus particulier à France Caron qui m'a approché pour participer à ce panel et qui m'a assuré de son soutien lors de ma présentation. Vous comprendrez à mon accent que l'anglais n'est pas ma langue maternelle. Conséquemment, France a donc « carte blanche » pour intervenir lors de mon allocution pour corriger les nombreuses erreurs de syntaxe et de vocabulaire que je ferai, et soyez assurés qu'il y en aura. Je vous remercie de votre compréhension et je vous prie de m'excuser à l'avance de m'en tenir à mon texte écrit.

Je remercie Mr Burkhardt pour sa présentation qui s'attaque à une problématique d'actualité, soit la place des mathématiques « fonctionnelles » et à la modélisation dans les pratiques pédagogiques et évaluatives des institutions et évidemment des enseignants.

Les propos tenus par Mr Burkhardt ne sont pas étrangers à la réalité que je connais davantage, soit celle de la réforme de l'éducation en cours dans les programmes de mathématiques québécois.

Mentionnons rapidement que le Québec, à l'instar de plusieurs autres pays, provinces ou États, est entré dans une période de renouveau pédagogique orienté vers une approche par compétences. Les objectifs principaux de ce changement voulant que les élèves transfèrent en situations complexes leurs apprentissages mathématiques et qu'ils donnent ainsi sens à ce qu'ils apprennent en classe. Ainsi, en mathématiques, des compétences disciplinaires sont développées et évaluées, pour chacun des niveaux au primaire comme au secondaire. Ces compétences, au nombre de trois, sont libellées de la façon suivante : *résoudre une situation-problème*, *déployer un raisonnement mathématique* et *communiquer à l'aide du langage mathématiques*.

Mon expérience d'enseignant m'a amené à constater l'impact non négligeable qu'avait la pédagogie par objectifs fortement présente (et toujours très présente d'ailleurs) sur l'enseignement. Tout comme Burkhardt le signale dans son texte, les élèves ne trouvent pas de sens à leurs apprentissages bousculés par l'enchaînement incessant de savoirs souvent déconnectés les uns des autres et, à plus forte raison, de leur réalité. Les contenus qui étaient alors présentés dans les programmes d'études étaient « découpés » en objectifs généraux, terminaux et intermédiaires, ce qui a « favorisé une approche éclatée du savoir et de l'apprentissage » (MELS, 2003, p.4). Cela ayant pour effet de négliger, à mon avis, certains aspects importants de l'activité mathématique dont la modélisation.

En fait, d'un paradigme comportementaliste où l'on morcelle à outrance les apprentissages en micro-objectifs, on privilégie maintenant, dans une approche par compétences, une entrée par les situations qui sont en soi plus globales et interdisciplinaires. Les situations d'apprentissage sont au cœur du développement des compétences. Elles placent l'élève dans l'agir, voire dans une situation complexe, où il devra mobiliser des ressources multiples et ainsi développer plusieurs compétences disciplinaires et transversales. Bref, l'élève compétent est celui manifeste une activité mathématique de qualité.

Les quelques situations qui nous ont été présentées dans le cadre de l'actuelle conférence me rappellent grandement les situations de compétences auxquelles l'élève québécois est confronté. Cette similarité soulève bien des commentaires et des questions. Je me limiterai ici quelques questions s'adressant à Mr Burkhardt limitées à trois thèmes qu'il a abordés.

La signifiance et les mathématiques « fonctionnelles »

D'abord, ma pratique de conseiller pédagogique m'amène à constater la difficulté de rendre les mathématiques signifiantes pour l'élève. D'ailleurs, qu'est-ce qu'une situation mathématique signifiante dans un contexte de classe ? La signifiance semble passer souvent par l'utilité des savoirs dans la vie quotidienne de l'élève. On semble passer rapidement des concepts de « signifiance », à celui « d'utilité », à celui « d'utilité dans la vie », à celui « d'utilité dans la vie de tous les jours », et, finalement, à celui « d'utilité dans la vie de tous les jours pour un élève ». Ce raccourci amène les enseignants québécois à proposer aux élèves des situations mobilisant souvent les mêmes savoirs mathématiques, ceux que l'élève mobilise dans son quotidien (les mathématiques liées aux coûts, aux rabais, des calculs liés aux proportions, certains concepts d'aire, etc).

J'aimerais, Mr Burkhardt, que vous clarifiiez le lien entre les mathématiques dites « fonctionnelles » et la signifiance des mathématiques exploitées en classe. Est-ce à dire que les mathématiques « fonctionnelles » doivent uniquement recourir à des savoirs mathématiques « utiles dans un avenir rapproché » ? Je ne nie pas l'importance de faire des liens entre les mathématiques et la « vie de tous les jours ». Je l'encourage même autant que faire se peut. Je crois toutefois que certains savoirs mathématiques, tout en étant signifiants et importants, ne peuvent pas toujours et immédiatement être rattachés à un quotidien. Pensons à l'algèbre par exemple. Comment s'insère ce domaine mathématique dans des mathématiques dites « fonctionnelles » ?

