How Well Does High School Prepare Students for University Chemistry?

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http://www.chem.utoronto.ca/~dstone/Research/survey.html

Introduction

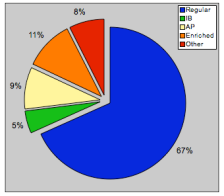
Each year, some 1,500–1,800 students entering 1st year at the University of Toronto take one of our undergraduate chemistry programs: either CHM 138H/139H or CHM 151Y. The aim of this pilot study was to see how well their final year of high school chemistry had prepared them for university chemistry, and identify practices within both high school and university programs that would help students better manage the transition. The pilot study consisted of a questionnaire, made available to all 1st-year chemistry students *via* the BlackBoard system, and follow-up small group interviews. A detailed five year study in the US on this transition has been reported,[1,2] while a similar survey at the University of Guelph was recently described.[3]

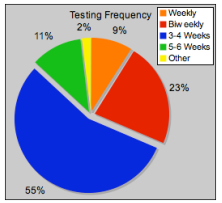
Survey Participants

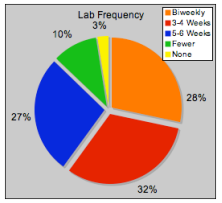
Number of 1st year students (all):	1830
Number of completed surveys:	320 (17.5%)
Number of unique schools represented:	123
Public schools	75
Catholic schools	23
Private/international schools	25
Number of schools by location:	
Ontario	81
Canada	22
International	20
Number of Ontario schools:	
Public schools	51
Catholic schools	20
Private/international schools	10
Reported class size for each school:	
> 30	19
21 – 30	63
11 – 20	31
5 – 10	10
< 5	0

- 58% of students had completed an independent study unit (ISU) or other research project in high school

Student High School Programs

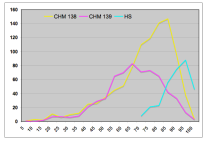




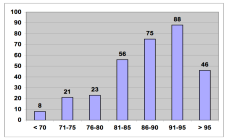


Grade Shock

Comparison of reported grade 12 chemistry grades with Fall semester 1st-year grades:

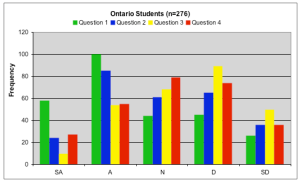


- CHM 138 Final Grade
  - Mean = 69.7 (*n* = 959)
- CHM 139 Final Grade
  - Mean = 63.8 (*n* = 633)
- Entry Average (2005-6)
  - Mean for Life Science = 87.4



- Students report being warned to expect a 10 point drop in average grade
- Very few believed it; some fared much worse...

"I felt that I was at a major disadvantage because I graduated from a different province. To graduate chem 12 with a 95% and then to fail the first chm 139 midterm that was supposed to be "review" was very upsetting"



1. "My high school experience helped prepare me for university"
2. "I feel high school sufficiently prepared me for university"
3. "I am doing as well as I expected in university chemistry"
4. "I am enjoying chemistry more in university"

- A recent study reports that even students doing well in introductory chemistry tend to have a negative attitude shift towards the subject.[4]

Transition – The Academic Challenges

1. Pace of material
   a) More information in shorter time
   b) Fewer evaluations on more material
   c) Tests in multiple courses at same time
2. Assigned readings
   a) Easy to fall behind
   b) Greater use of texts
   c) More independent study
3. Curriculum and testing
   a) Different style of questions
   b) Memorization *vs.* understanding
   c) Timing of advanced materials
4. Laboratory classes
   a) Duration, preparation, formal reports
   b) More varied, complicated equipment
   c) Lack of timely, appropriate feedback

"The university pace is quite a lot faster, and it requires a lot of motivation on your part and independent learning."

"I found that my time management skills were the only thing that was keeping me alive."

"I expected a lot of reading, but not as much ... Wow, that's a lot of reading!"

"The most important difference: if you fall behind, you stay behind."

"In high school, the hoops we had to jump through were more memorizational and less conceptually based (i.e. one could get an A without knowing chemistry"

"Questions on high school tests involving higher thinking are rare."

"[Lecturers] spend a lot of time dealing with easy things but near mid-terms introduce things that ... need time to explain, which they don't have"

"The lab manuals were hard to comprehend..."

"I don't think I get too many explanations about the labs, especially after they're done - I got my mark, and that was it"

Recommendations for Instructors

Labs and Lab Manuals

1. Written instructions can be hard to read or understand due to lack of prior experience
   - simplify language (many ESL students)
   - use simple diagrams and pictures[5]
   - use multimedia approach[6]
2. Lack of meaningful, timely feedback
   - on-line pre-lab quiz with immediate feedback[7]
   - improve TA training for consistency
   - use coding scheme for common errors
3. Unclear connection to lectures
   - lectures should reference specific lab experiments in theoretical context

"I just found that, from the lab, we were quite often asked to do things we had never done before, and apparatus that we had never seen before, and just read it. I need a picture and I need to see what it looks like because I've never ever seen it."

Assignments, Tests, & Exams

1. Classify questions by type. *e.g.*
   - Observation (factual/memorization)
   - Application (calculations, operational skills)
   - Reflection (problem solving/integrative)
2. Use more problem-solving questions
   - include with notes, homework, readings
   - present lecture concepts as examples of problem solving
   - teach students problem solving methods in labs/tutorials
3. Clearer statement of expectations
   - material to be covered for tests, *etc.*
   - relative emphasis on different *types* of question
   - on-line self-tests (with feedback) for background material

"Everything in university is worth a lot more."

General Recommendations

1. Avoid 'information overload'
   - spread important announcements out rather than all in the first class or week of classes
2. Increase awareness of learning issues amongst students
   - highlight availability of extra help sessions run by the department or colleges
   - emphasize discipline-specific learning and study skills through tutorials, FLCs, *etc.*
   - teach students how to evaluate the *effectiveness* of their current study habits
3. Increased communication with high school teachers and students
   - raise awareness of university expectations, student 1st-year experience, *etc.*
   - increased involvement with high school curriculum and teacher professional development

"I find that high school chemistry does not prepare you fully for university. My high school chemistry class was a joke."

"I feel my high school teachers prepared my very well for university, even though it was a big jump. Sometimes, change and challenge are nice and necessary for progress."

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