

“How well does high school prepare you for university chemistry?”

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with

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A CHM 299Y Research Opportunity Project

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

Chemistry for Life Sciences

- Before 2000-1:
 - CHM 137Y General/Physical Chemistry
 - CHM 240Y Organic Chemistry
- Since 2000-1:
 - CHM 138H Organic Chemistry I
 - CHM 139H General Chemistry
 - CHM 220H Physical Chemistry
 - CHM 247H Organic Chemistry II

CHM 139H1 Topics

- Reactions & stoichiometry
- Quantum nature of matter
- Gases, liquids, solids, solutions
- Kinetics & mechanism, enzyme kinetics
- Equilibria: acid–base, buffers, solubility
- Thermodynamics: H, S, G, laws
- Electrochemistry: redox, cells, potentials

CHM 138H1 Topics

- Structure & Bonding
- Resonance, acids & bases
- Alkanes & cycloalkanes
- Conformation, stereochemistry
- Organic reaction patterns & rates
- Alkenes
- Alkyl halides
- Benzene & aromaticity
- Alcohols, IR spectroscopy

Relevant Literature

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 Chemistry Grade Predictors?

- 1.
- 2.
- 3.
- 4.

Top Chemistry Grade Predictors

1. Last HS Math grade
2. SAT Mathematics score
3. Various:
 - Last HS Science Grade
 - AP Calculus course
4. Demographic factors

Chemistry Topics for Success?

- Atoms and the Periodic Table
- Biochemistry
- Chemical Reactions and Equations
- Gases and Gas Laws
- History of Chemistry
- Nuclear Reactions
- Solutions
- Stoichiometry

Chemistry Topics for Success

1. Stoichiometry (recurring topic)
2. Gases and Gas Laws (limited)

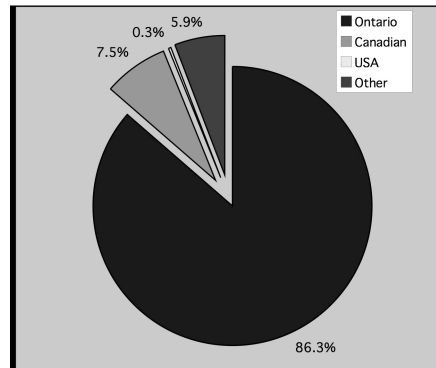
Negative impact:

- Nuclear Reactions

U of T Survey Cohort Data

- Students registered in *any* 1st-year chemistry course during 2006-7 (CHM138/139/151)
- 1830 eligible students in BlackBoard™
- Survey on-line during Spring 2007 session
- 320 completed surveys submitted (17.5%)
- 3 Focus groups held (March 2007)

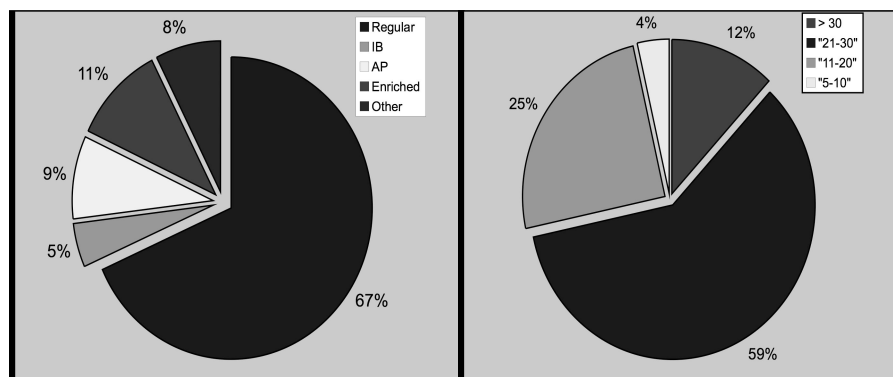
The Schools Represented:



123 different schools:

- 81 in Ontario
- 22 in rest of Canada
- 20 international
- 75 public schools
- 23 Catholic schools
- 25 private schools

