Refining scientific writing skills with feedback that works for students and instructors

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Scientific writing skills for Physics majors

- Support professional skills development
- Studied efficacy of two different feedback methods
- Observed correlation between feedback utilization and improvement in student work

Outline

- Motivation and context
- Description of the Modern Physics Laboratory course
- Feedback implementation and efficacy quantification methods
- Results
- Discussion and future directions

Undergraduate Learning Outcomes Assessment Program

- Semester length learning community
- Prepare future faculty to assess undergraduate learning, a skill that extends from classroom pedagogy to course and program planning
- Activities:
  - Annotated Syllabus
  - Needs Assessment Survey
  - Mid-Course Feedback Survey
  - Rubric Design
  - **Signature Assignment**

Undergraduate Learning Outcomes Assessment Program

- Signature Assignment
  - Should address learning outcomes (Rubric) and Program Learning Outcomes
  - Should exemplify student performance in the course
  - Assessment should show the efficacy of some kind of a pedagogical tool / “teaching intervention”
  - Technical Report, Modern Physics Lab

Physics Program-Level Outcome: Communication

- *"…students will be able to clearly explain their mathematical and physical reasoning, both orally and in writing."*
- Supported in the upper division curriculum through technical reporting in the Modern Physics Laboratory course, Physics 160.
- From Syllabus:

Learning Objectives	Outcomes
I will present a structure for reporting results and help each student improve their ability to communicate scientific results.	You will be able to formally present scientific results as a technical report and oral presentation.

Modern Physics Laboratory course-Spring 2013

- Eight (8) students, in pairs
- One lab assignment over 2 weeks
- Each pair cycles through 6 different lab setups
- Mostly upper division physics majors
- Technical reports are formatted to reflect the style of journal articles
- Collaborated with the Instructor of Record on rubric design

Rotation group	1	2	3	4
Week 3-4	Diode Laser	Noise	Labview	Double slit
Week 5-6	Noise	Labview	Doubleslit	Sonolumin
Week 8-9	Labview	Double slit	Sonolumin	NMR
Week 11-12	Double slit	Sonolumin	NMR	Diode laser
Week 13-14	Sonolumin	NMR	Diode laser	Noise
Week 15-16	NMR	Diode laser	Noise	Labview

Dense, Detailed Feedback

- Intervention: provide students with specific feedback on writing in technical reports
- Efficacy:
  - Monitor utilization of feedback (Turnitin.com, Office hour attendance, etc.)
  - Compare writing improvement with feedback utilization
  - Single-student normalized gain,

$$g = \frac{\%\ Gain}{\%\ Gain_{max}}$$

Hake, R.R. [PERC2002h-Hake.pdf] Physics Education Research Conference (PERC2002); Boise, Idaho; August 2002.

Example of Feedback

Abstract

Our goal is to prove that when we have an electrical current we will observe a background noise known as Johnson noise. In order to prove that such noise is apparent we used a High Level Electronic machine (HLE), Preamplifier Module, Low Level Electronic machine (LLE), Oscilloscope and a digital voltmeter (DMM). When we then set up the apparatus by making sure that all our components are set to their default settings. We hook up the Preamplifier Module to the HLE to the Oscilloscope to the digital voltmeter. Doing so will allow us to visually see through the Oscilloscope that background noise known as Johnson noise. By increasing the gain or our resistance (Ω) we should see a correlation and a change in "extra noise" and we should also see a dependence of bandwidth.

1 Background

A Swedish-born American physicist John Bertrand Johnson first observed Johnson noise. Johnson noise is caused by the thermal fluctuations and dissipations of stationary charge carriers (applies at any voltage). Voltage "is the electromotive force or potential difference expressed in volts"[1]. Voltage has a correlation with bandwidth, which is the difference between upper and lower frequencies in a continuous set of frequencies (Δf). Bandwidth should influence our noise voltage since at low frequencies we should get high noise voltage and at high frequencies we would get a weaker noise voltage. When voltage is influenced by bandwidth it's been known to radiate a current sound that is

Comment [LK1]: Unclear problem statement. Try choosing the main verb that describes what your data achieves and writing your problem statement around that verb.

