

## **The fundamental challenge of the teacher as artist.**

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Dear Colleagues:

Thanks to all those who have congratulated me and wished me well. We have at Queen's a versatile and dedicated Department and I look forward to guiding it through the next few years of its growth. I say "growth" in the faint hope that this means more than spiritual and intellectual growth, though the Dean seems unable to say more than that *some but not all* of our upcoming retirements will be replaced. These are challenging times.

Indeed, we are called upon now to do much more with many fewer resources than were available when I was a student here. Our response to each new cut over the years has been to squeeze harder and fit more in and I am now convinced that this response can no longer serve us or our students. It's time to do old things in a new way. I'm not sure just what a new system might look like, but my understanding of how significant advances were made in our evolutionary trajectory as a species is that it was at times of tight constraint that significant "saltations" were made.

I was glad that so many of you attended the colloquium last week—my thoughts on some possible changes in our large first-year service courses. It wasn't really meant as a directive though some of you might have wondered about that. Well maybe it was—certainly I am serious about this type of change: less breadth and more depth, a few critical examples, the best we can find, powerful, beautiful, engaging, exploratory, artistic, as many of those fine words as possible, done thoroughly and well, hopefully enough of these to capture the essentials of the subject, be that calculus or linear algebra. Such examples are not easy to find; but once you have them you have pure gold.

In the conversations I had afterwards, many of you picked up on my phrase that we should dare to be "less comprehensive and systematic." You pointed out that while most of these students will never encounter us again, some of them do stay to take MATH 211 or MATH 232 and there are many things they will need to know. It's true that some will go on to other math courses and in fact I hope that the changes I have in mind will encourage even more to stay with us longer and learn some more mathematics. In part, my purpose in writing this is to address this "prerequisite" worry that many of you seem to have.

On the other hand, perhaps I protest too much. Perhaps it's not such a worry. After all, these students are majors in another discipline and this is an applied course, and I am an applied mathematician and apparently a good teacher so on the whole you trust me with these students, and my schemes will probably turn out fine. And of course I did make it clear at the very beginning that I was not talking about our honours courses—those, we have a duty to teach "properly," a duty not only to our students, but to the subject itself. No, the colloquium was very much about our service courses.

But now I owe you a confession. The changes I have in mind apply, in my view, equally to the honours courses. In these courses, I think we can do much less, have more fun and engagement, and come away with a much higher retention rate. In saying this I am aware that our honours courses are generally very well taught and our graduating students on the whole look back on them with positive memories. But less than half of the students (in fact much less) who enroll in those courses wind up with any kind of math concentration. I want more of them to stay. I believe that more mathematics would serve them well, and that they in turn would serve our subject well in whatever they chose to do in lives.

I have already touched on this subject with one or two of you, and in fact, over the years, with other mathematicians at professional meetings. It is a difficult debate, partly because so much of it is waged abstractly away from concrete examples and explicit curriculum models. But the bottom line—what my conversations always seem to come down to—is your worry that my "schemes" will fail to properly prepare our students for upper level mathematics courses. Thinking about this, I wonder exactly what it is that you are worried about. Is it the students themselves and their future? Is it the reputation of the university? Or is it your own future courses, the readiness with which the students will be able to grapple with the many neat things you want to teach them?

Well let's think for a moment about these students. They come in different flavours. First there's A and B who are natural problem solvers and might well wind up in research careers in mathematics or science. These students will thrive with your curriculum as well as with mine—all they need is good problems and someone to talk to about them. So can we agree that they are not the problem? Then there are C, D, E, F, G, H, I and J. Some of them will go on to law or business, some to government, some are in our teacher program. And then of course there is (or will be) X, Y and Z who started out in the service courses but because they were so interesting and lively (!) decided to switch to a math major and find themselves now in third year. You seem to suggest that these student, from C to Z, would have great difficulty filling in the gaps on their own, that if we do not teach them a “proper” systematic course they will not manage to carry the subject effectively forward.

Well, in my experience, they do not now carry the subject effectively forward. Many of them take my MATH 382 and I can attest that they are not very good at using simple (basic!) ideas of calculus and linear algebra to solve new problems. [Actually I don't mean to suggest that they *should* be able to do that in third year; the point I'm making is that they don't come away (from the teaching and learning) with what you might think, that while an alternate approach might be no better than the traditional one, it might equally well be no worse. In fact I have reasons for thinking that a lighter livelier approach might actually work better and gain us more students. As an example I cite my way of treating eigenvalues which (I feel) is much more fun than the standard approach but which I am sure gives them a much clearer idea of what an eigenvalue really is. ]

For most of our math majors (from C on), it is enough that they learn a little math, enough math to see the power and beauty, and learn it well and positively enough that they can feel it belonging to them, feel it part of their domain. After that, we simply have to trust the subject itself to impel them forward as appropriate, and trust them to respond.

I know that many of you have important stories that you want to tell your senior students, stories that they would not be able to appreciate or even understand without a “proper” grounding in the first and second year, and so you are understandably worried by my suggestion that we might lighten (that word in all its meanings!) our introductory courses. I find that the metaphor of “teacher as artist” is helpful here.

Briefly, the idea is that the curriculum be regarded as a set of integral works of art. Because such works have a wholeness in themselves, it is not so crucial whether the student has mastered this technical skill or that, rather what counts is the nature and level of sophistication of the technical skills he has mastered, and it is this that should increase from year to year. As each new work is brought forward, crucial technical skills can be, and indeed ought to be, reinvented in the new context, and the experience that is needed for this to succeed is of a general rather than a specific nature.

The artist and the poet do not to tell the entire tale as they know it. Rather they display it on the canvas, or on the page, in a way that is true both to the story and to the constraints imposed by the medium. The response of the artist is therefore highly conditioned, bowing to form, and to technique, *but it is the more powerful for that*; this is the wonderful paradox of artistic expression. Good stories become art when they are told in simple ways which capture their richness. It is a challenge to find such ways, but it is the fundamental challenge of the teacher as artist.

In closing, these remarks of mine focus on what I believe are fundamental problems of the area of study known as mathematics education (for example, that was the field of our recent PhD student Nathalie Sinclair). For 30 years I have attended professional meetings and read journal articles in this field and followed the big debates and you know what?—except for an oscillation from right to left and back again, little seems to change. One problem is that the system is completely interconnected—a powerful current of experience and ideas runs from elementary school through high school and university, to teacher's college and right back to the beginning again. Perhaps the only hope is a decisive intervention at some critical point in the system and my target these days is that crucial first year in which we play host to a significant fraction of the students at this university.

You've noticed a strong thread of idealism running through this letter. That's how we're going to start. We'll temper it as we go.

All the best,  
Peter