High to Low Tide: The high school–university transition

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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:

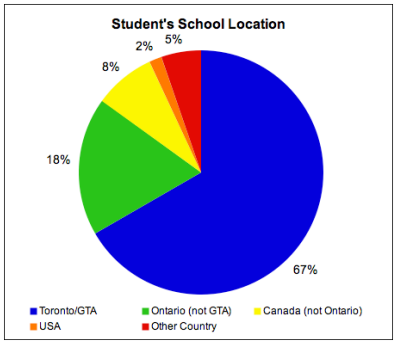
- CHM 138F (Introduction to Organic Chem.)
- CHM 139F (General Physical Chemistry)
- CHM 151Y (Advanced Introductory Chem.)

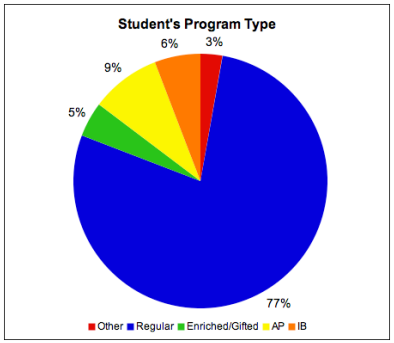
Year	Enrolment	Surveys	Response
2006-7	1830	320	17.5%
2007-8	1803	536	29.3%
2008-9	1723	414	24.0%
Total:	5356	1270	23.7%

Who Are Our Students?

Category	2006-7	2007-8	2008-9
Female:	–	60.6%	59.4%
Male:	–	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:

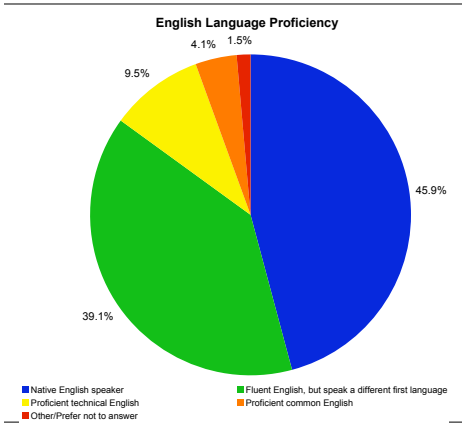




- Over 430 different schools
- ~ 200 Toronto/GTA schools
- ~100 other Ontario schools

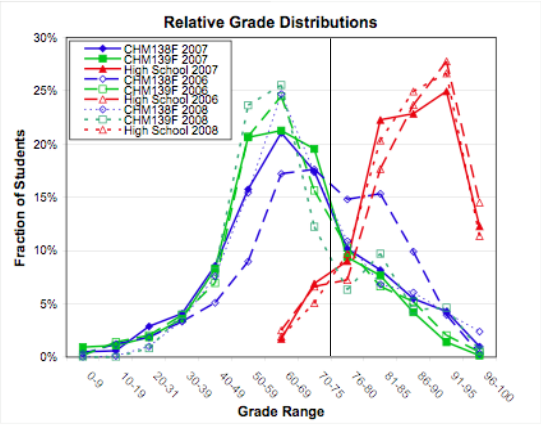
- 69% public board students
- 19% catholic board students
- 12% private school students

English Language Skills:



- Self-reported level
- Low ESL students may not have participated
- Several ESL tests recognized
- Some students memorize ESL essays

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)

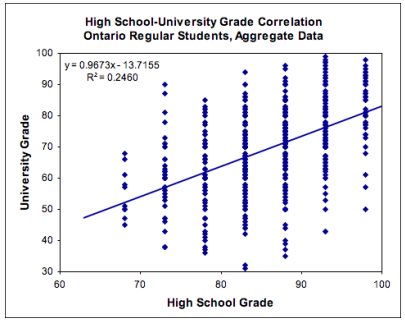
Educational Research (1):

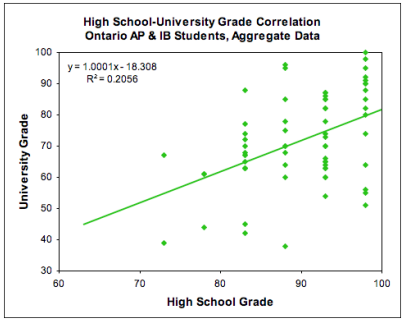
"Teaching is a messy, messy business"

Peter Bloch

– but educational research is messier!

