

*The High School–University
Transition in Chemistry*

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College Chemistry Canada May 2009

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<http://www.chem.utoronto.ca/~dstone/Research/ROP299.html>

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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?

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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%

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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%

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Aggregate Demographics:

Student's School Location

Location	Percentage
Toronto/GTA	67%
Ontario (not GTA)	18%
Canada (not Ontario)	8%
USA	2%
Other Country	5%

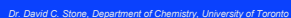
Student's Program Type

Program Type	Percentage
Regular	77%
Enriched/Gifted	9%
AP	6%
IB	3%
Other	5%

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

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

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A Grade Disappointment:

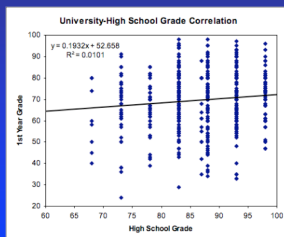
Relative Grade Distributions

Legend:

- CHM 138F 2007
- CHM 138F 2006
- CHM 138F 2005
- CHM 138F 2004
- CHM 138F 2003
- CHM 138F 2002
- CHM 138F 2001
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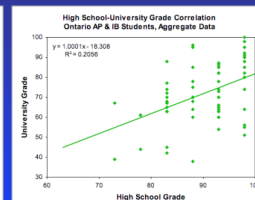
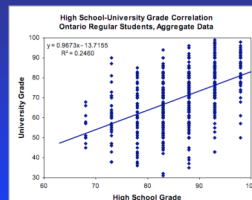
Grade Correlation 2007-8:



- 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 ($n = 31$)

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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 $n = 28$

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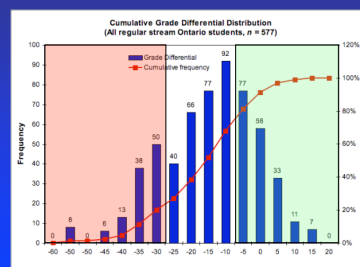
Aggregate Correlation Data:

- 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

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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

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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

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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 Sadler, *op. cit.*

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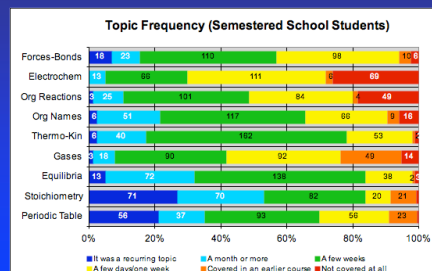
Topical Content:

- 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)

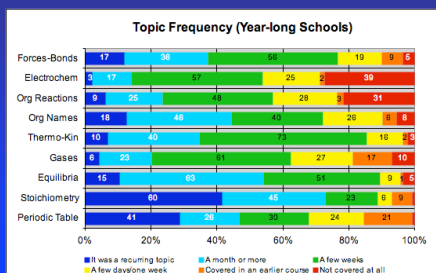
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Topical Content - Semestered



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Topical Content - Year-long



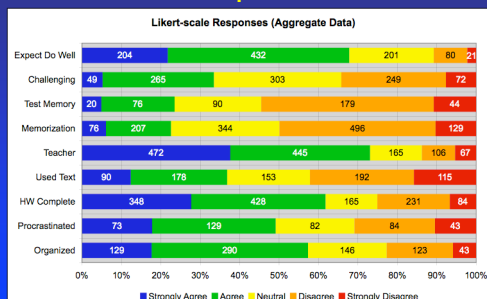
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Student Perceptions - School:

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

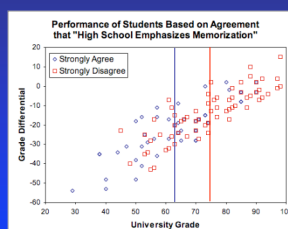
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Student Perceptions - School:



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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

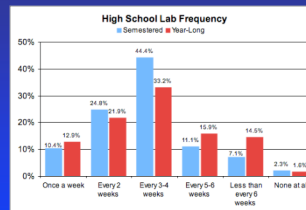
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Focus Group Themes:

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

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High School Labs:



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

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

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
 - Adlene Russell, JCE 1994 (71) 314-317
- CIC Chemistry Exam (Part A)
 - based on Pan-Canadian Protocol, Grade 12

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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."

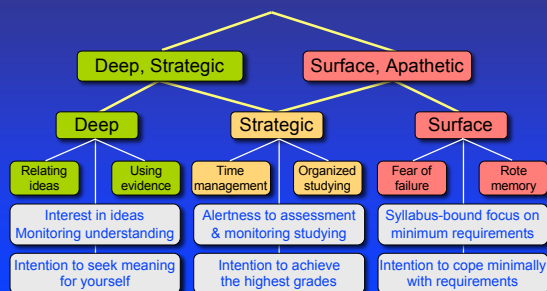
H. Tait and N. Entwistle, Higher Ed. 1996 (31) 99-118

Approaches & Study Skills Inventory for Students (ASSIST)

Deep	Surface
Strategic	Apathetic

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ASSIST Concept Map:



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The ROP299 Teams:

2006-7:

Robin Baj
Michael Lebenbaum
Sujan Saundarakumaran
Derrick Tam
Jakub Vodsedalek

2008-9:

Marlena Colasanto
Lauren Cosolo
Darrin Gao
Inna Genkin
Kelly Hoang

2007-8:

Mena Gewarges
Cindy Hu
Gordon Ng
Jana Pfeifferle
Curtis Wang

Justina Lee
Bryan Nguyen
Emily Plobner

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Acknowledgements:

- U of T 1st-year students, for participating
- 1st-year instructors and peer mentors
- Faculty of Arts & Science (financial support)
- RCAT/portal staff (technical assistance)

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