Transition to University
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There are two aspects to the transition:
High school – university
Old Curriculum – new curriculum

The first of these is an adjustment students have to make, the second is one we have to make. They are not completely separate, for with the new curriculum, students are also a year younger, making the first transition potentially more difficult.

Younger students.

On the first I have only some anecdotes, and these second hand:

My colleagues David and Maya-Lisa Thomson live near campus. Maya Lisa commented to me that this year is the first year they have seen students go by their house in large numbers during week days after spending the evening at a pub.
Maya Lisa reported speaking to a residence don, who commented a few weeks ago that up to that point there had only been one student on his floor who had occasionally had the discipline to turn down an invitation to a night out because he had work to do.
One of my upper year students, who is a residence don, reports of a student on her floor who spends nearly all his time in a deep drunken stupor.

It may be a comment on the party atmosphere at Queen's as much as a comment on the students, but the younger students are probably more vulnerable.

Readiness for calculus.

This, too, is difficult to measure. Certainly there are no startling problems. On the whole the students do not complain that they find the subject difficult to learn. Our first year course has enough review and looking-at-the-same-thing differently built into it to take care of a very wide variety of backgrounds (out of province, out of country).

Last year we worried about a class half of which consisted of old curriculum students and half of which consisted of new curriculum students, anticipating a serious mismatch. We need not have worried. The class was probably the best we ever had in first year, and it was difficult to distinguish between the old curriculum students and the new curriculum students. I will say a little about one attempt in a moment.

Encouraged by that, we made few changes coming into this year. Two things happened: Queen's had to drop its admission standards to maintain enrolment in a shrinking pool; and we began to notice lacunae in the students' preparation. These effects are probably related: Last year's class included all the ambitious and confident students who felt they could compete for university positions with graduates of the five year program. This year's class includes the many students who held back because they lacked that confidence.

Are we getting a truer picture this year? It is hard to say. Some adjustments will have to be made for next year to take greater account of student weakness in certain areas:

trigonometry, trigonometric functions and identities

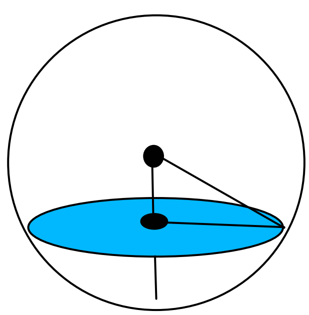
geometry, especially the relationship between an equation and its solution set

Incidentally, while Canada did quite well on the PISA mathematics evaluation, the area in which our 15-year-olds did badly was space and shape.

As an illustration of weaknesses in geometry and trigonometry, let me describe the two questions I marked last term on the final exam in my calculus course for engineers. They were both integration problems. I noticed after a while that a high percentage of students were making the same mistakes – mistakes I would not have expected. To study the frequency of these mistakes, I decided to keep track of their occurrence on two bundles, totalling 72 exam papers.

The first problem was a volume question. At some point in the question the students needed the formula for the area of a circle. Of the 72 students, 10 were not able to write down the formula correctly. In many cases they confused it with the formula of the circumference. In some cases they wrote down a hybrid of the two.

The second problem asked student to do a work calculation. In it they had to slice through a sphere of radius 2 meters at a distance x above the bottom of the sphere or 2-x meters below its centre. To do the problem they had to express the radius of the circular cross-section in terms of x.   Of the 72 papers there were 16 who did not get to the point in the solution where they would realize that that is what was needed. Of the remaining 56 students, 30 were not able to use the Theorem of Pythagoras to determine that relationship!



Of the ones who could not find it, nearly all (some realizing that their answer was not correct, many apparently unaware of it) simply asserted that "since the object was a sphere, the radius of the circular section was equal to the distance from the bottom of the sphere." It seems that in these cases the students have become used to the kind of qualitative, superficial understanding that can result from uncritical use of investigative technology.

Willingness to explore

One of the new directions in the new curriculum is the use of student investigation. I tried last year (with that very strong group) to explore the difference between the old curriculum students and the new curriculum students in this respect. In my first year course I include 4 “challenge problems” for the students who feel under-challenged. These problems are optional, each worth one bonus mark on the final mark.

The first of these gives them a cubic polynomial ($p(x) = x^3 – a x – b$) with two varying coefficients, a and b, one of which (a) varies slowly and randomly around an initial position, while the other (b) is one that you can control. The idea is to keep the root of the polynomial fixed by adjusting b in response to perceived changes in the location of the root of the polynomial.

In the fall of 2003 I had 54 students participate in the first challenge. I found that the participation of new curriculum students was higher than the old curriculum students: 22 new curriculum students, but only 11 old program students. The others were a mix, or were out of province. Incidentally, the 17 out-of province students who participated (out of a total of 134) represented a high participation rate as well. I looked for differences in the way different groups approached the question, but did not see a pattern.

In the second term, the difference in participation rates had vanished, and at this point, with a smaller sample, it did seem that new curriculum students were less likely to analyze the problem mathematically than their old curriculum counterparts, and were more likely to resort to computer experimentation (Maple) for their solutions. The second problem in the second term was a problem about improving estimates of the sum of the series $\sum(1/n^2)$ by taking the difference with a telescoping series. My notes indicate that when I reviewed this challenge (with a total of 30 participants) I found that among the students who made a good attempt at analysing the problem mathematically, 6 were new curriculum students, 9 were old curriculum, and 6 were out of province. Among the ones who, in my estimation, were too quick to rely uncritically on Maple calculations there were 5 new curriculum students, 1 old curriculum, and 3 out of province.

The total participation remained encouraging last year, with 25 and 30 students participating in the two challenge problems that term.

The participation of this year's class in the challenge problems started out as promising as last year's, with 51 students submitting something for the first challenge problem. There was an enormous drop-off to 4 students for the second challenge. I think I made that one too difficult. The first challenge problem in the second term was no better, with only 4 participants, all with foreign names and accents.

The perceived difficulty of the Geometry and Discrete Mathematics Course.

The Faculty of Applied Science at Queen's became concerned this year about a sudden unprecedented drop in applications to applied science. This concern is shared by faculties of applied science throughout Ontario. A similar drop of applications is seen in computer science I understand. Some checking with high school counsellors persuaded the faculty that the problem originated with the perceived difficulty of the Geometry and Discrete Mathematics course. Queen's has decided (to my chagrin) to drop the course as a requirement for entry into Applied Science. Discussions with Waterloo and McMaster reveal that they are contemplating doing the same.

I am very concerned about this move, not because I do not believe there are problems with the course, but because without the pressure from universities, there is going to be less incentive to take a serious second look at the course to see how it can be improved. More than any other, it is the course that does serious mathematics. In particular, it is the course that does some of the geometry we are already concerned about. It is also the only course that does vectors and elementary linear algebra in a way that matters both to mathematics departments and to physics departments. It would be better, if time is a problem, to remove calculus from the highschool curriculum and to do the other things really well. With a solid background in high shool mathematics, calculus can easily be taught in one year.

The physics department was especially upset at Queen's decision. They depend as much on the quality of high school mathematics education as do the mathematics departments. I had an interesting conversation with David Hanes, the head of the department of physics, a few weeks ago. One comment surprised me, and should raise questions for high school science teaching, for David is someone who cares about students and about the delivery of a good program: He stated bluntly that the physics department assumes that incoming students have no idea at all how to think about physics/science. They expect to teach it from scratch. However, they have come to expect a strong background in mathematics. Without that ability to count on a strong grounding in mathematics, they feel that their problems would be serious indeed.