Student Class Profiles

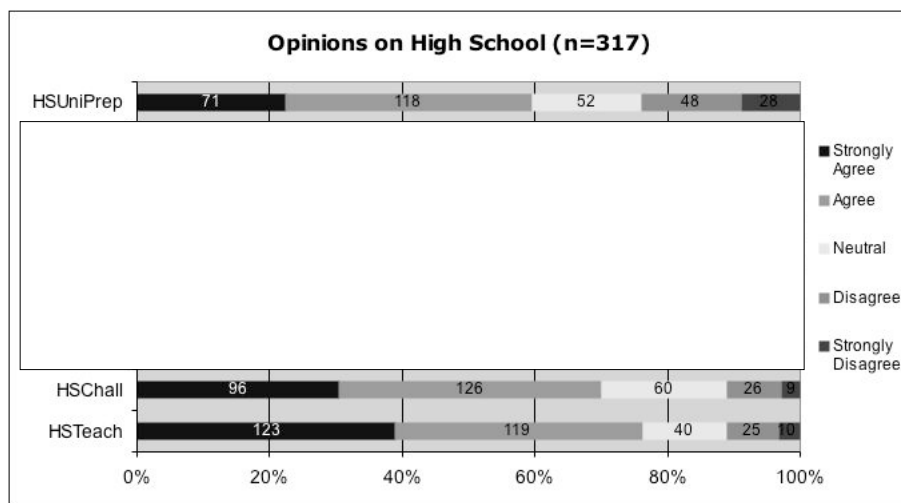


- 56% completed an independent study unit in high school

Student Perceptions of High School Chemistry

- “My high school chemistry teacher performed effectively as a teacher”
- “My high school chemistry teacher challenged our class”
- “My high school experience helped prepare me for university”

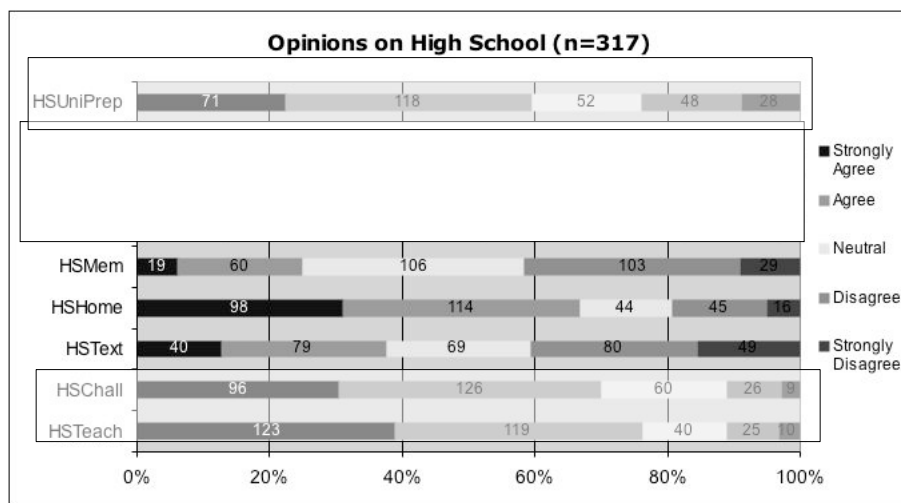
Student Perceptions of High School Chemistry



Student Perceptions of High School Chemistry

- “I spent a lot of time reading the textbook in high school chemistry”
- “I always completed my homework in high school chemistry”
- “Grade 12 chemistry (or equivalent) had a greater focus on memorization than comprehension”

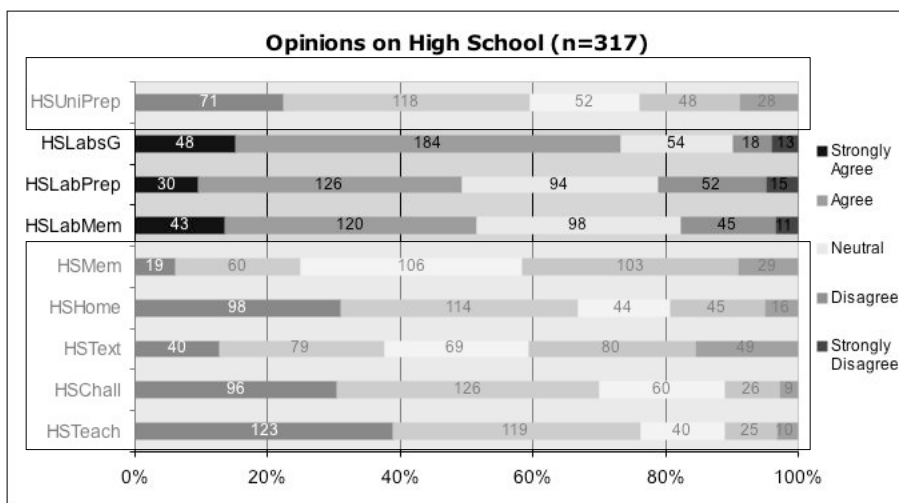
Student Perceptions of High School Chemistry



Student Perceptions of High School Chemistry

- “In preparing for high school chemistry labs, there was more emphasis on understanding concepts than memorizing”
- “My high school chemistry teacher spent enough time preparing us for labs”
- “My high school chemistry labs were useful and relevant to the topics covered in class”

Student Perceptions of High School Chemistry



High School Perception - Good

“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.”

