The High School–University Transition in Chemistry

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Chemical Education Survey:

- Pilot study in 2006-7
- 1st major survey in 2007-8
- 2nd major survey in 2008-9
- Mixed qualitative/quantitative study

What factors contribute to a successful high school–university transition?

What can schools and universities do to help students manage this transition?

The Survey Cohort:

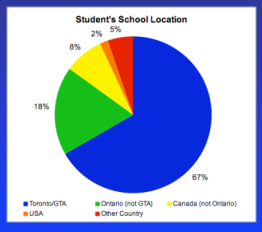
- CHM 138F (Introduction to Organic Chem.)
- CHM 139F (General Physical Chemistry)
- CHM 151Y (Advanced Introductory Chem.)

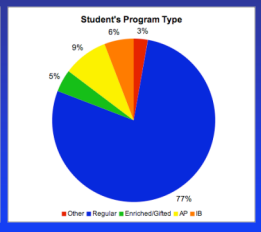
Year	Enrolment	Surveys	Response
2006-7	1830	320	17.5%
2007-8	1803	536	29.3%
2008-9	1723	414	24.0%
Total:	5356	1270	23.7%

Who Are Our Students?

Category	2006-7	2007-8	2008-9
Female[1]:	–	60.6%	59.4%
Male[1]:	–	39.4%	40.6%
Toronto/GTA:	–	68.9%	69.1%
Total Ontario:	86.4%	84.4%	84.5%
Regular stream:	68.1%	82.3%	78.8%
Semestered:	–	58.4%	65.1%
Native English-speaker:	–	44.8%	45.9%*
Independent Study:	56.0%	57.7%	44.9%

Aggregate Demographics:

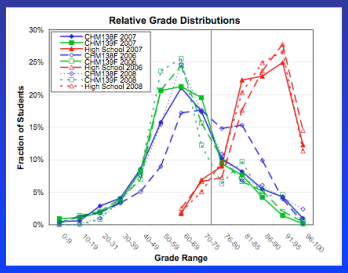




- Over 430 different schools
- ~ 200 Toronto/GTA schools
- ~100 other Ontario schools

- 69% public board students
- 19% catholic board students
- 12% private school students

A Grade Disappointment:

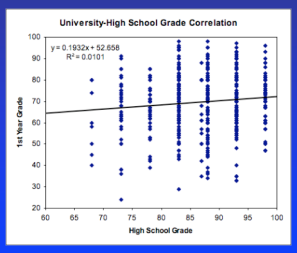


High School:
- 87.3% (2006)
- 87.1% (2007)
- 87.3% (2008)

CHM 138F:
- 69.7% (2006)
- 65.0% (2007)
- 67.2% (2008)

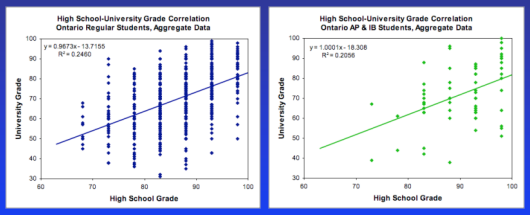
CHM 139F:
- 63.8% (2006)
- 63.3% (2007)
- 64.6% (2008)

Grade Correlation 2007-8:



- High school grades assigned as central value
- Missing high school grades imputed
- Only students who wrote 1st-year final exam
- No correlation at the 99% confidence level!
- No difference between CHM138 & CHM139!
- Slight correlation for AP & IB combined (n = 31)

Aggregate Correlations:



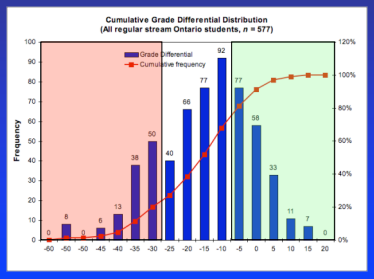
- High school grades assigned as central value for each range
- Data for missing high school/university grades omitted
- Data for Ontario students who wrote 1st-year final exam
- Regular stream n = 584; AP n = 39; IB n = 28

Aggregate Correlation Data:

- Ontario students with full grades reported

Category	n	r	t	p (t)
All	690	0.490	14.8	< 0.0001
CHM138F	489	0.458	11.4	0.00012
CHM139F	201	0.580	10.05	< 0.0001
Regular	584	0.496	13.8	< 0.0001
AP/IB	67	0.454	4.102	< 0.0001

Grade Differential (Aggregate):



GD = Uni – HS

Regular:
–16.7 ± 13.7
AP:
–15.5 ± 12.7
IB:
–20.3 ± 14.2
CHM138:
–15.7 ± 13.8
CHM139:
–18.3 ± 13.5

Related US Study:

Survey of 12 US colleges & universities:

- R. H. Tai, P. M. Sadler, and J. F. Loehr
  - *J. Res. Sci. Teaching*, 2005, *42(9)*, 987-1012
- R. H. Tai, R. B. Ward, and P. M. Sadler
  - *J. Chem. Ed.*, 2006, *83(11)*, 1703-1711
- R. H. Tai and P. M. Sadler
  - *J. Chem. Ed.*, 2007, *84(6)*, 1040-1046

Top Grade Predictors:

1. Last HS Math Grade (AP and/or calculus) – SAT Math score also highly significant
2. Last HS science grade (not specifically chemistry)
3. Time spent on stoichiometry (*recurring topic*)
4. AP instead of regular chemistry; emphasis on understanding *vs.* memorization

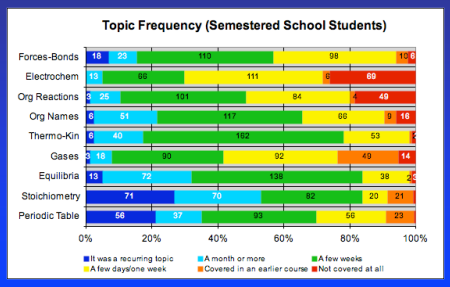
Tai and Sadle, op. cit.