Comment [LK2]: This information is more appropriate in the methods section. The abstract is usually just the problem statement, any distinctive characteristics of the setup (unusual/critical components) and quantitative results (and conclusions)!!!!

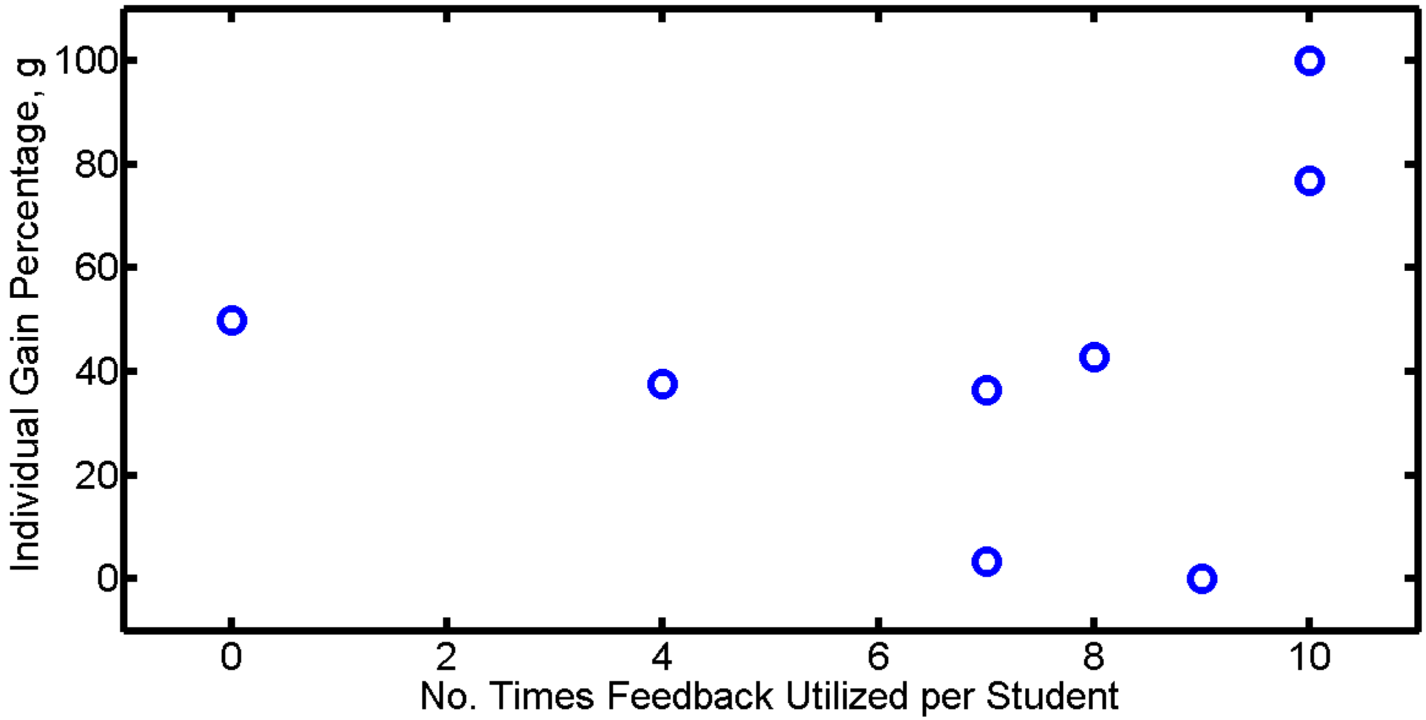
Comment [LK3]: Good information for an abstract!!!

Comment [LK4]: Historical information is not necessary.