“... we got a really good chemistry teacher because she really prepared us for what's coming. And also, the really fundamental concept was emphasized over and over.”

High School Perception - Mixed

“Grade 11 and 12 chemistry prepared me extremely inadequately for organic chemistry, but prepared me extremely well for physical chemistry”

“High school prepared me for university in as much as allowing me to realize that no one really cares if you do an assignment or not, learning is for yourself and yourself alone”

High School Perception - Bad

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

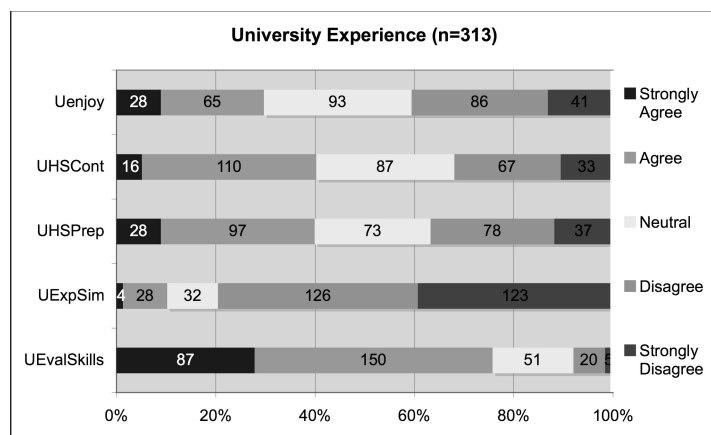
“I went to a snobbish private school where academics [sic] were a big joke and athletic [sic] always came first. That's one reason why i find it so different, but U of T has its flaws too”

“The biggest issue with High School Chemistry, for me, was that my teacher was very dis-organized, and was not very knowledgeable in Chemistry. ... there was practically a whole entire class (most students) filled with his students in Night School the following semester”

University vs. High School

- “I enjoy university chemistry more than I enjoyed high school chemistry”
- “I feel my university professors picked up where high school left off”
- ““I feel high school sufficiently prepared me for university”
- “I find that university is a similar experience to high school”
- “I have had to re-evaluate my study skills since coming to university”

University vs. High School

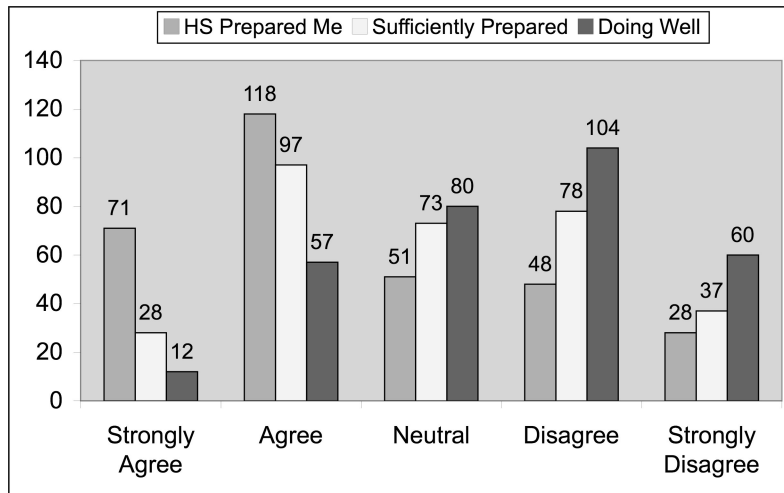


Student Impressions

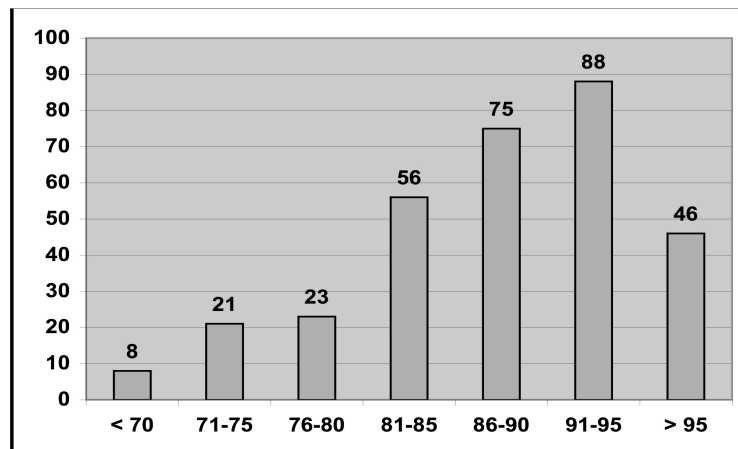
- “My high school experience helped prepare me for university”
- “I feel high school sufficiently prepared me for university”
- “I am doing as well as I expected in university chemistry”