Topical Content:

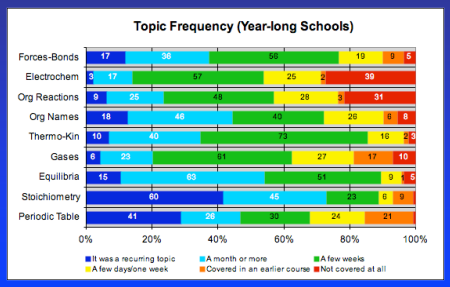
- Atoms & periodic table (electron config., periodicity, *etc.*)
- Stoichiometry (chemical reactions & equations)
- Equilibria (reactions, acid/base, solubility)
- Gases (properties, gas laws)
- Thermodynamics & Kinetics (energy, Hess' Law, *etc.*)
- Organic Chemistry (naming, groups, structure)
- Organic Chemistry (reactions, mechanisms)
- Electrochemistry (redox, galvanic & voltaic cells)
- Forces & Bonding (VSEPR, van der Waal's, *etc.*)

Ontario Curriculum: Grade 11 and Grade 12 (2000-9)

Topical Content - Semestered



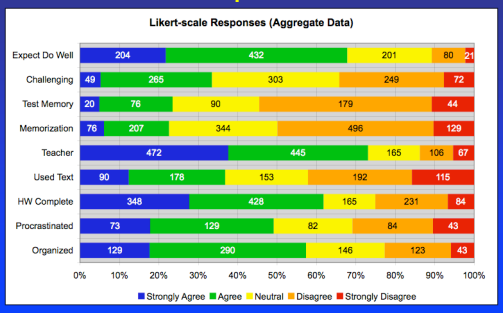
Topical Content - Year-long



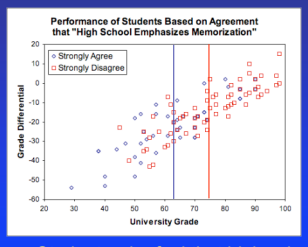
Student Perceptions - School:

1. I expect to do well in university chemistry
2. I found high school chemistry challenging
3. Tests emphasized memorization
4. Classes emphasized memorization
5. My teacher performed effectively
6. I used the text extensively
7. I always completed homework
8. I procrastinated a lot
9. I was organized and used my time effectively

Student Perceptions - School:



High School Memorization:



Statistical tests:

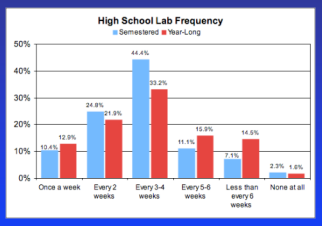
- Same mean high school grades ($\alpha = 0.01$)
- Different mean university grades ($\alpha = 0.0001$)
- Different mean GDs ($\alpha = 0.001$)

- Students who feel that high school emphasizes memorization tend to do worse in university

Focus Group Themes:

- Teaching & evaluation practices
- Use of text (by student or teacher)
- Self-directed learning & pace of material
- Relevance & complexity of labs
- Organic coverage from curriculum

High School Labs:



- Quality of labs highly variable
- Funding depends on school/board priorities
- No technical help!
- Highly restricted list of "allowed" chemicals

Aggregate data, 2007-8 and 2008-9
Semestered n = 577, Year-long n = 365

Diagnostics - Content:

"The decline in A and B grades has been accompanied by a marked increase in F and dropped grades."

Nelson Hovey & Albertine Krohn, JCE **1958** (35) 507-509

- California Chemistry Diagnostic Test
  - ACS Examinations Institute

Arlene Russell, JCE 1994 (71) 314-317

- CIC Chemistry Exam (Part A)
  - based on Pan-Canadian Protocol, Grade 12

Diagnostics - Style/Skills:

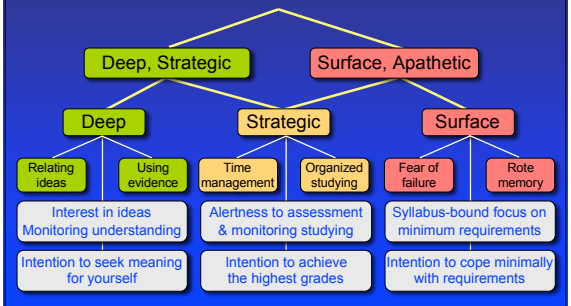
"The most accurate predictive measure of degree results is generally first-year grades, but the highest proportion of failure occurs during the first year."

H. Tait and N. Entwistle, Higher Ed. 1996 (31) 99-118

Approaches & Study Skills Inventory for Students (ASSIST)

Deep	Surface
Strategic	Apathetic

ASSIST Concept Map:



The ROP299 Teams:

2006-7:
- Robin Baj
- Michael Lebenbaum
- Sujan Saundarakumaran
- Derrick Tam
- Jakub Vodsedalek

2007-8:
- Mena Gewarges
- Cindy Hu
- Gordon Ng
- Jana Pfefferle
- Curtis Wang

2008-9:
- Marlena Colasanto
- Lauren Cosolo
- Darrin Gao
- Inna Genkin
- Kelly Hoang
- Justina Lee
- Bryan Nguyen
- Emily Plobner

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