Comment [LK5]: Use a resource that is a trusted authority on electrical noise. The error analysis book probably cites a different source for this information!!

Comment [LK6]: Why do you expect this? Can you show this with the relevant equations?

Single Student Normalized Gain



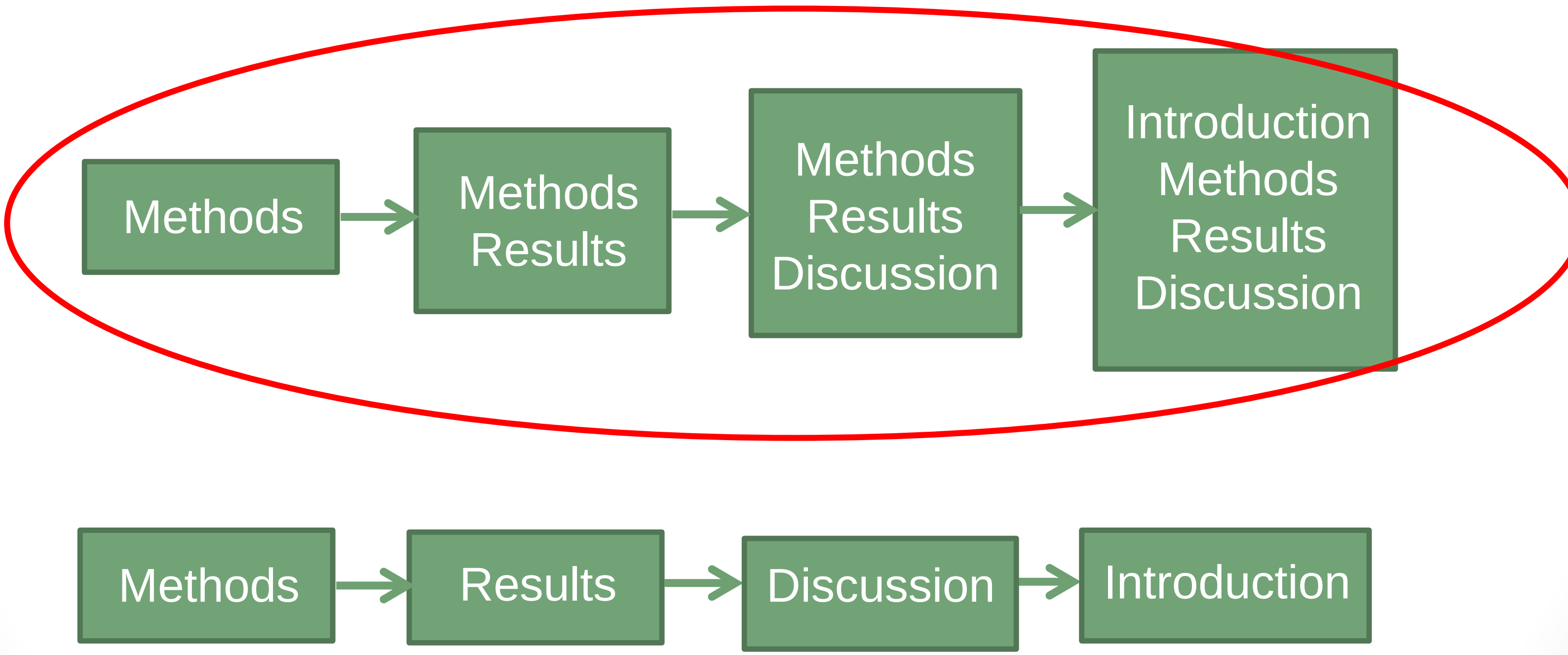
- All students receive summative feedback in class
- Direct and Indirect evidence suggests a threshold

Discussion

- We find that student review of dense feedback is effective in supporting scientific writing skills for some students
- Indirect evidence of feedback utilization suggests efficacy of this feedback method
- Small class size makes it difficult to generalize these results, a larger study is needed
- This feedback method is unscalable for larger class sizes

