The Double Cohort from the University's Point of View

A report for the Mathematics Education Forum meeting for Saturday, January 24, 2004

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A small survey of colleagues at various Ontario universities was made to get some sense of how the students graduating from high school in 2003 are faring in their first year of university.

The following comments are based on replies from ten colleagues from Brock University, Queen's University, University of Toronto, University of Windsor and York University. Most of the courses given by the respondents were calculus, but there were also courses in linear algebra and introductory courses with a broader syllabus.

1. The students

Most respondents noticed no significant difference between the two cohorts. One calculus service course instructor noticed that students did better than expected on tests, and conjectured as to whether it was because of the increased competition. This improvement in grades was noted elsewhere. A couple noted that the students seemed more hardworking and conscientious, and attended tutorials more regularly. This was offset by two opinions that the new students were less serious about studies and seemed more lost.
However, one lecturer noted that the students were more willing to engage in class discussion.
One wondered whether the new students were less confident in their arithmetic abilities when he saw, for the first time, a student write sqrt{4} in place of 2. Grades were a bigger issue for some students.

The following weaknesses were noted:

(a) difficulty with arguments: inability to distinguish between logical arguments and 'vague musings'; lack of rigour

(b) difficulty reading and extracting information

(c) poor fundamentals: less able to follow algebraic manipulations, 'surprising' difficulty with the chain rule for differentiation, possibly due to having deal only with very simple functions in high school; deficiencies in trigonometry (see below)

(d) trouble with concepts and preference for recipes

(e) students from grade 12 had much slighter preparation and seemed to be more "needy"

However, it was observed that these deficiencies were not new and not restricted to the new cohort.

Students from grade 12 had no experience of integration, whereas this was known to OAC students.

One lecturer of engineers did not observe an expected weakness in knowledge of conic sections, probably because all the grade 12 class would have had the grade 11 functions and relations course.

Respondents were asked whether students seem more capable of setting up and thinking around problems, and all reported that there was no evidence of this.

Respondents were asked whether they had had direct feedback from the students themselves, and most reported in the negative. However, some students seemed to experience more difficulty than previous. Others felt hindered by a lack of exposure to trigonometry, another at not having seen integration. One girl felt at a disadvantage at not having seen some topics or learned them only quickly, but eventually felt that is was useful to have had to master material in a shorter time. One OAC student complained about the immaturity of the younger students.

One lecturer passed on comments from students themsleves from his end-of-term comment sheet. They were asked to answer the question as to how well they were prepared at the beginning of the course. Here are the results:

(a) I come from grade 12 & noticed that I learned little of this stuff from high school. The OAC's had a great advantage, as this was review for them and could expand their thinking more since they already knew the basics

(b) As an OAC, I felt I was much better prepared than those from grade 12.

(c) Not very b/c my high school did not teach much if anything on cosecant, secant, cotangent.

(d) Very well, except for trig intro.

(e) Out of Grade 12, and was not prepared at all.

(f) Not very well at all considering not taking OAC calculus and never ever hearing what secant, cosecant and cotangent were in my life. Also, no trigonometry was taught in grade 12.

(g) I knew everything the course covered except the 'Mean Value Theorem' prior to taking this course.

The lecturer adds that, on balance, more students reported that they felt better prepared than otherwise; this probably correlates with their OAC or Grade 12 background.

2. Changes in courses in expectation of the double cohort

While only one institution, University of Toronto at Scarborough, reported having separate classes for the graduates of the two curricula, most respondents made changes in expectation of the new cohort. They expected that students would not have a good trigonometry background, and so spent a week or two at the beginning to teach trigonometry. The also assumed that students would not have any integral calculus. At one university, a common background of AFIC (the new curriculum) was assumed, so that the OAC students encountered review material that was new to the others. Other changes reported included:

(a) three instead of two lecture hours per week;

(b) additional help sessions on trigonometry;

(c) additional hours of one-one tutoring at the help centre;

(c) omission of some proofs;

(d) treating proof by induction;

(e) giving more examples of intergration by substitution;

(f) 'slowing the pace of the course, watering down the material, making tests and exams weaker'

(g) more careful treatment of differentiation

Most respondents to the survey did not have knowledge as to which students came from OAC and which from Grade 12.

It is worth noting that the Brock mathematics department started planning for the new curriculum two years ahead of time. Their preparation was helped by a simultaneous increase of the term length from 12 to 13 weeks, so that trigonometry could be inserted without a loss of other material.

3. Trigonometry

This is worth a separate section as it figured so largely in the responses. It was generally accepted that the 4U students would not have had trigonometry in Grade 12 and provision

made for this. However, it was clear that the lecturers felt that knowledge of trigonometry was important and that in some cases students were poorer than expected. One respondent went so far as to opine that "having no study of trigonometry in grade 12 is one of the more ignorant aspects of the new curriculum".