L'évaluation de situations dans le contexte des mathématiques « fonctionnelles »

Vous m'avez convaincu Mr Burkhardt que les mathématiques « fonctionnelles » nécessitent de recourir à des situations encourageant le processus de modélisation chez l'élève. Un processus complexe qui lui-même s'opérera à partir de situations complexes. Dans ce contexte, la démarche de l'élève constitue l'objet central de l'évaluation et pose la question des moyens d'évaluation susceptibles d'en rendre compte. Il n'est en effet pas facile pour un enseignant de suivre la démarche de résolution de l'élève. Souvent, la difficulté de décoder cette démarche à travers les traces laissées par écrit ou encore le manque de temps de correction empêchent de tirer parti de cette démarche et amène à concentrer son attention sur la réponse donnée.

Comment faites-vous pour évaluer la réussite ou non d'une situation de « mathématiques fonctionnelles » proposée à l'élève ? À partir de quels critères la démarche de résolution de l'élève est-elle corrigée ? Quels sont les fondements théoriques de ces critères ? Les situations proposées viennent-elles avec une liste de manifestations observables permettant une analyse des productions des élèves ?

L'accompagnement des enseignants dans l'utilisation des mathématiques « fonctionnelles »

Dans un contexte favorisant l'utilisation des mathématiques « fonctionnelles », les décisions pédagogiques et didactiques de l'enseignant apparaissent centrales. Les nouveaux programmes de mathématiques québécois incitent les enseignants à faire des liens entre différentes disciplines, notamment avec le domaine des sciences afin de montrer, en contexte, l'utilité des mathématiques. Nous avons dans ce sens un partenariat avec le milieu universitaire (*École de Technologie Supérieure*) pour créer des situations de mathématiques appliquées.

Bien qu'étant très motivés, les enseignants sont souvent démunis devant la création de situations mettant l'emphase sur les applications mathématiques. Ces derniers affirment ne pas avoir de formation pour voir les potentialités mathématiques des situations à exploiter avec les élèves. D'où l'intérêt d'établir un partenariat avec des spécialistes des milieux universitaires.

Je note aussi une résistance des enseignants quant à l'utilisation de données empiriques dans le contexte des mathématiques. Ces derniers mentionnent ne pas avoir le temps d'analyser avec leurs élèves des données « non modélisées » et préfèrent utiliser des données « parfaites » menant à la courbe attendue dans le programme, celle qui doit être étudiée.

Observez-vous dans votre accompagnement des enseignants le même genre de résistance face l'utilisation des mathématiques « fonctionnelles » ? Pouvez-vous préciser, le cas échéant, les travaux que vous mener pour encourager, auprès des enseignants, le recours à des situations « mathématiquement fonctionnelles » ?

Je vous remercie encore une fois pour la pertinence de votre propos.

Good evening everyone,

Let me start by thanking the organizers of the Canadian Forum on Mathematics Education on giving me this opportunity to share my reaction to the conference of Hugh Burkhardt. A particular thank to France Caron who approached me to participate in this panel and who ensured me of her support while I would be giving my presentation. You will guess from my accent that English is not my first language. Consequently, France has full liberty to jump in while I talk and correct the mistakes I might be making. You can rest assured that there will be some.

I would like to thank Mr Burkhardt for his presentation, which addresses a current key issue, the place of "functional" mathematics and modeling in teaching and assessment practices of both the institutions and the teachers.

The discourse of Mr Burkhardt is closely related to the reality I know more, that is the current reform in the Quebec mathematics curriculum.

Let me briefly mention that Quebec, as many other countries, provinces and states, has entered a competency based curriculum reform. The main intentions behind this change is to have students see the meaning of what they learn in class and empower them to transfer this learning to tackle complex situations. To that effect, in mathematics, three competences are being developed and assessed at every year of elementary and secondary school. These three competences are labelled as: "Solves a situational problem", "Uses mathematical reasoning", "Communicates by using mathematical language".

My prior experience as teacher has made me see the non negligible impact on teaching of the behaviourist pedagogy that was strongly present then (and is still very present). As Mr Burkhardt described in one of his papers, the students did not see the point in the never-ending succession of elements of knowledge that were both disconnected from one another, and of their reality. The mathematical content that was presented in the mathematics curriculum was broken into general, terminal and intermediate objectives, and, according to the Ministry of Education itself (MELS, 2003, p.4), this had favoured a disconnected approach to knowledge and learning. For me, this also had the effect of neglecting key aspects of mathematical activity, such as modeling.