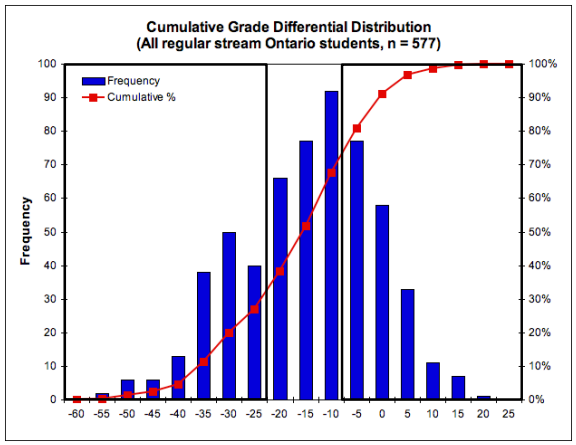
Aggregate Correlations:





- 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 $n = 28$

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

Educational Research (2):

Educational research repeats itself.

Has to.

Nobody listens.

(With apologies to Steve Taylor)

Predicting Chemistry Success:

- Everhart & Ebaugh (Denison) 1929
- Scofield (Syracuse) 1930
- Hermann (Marquette) 1931
- Steiner (Oberlin) 1932
- Clark (Muskingum) 1938
- McQuary *et al* (Wisconsin) 1952
- Hadley *et al* (Southern Illinois) 1953
- Brasted (Minnesota) 1957
- Hovey & Krohn (Toledo) 1958, 1963
- Ozsoggomonyan & Loftus (Berkeley) 1979

(and so on...)

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

Metrics of Learning:

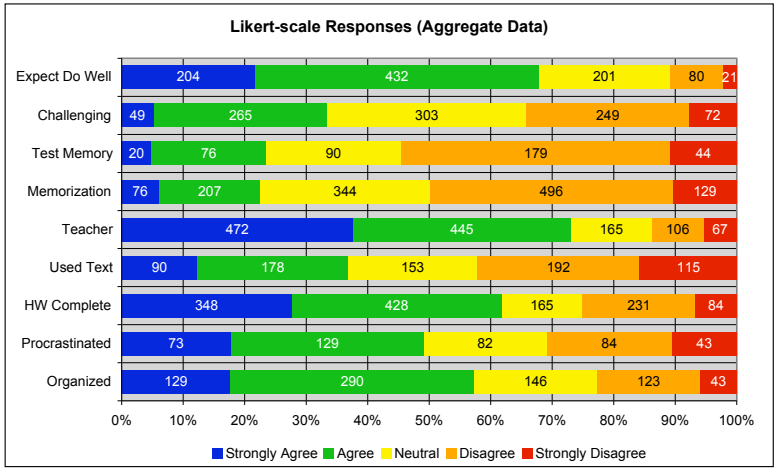
"There is some indication that taking high school chemistry may be used as an indicator of success in college chemistry. There are indications that a math/physics background, high placement scores, achievement tests scores, intelligence, and age may be better, or at least as good, as indicators. There is also evidence that no indicator is all that good"

W. R. Ogden, School Sc. & Math. **1976**, *76, 122-126.*

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:



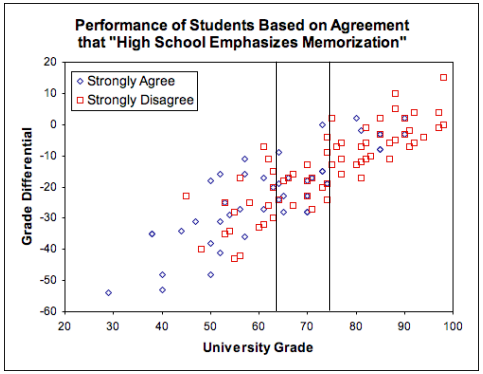
Educational Research (3):

Quantitative educational research is…

The art of using statistics to state the obvious...

...at least, it's obvious once you've stated it!

High School Memorization:

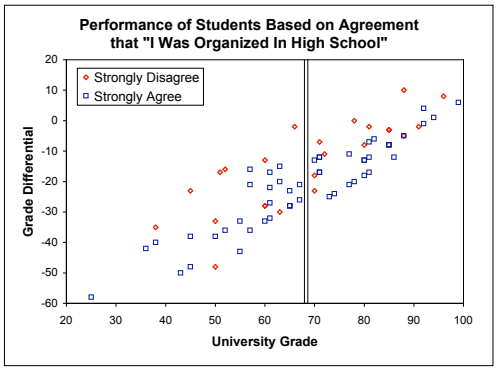


Statistical tests:

- Same mean high school grades ($p > 0.01$)
- Different mean university grades ($p < 0.0001$)
- Different mean GDs ($p < 0.001$)

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

High School Organization:

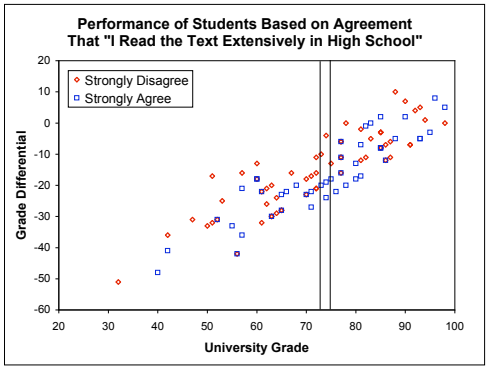


Statistical tests:

- Different mean high school grades ($p < 0.005$)
- Same mean university grades ($p >> 0.01$)
- Same mean GDs (?) ($0.01 < p < 0.05$)

- Students who were "organized & efficient" in high school do not appear to perform better at university

High School Text Use:

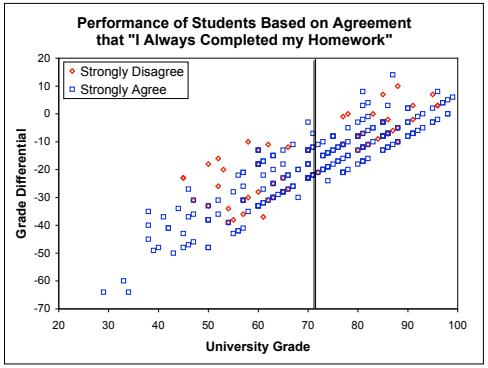


Statistical tests:

- Different mean high school grades ($p < 0.001$)
- Same mean university grades ($p >> 0.01$)
- Same mean GDs ($p >> 0.01$)

- Students who used the text in high school do not appear to perform better at university

High School Homework:

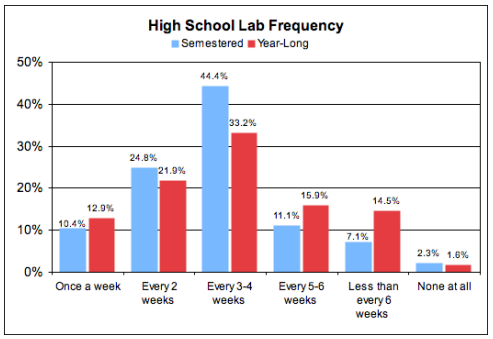


Statistical tests:

- Different mean high school grades
  ($p < 0.005$)
- Same mean university grades
  ($p >> 0.01$)
- Same mean GDs
  ($p > 0.05$)

- Students who completed high school homework do not appear to perform better at university

High School Labs:



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

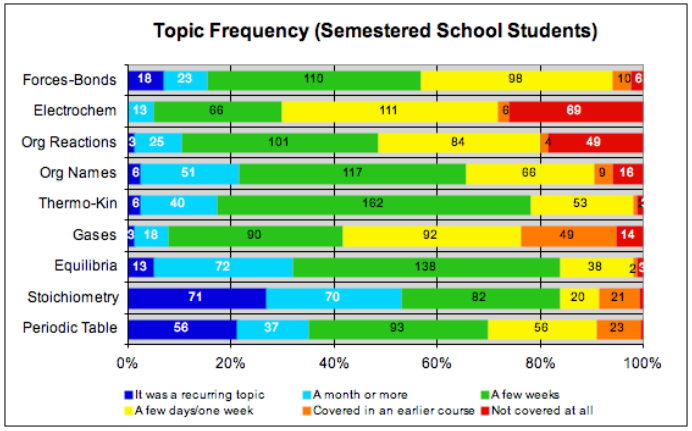
Aggregate data, 2007-8 and 2008-9
Semestered n = 577, Year-long n = 365

Topical Content:

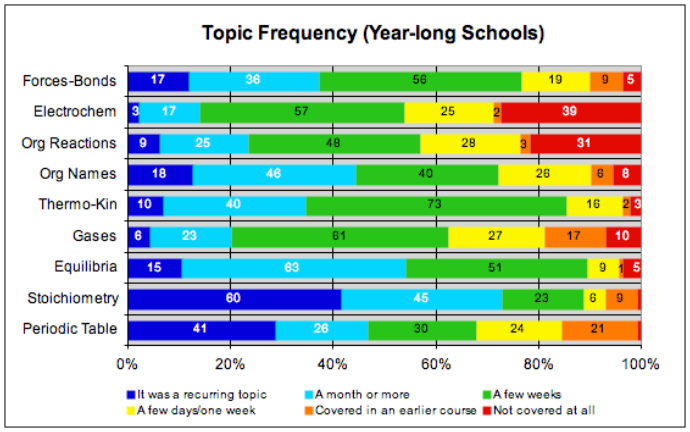
- Atoms & periodic table (electron config., periodicity, *etc.*)
- Stoichiometry (chemical reactions & equations)
- Equilibria (reactions, acid/base, solubility)
- Gases (properties, gas laws)
- Thermodynamics & Kinetics (energy, Hess' Law, *etc.*)
- Organic Chemistry (naming, groups, structure)
- Organic 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)