Before the new curriculum was implemented, revisers were implored in particular by science and engineering instructors to assure that students get a solid grounding in trigonometry. It is not clear why this advice was so assiduously ignored, as there is a great deal to be said for a strong trigonometric component in the syllabus. Apart from providing a background in important transcendental functions and giving the occasion to develop a strong algebraic facility, the topic raises many important mathematical issues including a very elegant formulation of technique for practical use, the highlighting of significant information through algebraic manipulation.

Probably the most major improvement that can be made is to find a place for trigonometry in the Grade 12 curriculum. It should not be too difficult to include trigonometric functions in the calculus sequence; it reintroduces some fundamental identities, motivates the use of radians and the sum-to-product conversion formulae, and provides the tools for a wider range of examples and exercises. In algebra, trigonometry can be used as part of a richer treatment of complex numbers and vectors. It needs to be appreciated that the university curriculum is also very crowded, particularly in engineering where accreditation is an issue, that science courses need to count on a reasonable facility, and that students need to 'hit the ground running' with respect to algebra and trigonometry.

4. University of Toronto at Scarborough

At Scarborough, separate courses in calculus for the physical and the life sciences were terminated, and a new 'general purpose' half course in calculus was established, with separate classes for the two cohorts. The new courses were less theoretical, but covered substantially the same material. Lecturers consulted regularly and were prepared to adjust to circumstances at they arose. There was more testing than usual to monitor what was happening. The courses used a Harvard reform text, which the students did not like because of the absence of worked examples.
The final marks were not significantly different in the two groups, and the lecturers felt that the two curricula seemed to function about the same in preparing students for university.

5. Advice to teachers

One respondent commiserated with high school teachers forced to "follow an ill-devised curriculum."

(a) teach ideas as well as formulae and set procedures;

hammer home concepts;

(b) use technology for concept development;

(c) make students comfortable with mental calculations;

(d) focus on teaching how to construct a proof;

(e) review trigonometry in Grade 12 and teach the basic formulae;

(f) prepare students to execute fundamental precalculus skills with accuracy and without pause;

(g) basics should be taught and practised, especially in Grades 5-8;

(h) make your own curriculum meaningful rather than concentrate on where students are growing; get students to think about how a
problem relates to their own mathematical knowledge, and how to look at it in various ways;

(i) take the cognitive and reasoning aspects of the curriculum seriously and help the students aim for right thinking, not just right answers;

(j) promote good written style; writing mathematics carefully makes students think about it carefully;

(k) standardization of mathematics grades would be helpful.

6. Individual Comments

"I do get the feeling that the whole curriculum here was designed years ago to build on top of high school education, except that high school education has evolved since, and now there is a wide gap between high school and university level education. As we cannot change high schools, we have to adapt the way they have changed. This calls for a system-wide reorganization, not merely for changes at the level of individual courses."

"The failure rate was much lower than in the past, but also there were fewer A+ grades."

"It seems important to note that we did not restrict the use of calculators, rather encouraged tthe students to use them as an exploratory tool. Given that the younger half should be familiar with scientific calculators since grade 9, the experience was disappointing; many students had not previously used calculators to an extent that made them useful. The calculators were mainly used for algebraic manipulation, not exploration."

"The mathematics grades that some students claimed they received in high school were tough to imagine as being credible indicators of ability to perform routine manipulations. The high school marks they quoted ... were mind-boggling given their performance."

"The students are uncomfortably aware of their basic weakness in algebraic manipulations. Some cling to their calculators, but many students were not proficient in their use either."

"A lot of students had quite unrealistic expectations and self-evaluations throughout the course. More students than in previous years had the expectation of getting a passing mark even though they performed poorly. We had more requests and pleas this year than any other year from students who failed to simply raise their marks to a passing grade. It seemed that it was expected from them that the marks will indeed be raised. The negative response to their request seemed a surprise."

"The students seemed less willing to go to trouble with assignments. They were more likely to engage in class discussion than those in earlier years. I did not keep track of which had the new and which had the old curriculum. My guess would be that the differences would be more attributable to lesser maturity and experience than to actual knowledge of parts of the curriculum."

"Just a hunch, but it may be that the students from grade 12 were less deliberately prepared for university than their seniors. OAC, and grade 13 before it, were treated by many schools as transition years, assuming students in that year were university-bound. Grade 12 is just the last year of high school."

"It is remarkable to notice that Grade 12 students with one or more fewer mathematics courses performed as well as OAC students on a conceptual first year calculus course."