Scalability to large class sizes

- Developing one section of the technical report each time



Physics 10 & 160: Tech Report Grading Rubric

Spring 2014

Your tech reports will be graded on *Content* and *Style*

***Content*:** The base score is 3 points for excellent, 2 points for good, and 1 point for poor. A score of zero is also possible if this section is missing or for extremely poor quality. When the section becomes active, the base score is scaled as given in the table (i.e. *base * scale*)

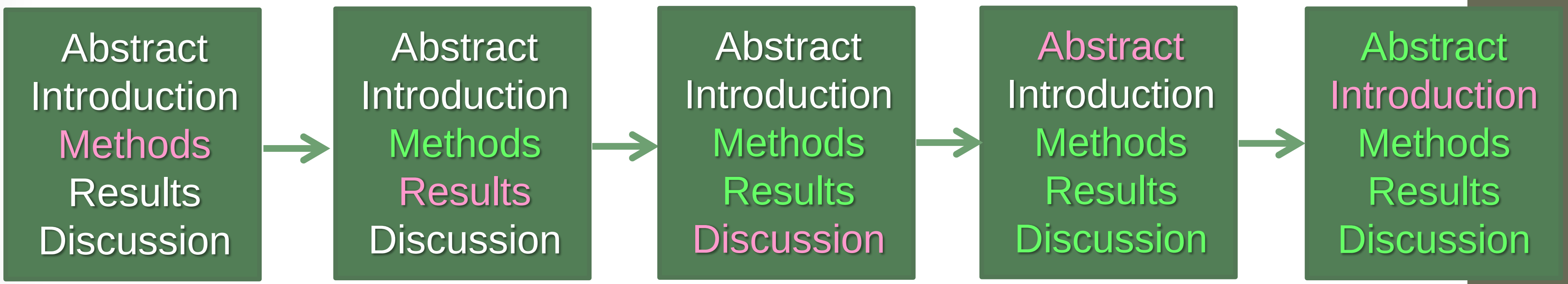
SECTION	GOAL	EVALUATION		
		Excellent 3 points	Good 2 points	Poor 1 point
Title **Scale = 1**	To give content information to reader	• Engaging	• Appropriate	• Not enough content information or too much
Authors **Scale = 1**	To formally recognize all contributors to the lab work	• Listed and properly attributed	• n/a	• Not all listed and properly attributed.
Abstract **Scale = 3**	To concisely summarize the experimental question, general methods, major findings, and implications of the experiments in relation to what is known or expected	• Key information included: o *Problem statement* o *Description of methods* o *Quantitative results with uncertainties* • Presented clearly & concisely • All information is correct • Organization is logical • Captures any reader's interest	• Sufficient information is presented in proper format • Would benefit from some reorganization • Understandable with some prior knowledge of experiment	• Some key information is omitted or tangential information is included • Some information is misrepresented • Some implications are omitted • Incorrect format is used
Background **Scale = 3**	To identify central experimental questions, and appropriate background information. To present a plausible hypothesis and a means of testing it	• *Clear statements of the hypothesis (including mathematical basis of hypothesis), experimental goals, and predictions.* • Your experimental goals and predictions are clear and seem a logical extension of existing knowledge • Relevant background information is presented in balanced, engaging way • Writing is easy to read • All background information is correctly referenced	• Relevant background information is presented but could benefit from reorganization • Your experiment is well described and a plausible hypothesis is given • With some effort, reader can connect your experiments to background information • Writing is understandable • Background information is correctly referenced	• Background information is too general, too specific, missing and/or misrepresented • Experimental question is incorrectly or not identified • No plausible hypothesis is given • Writing style is not clear, correct or concise • References are not given or properly formatted
Materials and methods **Scale = 4**	To describe procedures correctly, clearly, and succinctly. Included a correctly formatted citation of the lab manual	• Sufficient for another researcher to repeat your experiment o *Includes a good diagram: informative, labeled* o *Neither too broad nor too specific* o *(i.e. not a rewrite of the manual)*	• Procedures could be pieced together with some effort • Lab manual cited	• Procedures incorrectly or unclearly described or omitted • Lab manual not cited