Moving from a behaviourist paradigm where all learning was chopped into behavioural micro-objectives, the Ministry is now promoting, with its competency based approach, an entry through situations which aim at being more global and interdisciplinary. Learning situations are at the heart of competency development. They put the student in action, possibly in a complex situation, where he or she will have to mobilize multiple resources and develop several competencies, either associated to a particular discipline, or common to many disciplines (we call those "transversal"). In short, the competent student is one that performs a quality mathematical activity.

The situations that were presented in the conference remind me greatly of the competency oriented learning situations that the Quebec student must now tackle. This similarity raises many comments and questions. I will limit my questions to Mr Burkhardt to three themes that he addressed in his talk.

The significance and the « functional » mathematics

In my current practice as a pedagogical counsellor in mathematics, I can testify of the difficulty of making mathematics significant for the students. But what is a significant mathematics situation in the context of a class? Significance often seems to be associated with the usefulness of knowledge in students' daily life. We rapidly move from "significance" to "usefulness", to "usefulness in the daily life", to "usefulness in the daily life of a student". This shortcut brings Quebec teachers to propose students with situations that often require the same basic elements of mathematical knowledge, those that the student may use in his or her daily life: the mathematics of shopping (taxes and discounts); calculations based on proportions or areas, etc.

I would appreciate, Mr Burkhardt, if you could clarify the relation between those « functional » mathematics and the significance of the mathematics used in the classroom. Must we understand that « functional » mathematics relate exclusively to elements of the mathematical content that are expected to be « useful in a near future » ? I don't deny the importance of making connections between mathematics and « daily life ». I even encourage it, whenever possible. But I believe that some important and significant elements of mathematical knowledge cannot always and immediately be connected with the daily life. Let us think of algebra for example. How does this mathematical domain fit into "functional" mathematics?

Assessment through situations in the context of « functional » mathematics

You have convinced me, Mr Burkhardt, that "functional" mathematics requires the use of situations which encourage the student to enter a modeling process; a complex process that will proceed from complex situations. In this context, the approach used by the student becomes the central object of assessment and poses the question of the tools that will allow to assess it. It is not always easy for a teacher to grasp and follow the reasoning of a student. Often, the difficulty of decoding from the traces left by the student or the lack of time for grading act as obstacles and lead to focus attention on the answer given.

How do you assess a student's performance in response to a situation of « functional mathematics » ? Based on what criteria is his solving process to be assessed? What are the theoretical foundations for these criteria? Do the situations come with a list of observable outcomes to help analyse and assess students' productions?

Supporting teachers in using "functional mathematics"

A context that promotes the use of « functional » mathematics relies heavily on teachers pedagogical and didactical decisions. The new Quebec mathematics curriculum encourages teachers to make connections with other disciplines, science in particular, in order to show in context the usefulness of mathematics. Although they show strong motivation, mathematics teachers often feel ill equipped to elaborate such situations that put emphasis on applications of mathematics. They claim they have never been prepared to exploit with their students the mathematical potential of situations which lie outside the mathematical domain. To help fill the gap, we have established a partnership with university (*École de Technologie Supérieure*) in an effort to elaborate jointly learning situations in applied mathematics.

I also see resistance from teachers in using empirical data in the context of mathematics. They say they don't have the time to analyse with their students data which does not come from a model, and they prefer to use "perfect" data whose curve will lead directly to the function to be studied.

Do you observe in your collaboration with teachers similar resistance towards « functional » mathematics? And if yes, can you specify the type of work you do to encourage and support teachers to use "mathematically functional" situations?

I thank you once more for the relevance of your talk.

Making school mathematics functional – the response from a pure mathematician … ough!

Frédéric Gourdeau
Université Laval, QC

The ideas presented in the plenary are attractive. The critique of the situation is engaging, the examples presented are relevant and striking, and the alternative presented is rich, at least in some aspects. Changes in the curriculum, and the crucial importance of assessment in this process, is very well explained and food for thought. However, many aspects of the presentation are questionable, and here are some questions or remarks which I would have liked the speaker to address.

- The engineering metaphor leaves me wondering. It seems largely to rely on human beings as cultureless beings which, placed in an appropriate setting, will react according to plan. Even in very simple setting (long jump competitions, for instance), cultural bias are present this was brushed off by the speaker in his reaction to some questions raised during the plenary as trouble making, or so it seemed to me.

- In all classroom activities, pedagogy is important. In the types of mathematical activities proposed, pedagogy is key. Are open questions really open? How do you deal with the naughty kid, who understands the question differently or with more imagination?