*Answered on a 5-point Likert scale: “Strongly Agree”,
“Agree”, “Neither Agree nor Disagree”, “Disagree”,
“Strongly Disagree”*

Student Impressions



Student Grade Distributions

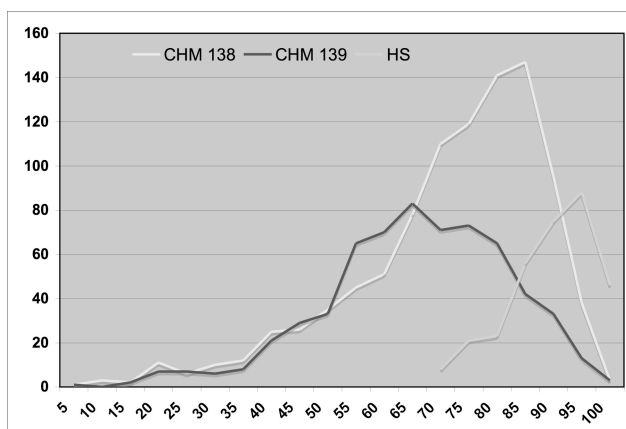


The Grade Point “Hit”

- Students typically 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”

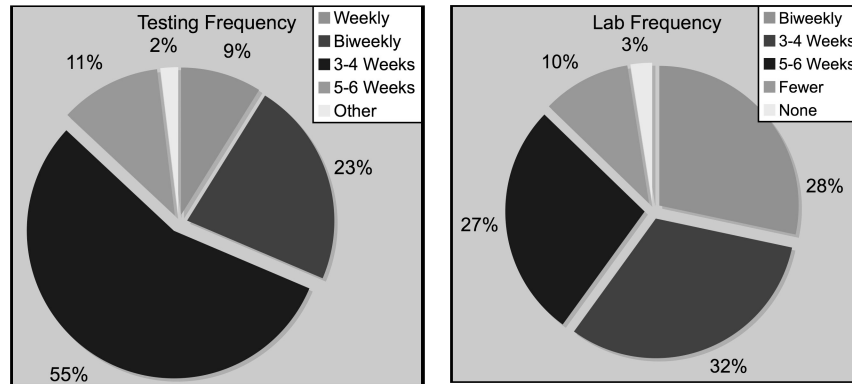
Comparison with CHM 1xx



- CHM 138
 - ave. 69.7
 - $n = 959$
- CHM 139
 - ave. 63.8
 - $n = 633$
- Global HS:
 - ave. 87.4

Results for Fall 2006 session; Life Science HS entry average for 2005-6

School Labs and Evaluation



CHM 138/139: biweekly 3-hr labs; 1 mid-term (now 2)

Changes From High School – Labs

- Quality and quantity of labs
 - unaccustomed to duration
 - unused to required preparation
 - lack experience with formal reports
 - more varied, complicated, use of equipment

“I find the labs to be pretty ridiculous. They're long, take a huge chunk out of my day, take a lot of preparation time and cover topics we haven't really covered yet in lectures.”

“the labs were a big change for me; in high school labs weren't really anything, just something we do once in a while”

Changes From High School - Pace

- The Pace

- more information covered in shorter time
- fewer evaluations covering more material
- tests for multiple courses compressed into short time

“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.”

Changes From High School – Text

- Readings

- easy to fall behind, hard to catch up
- much greater emphasis on independent study

“A lot more reading than we used to have to do.”

“Not everything is going to be covered in the lectures”

“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.”