Adapted from: MIT OpenCourseWare

By: Dr. Carrie Menke, Leily Kiani

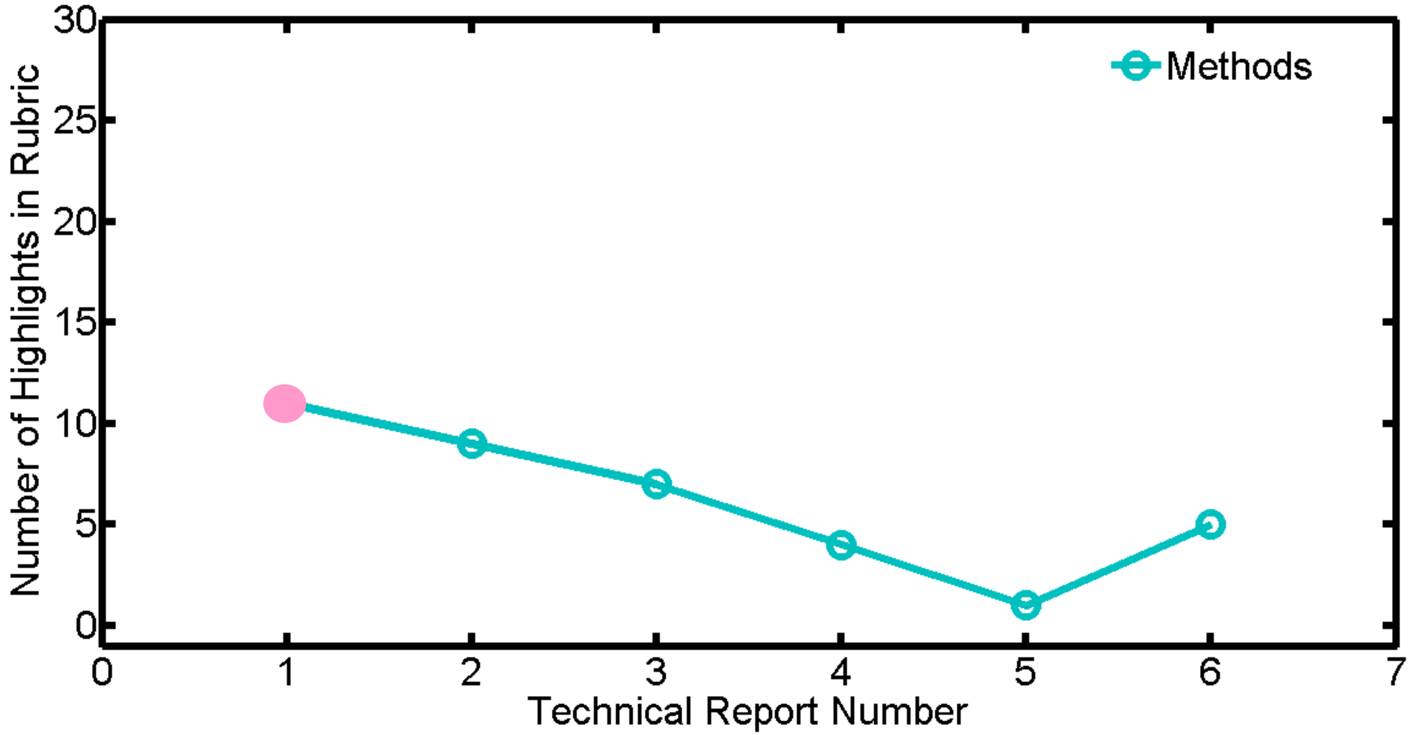
Combination of detailed and general feedback-Spring 2014