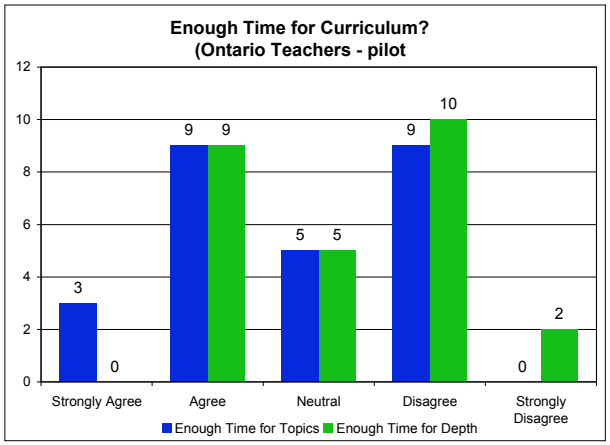
Topical Content - Semestered



Topical Content - Year-long



Teacher Survey - Time:



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

- Toledo Placement Exam
  - ACS Examinations Institute

Hovey & Krohn, Niedzielski & Walmsley

- California Chemistry Diagnostic Test
  - ACS Examinations Institute

Arlene Russell, JCE 1994 (71) 314-317

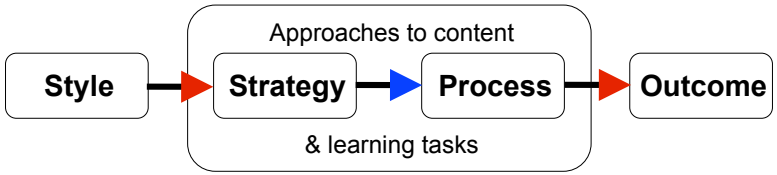
Diagnostics - Content:

Canadian equivalents?

- CIC Chemistry Exam (Part A)
  - based on Pan-Canadian Protocol, Grade 12
- Chemistry Pre-test
  - U of Toronto, U of Guelph

Psychology of Learning:

- Information input & processing – VARK
  - http://www.vark-learn.com/english/index.asp
- Approach to learning and learning tasks:



(After Entwistle, Marton, Pask, Biggs, etc.)

Learning Styles & Strategies:

Orientation & intention	Motivation (personality)	Style	Process		Outcome
			Stage I	Stage II	
Understanding	Intrinsic (Autonomous, syllabus-free)	Deep approach /	All four processes below used appropriately		Deep level of understanding
		Comprehension learning	Building overall description of content area	Reorganizing & relating data, personal meaning	Incomplete understanding (*globetrotting*)
Reproducing	Extrinsic, fear of failure (Anxious, syllabus-bound)	Operation learning	Attention to evidence & logic of	Relating evidence, objective stance	Incomplete understanding (*improvidence*)
		Surface approach	Memorization	Over-learning	Surface level of
Achieving high grades	Hope for success (Stable, self-confident)	Organized / achievement orientated	Any combination of six above processes considered appropriate to *perceived* requirements of task and criteria of assessment		High grades with or without understanding

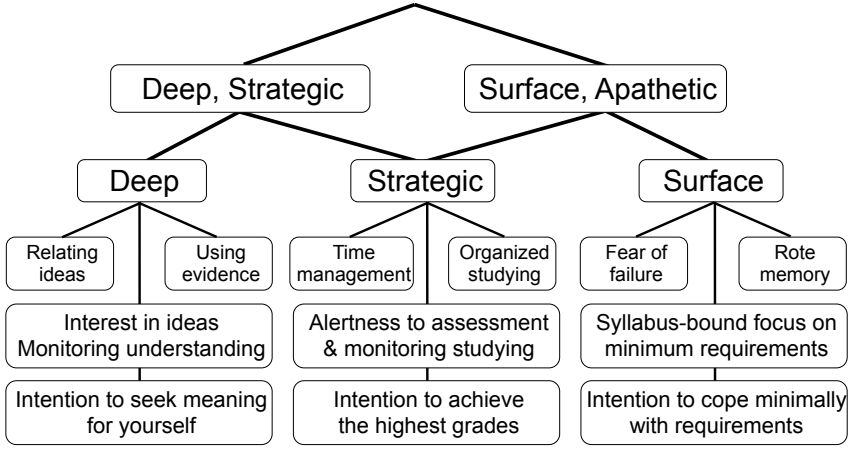
Diagnostics - Style/Skills:

"I think the difficulty of university chemistry is overrated. […] As I have learned how to learn already, for me, university has simply meant a more diligent approach..."

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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