Developed Metrics for Scholarly Research-Based Writing

(A) Critical thinking / Interpretation of results	(B) Research and Engagement
1) Raw data as "results"	1) Didn't understand the result
2) Makes observation of data in prose	2) Used pre-lab, lab manual, lecture, and course text for background
3) Any discussion of "correctness" of result (accuracy, etc…)	3) Looked for *any* result *anywhere* to match results
4) Appropriate discussion of "correctness"	4) Found a reputable / primary source to match the results
5) Science behind the result is discussed (limits, applicability,…)	5) Surveyed the literature for appropriate source to contrast
6) Links results to motivation and impacts	6) Researched to determine the reason for their result, not just a source that is similar
7) True motivation, true impacts	

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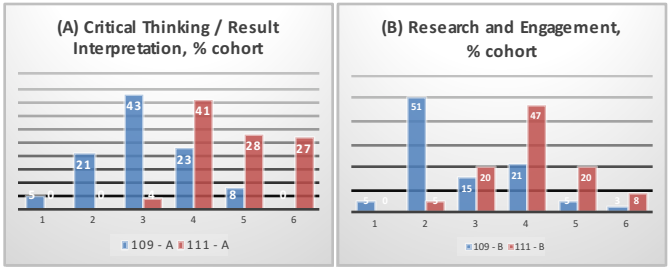
Major gains in rubric metrics

Cohort	(A) Critical thinking / Result Interpretation	(B) Research and Engagement
Incoming students	~ 2	~ 2
Post "Year 0" CH111	3 – 4	3
Post "Year 5" CH111	4.8 ± 0.9	4.0 ± 1.0
Post CH109 students	3.0 ± 1.0	2.8 ± 1.2



Significant shifts in students attitudes

Attitude	Before CH111	After CH112
Understand importance of writing in science	3.0 ± 1.0	4.7 ± 0.5
Scientists write in complicated/obtuse way	4.0 ± 0.8	1.9 ± 0.8
Feel prepared to write science papers	2.1 ± 0.9	4.4 ± 0.5

Student feelings about program components

Question about program	Response
Despite being more work, do it again?	4.6 ± 0.7
Necessity of program documents	4.3 ± 0.7
Usefulness of writing assistant	4.3 ± 0.9

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Major Conclusions – What we believe

- No assumptions about "craft" abilities. ***Teach everything.***
- Do *not* waste time ill-conceived work. ***Less is more, Just-in-time***
- Focus on nature of science and crafting ***strong arguments*** leads to writing in the sciences with maturity
- Writing must be ***preceded*** by instruction in critical thinking
- Students must ***engage with sources*** as part of process of science
- Structure and conventions should taught ***in context*** of argument

Major Outcomes

- ***Content Knowledge Gains*** achieved without explicit goals stated
- Major ***shift in attitudes*** about the nature of science and writing
- Increased rate of funded undergraduate research proposals
- ***ESL students thrive*** as well as native speakers in this program.

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