Changes From High School – Exams

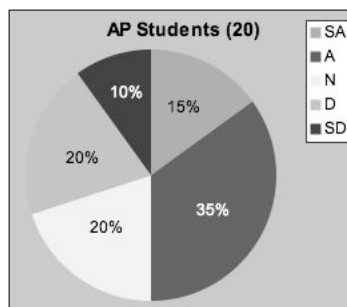
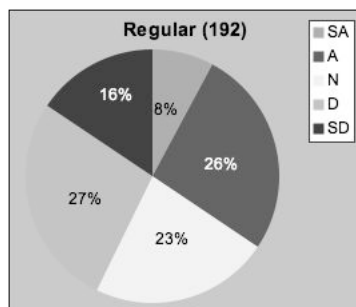
- Learning Emphasis
 - memorization vs. understanding
- Curriculum and testing
 - style of questions, complexity of material

“In high school, the [tests] were more memorizational and less conceptually based (i.e. one could get an A without knowing chemistry)”

“They [high school] showed you a breakdown, and they show you that your memorization is worth more on tests than your actual application”

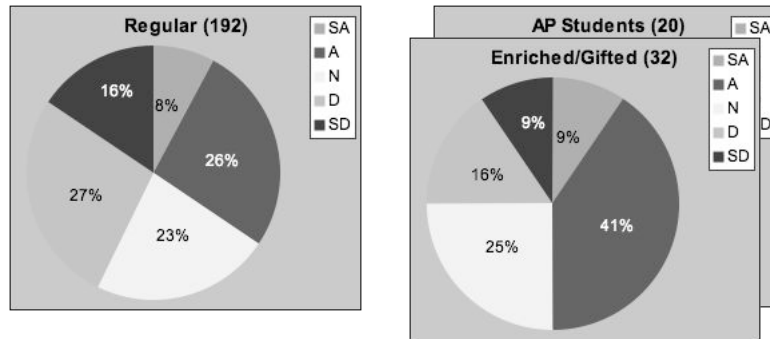
“Questions on high school tests involving higher thinking are rare.”

Do AP/IB Students Gain An Advantage? (Did high school sufficiently prepare you?)



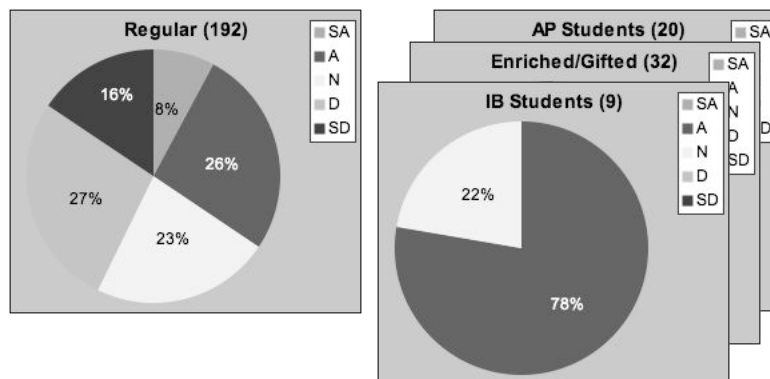
(Data for Ontario students only)

Do AP/IB Students Gain An Advantage? (Did high school sufficiently prepare you?)



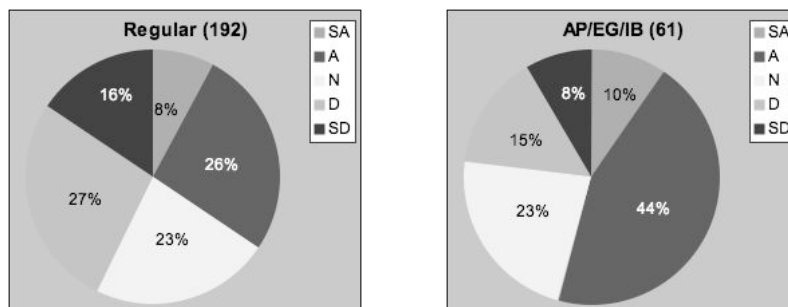
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Do AP/IB Students Gain An Advantage? (Did high school sufficiently prepare you?)



(Data for Ontario students only)

Do AP/IB Students Gain An Advantage? (Did high school sufficiently prepare you?)



(Data for Ontario students only)

High School Recommendations

- One or more university–style classes
 - Skeletal handouts, note–taking from lecture
 - Evaluate notes and give feedback
- One or more university–style tests
 - Cumulative or comprehensive tests
 - Emphasize conceptual & problem-solving questions

High School Recommendations

- More frequent and complex labs
 - Require at least one formal report *without* guiding questions
 - Use “discovery” style ISUs/experiments
- Spread more complex topics throughout the year
 - Include organic chemistry!
 - Cover some reactions

Challenging Better Students



Canadian Chemistry Olympiad

<http://www.chem.utoronto.ca/IChO.Ontario/>

- on-line student preparation problems
monthly (with registration)

Canadian Chemistry Contest

<http://www.chemistry.ca/nhsce>

- past problems & solutions on-line



Combined National Exams:

April 22nd, 2007

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