- The examples were not, for me, very imaginative or fun. I did not see an artistic component or a very creative aspect. Is this because of the sample of activities presented or is it typical?

- The complex tasks presented rely on a very good command of the mathematical knowledge to be used. The idea that these tasks therefore need to rely on mathematics which has been known for a few years, the 'gap', was well explained. This raises many questions, and I asked one: how do these activities help with the learning of new, more complex or advanced, mathematics. "Mind the gap" came to mind…

As this is a Canadian forum, I was also struck by the derogatory remarks and the easy jokes made by the plenary speaker about 'pure mathematicians' (his expression). They (and I, as I am one of 'them') seemed to be a problem. I offered that something should be learned from Canada in this respect, where the Canadian Mathematics Education Study Group (CMESG) has been active in mathematics education, bringing together mathematicians and mathematics educator to work together, listening to each other, learning (and creating knowledge) together. The profound respect I see as part of the very essence of CMESG, if it was part of the plenary, was very well hidden. I found that disturbing.

In the opening panel of the forum, relationships were presented as central: between students and teachers; and between teachers and other teachers. There was a sense that being part of a community engaged in education was important. Fostering change in the education system is partly about creating a more inclusive, more respectful and stimulating learning community. I believe that we should also live these values as mathematics educators.

Six difficultés avec la mise en pratique des 'mathématiques fonctionnelles' dans les salles de classes à l'école secondaire

Eric Robert
Leo Hayes High School, Fredericton NB

1. Avec ce qui semble être de plus en plus de pressions (parentale, sociale...) pour que nos étudiants gardent le plus grand nombre de portes ouvertes en préparation à la vie postsecondaire, de grands nombres d'élèves choisissent des cours de

mathématiques pour lesquels ils ne sont pas bien préparés, et pour lesquels ils ont très peu d'intérêt, juste au cas où ils auraient besoin du crédit plus tard. Ces élèves ont souvent atteint un niveau de succès marginal dans le passé et ne sont pas prêts à utiliser les idées mathématiques qu'ils ont vues dans les dernières années dans un contexte plus 'fonctionnel'.

2. Si, pour l'accès à la vie postsecondaire (travail, collège, université...), on continue d'évaluer les étudiants avec leur moyenne obtenue à l'école secondaire, nos élèves et leurs parents vont continuer à s'inquiéter plus de leurs notes que de leur apprentissage. Lorsque nos élèves perçoivent les 'mathématiques fonctionnelles' comme plus risquées (parce que l'étude devient moins algorithmique, et fait davantage appel à la résolution de problèmes nouveaux), ils semblent se sentir moins en contrôle de leur résultat final et ne sont pas aussi encouragés à mettre leurs meilleurs efforts lorsqu'ils trouvent et suivent la route du moindre effort.

3. Si les cours d'université de mathématiques des premières années ne changent pas radicalement, plusieurs élèves ne verront pas de cours avec des 'mathématiques fonctionnelles' après l'école secondaires et ne verront pas l'utilité d'avoir passé du temps à les apprivoiser. En très peu de temps, le message qui circule est que cette partie des cours de mathématiques n'est pas évaluée après l'école secondaire et n'est donc pas importante.

4. Un dilemme auquel je fais face : si j'inclus des 'mathématiques fonctionnelles' dans ma salle de classe mais que je ne leur fais pas une grande place dans mes évaluations, plusieurs élèves mettent très peu d'efforts dans la salle de classe. Si mes évaluations contiennent des questions plus ouvertes, et plus 'fonctionnelles', les élèves et les parents se plaignent à la direction puisque les autres classes n'ont pas à faire le même genre de problèmes dans leurs évaluations.

5. Les conditions dans les salles de classe doivent s'améliorer si l'on souhaite que les enseignants investissent de leur temps précieux à réorganiser le curriculum pour inclure des 'mathématiques fonctionnelles'. Bien d'autres problèmes dans les salles de classe (l'intimidation, les téléphones cellulaires en classe, les difficultés d'apprentissage et le manque de ressources...) sont si urgents qu'il est difficile de mettre le curriculum en priorité.

6. Le manque de cohérence dans la mise en pratique des 'mathématiques fonctionnelles' entre différentes classes de mathématique d'une même école crée souvent une situation où des élèves perçoivent qu'il est plus difficile d'avoir une bonne note dans certaines classes que dans d'autres. Si ces élèves peuvent trouver des façons de contourner le 'problème' en choisissant les enseignants qui leur permettent de continuer avec un enseignement plus traditionnel, il devient encore plus difficile de faire de la place aux 'mathématiques fonctionnelles'.