- Examined change in the number of highlights per section after each iteration of dense feedback



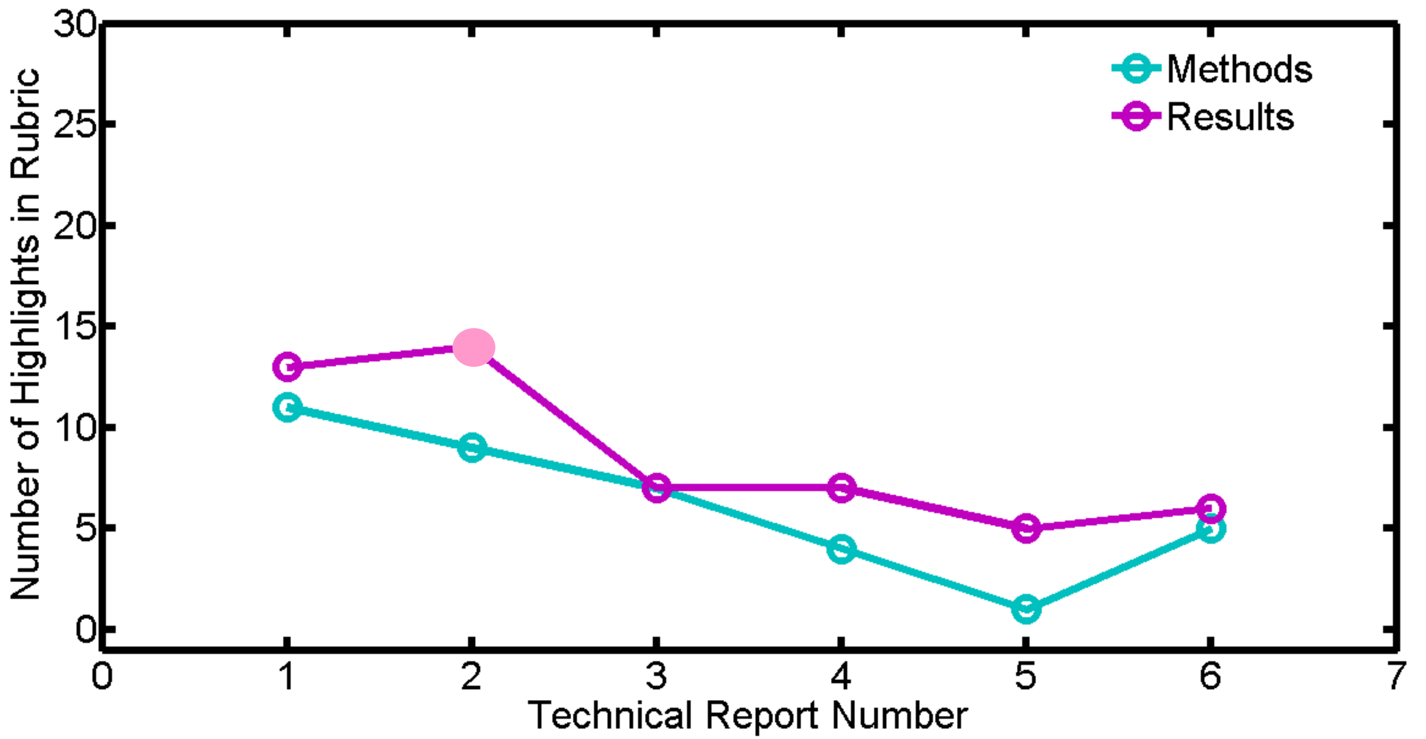
White: Rubric highlights
Pink: Dense + Detailed feedback
Green: Follow-through on written feedback

Development of scientific writing skills



- Figure shows total number of highlights for each iteration of the technical report,
- 7 students total, 6 technical reports per semester
- Fewer highlighted bullet points in rubric implies improved student writing

Development of scientific writing skills



- Dense and detailed feedback for the results section implemented in the second week

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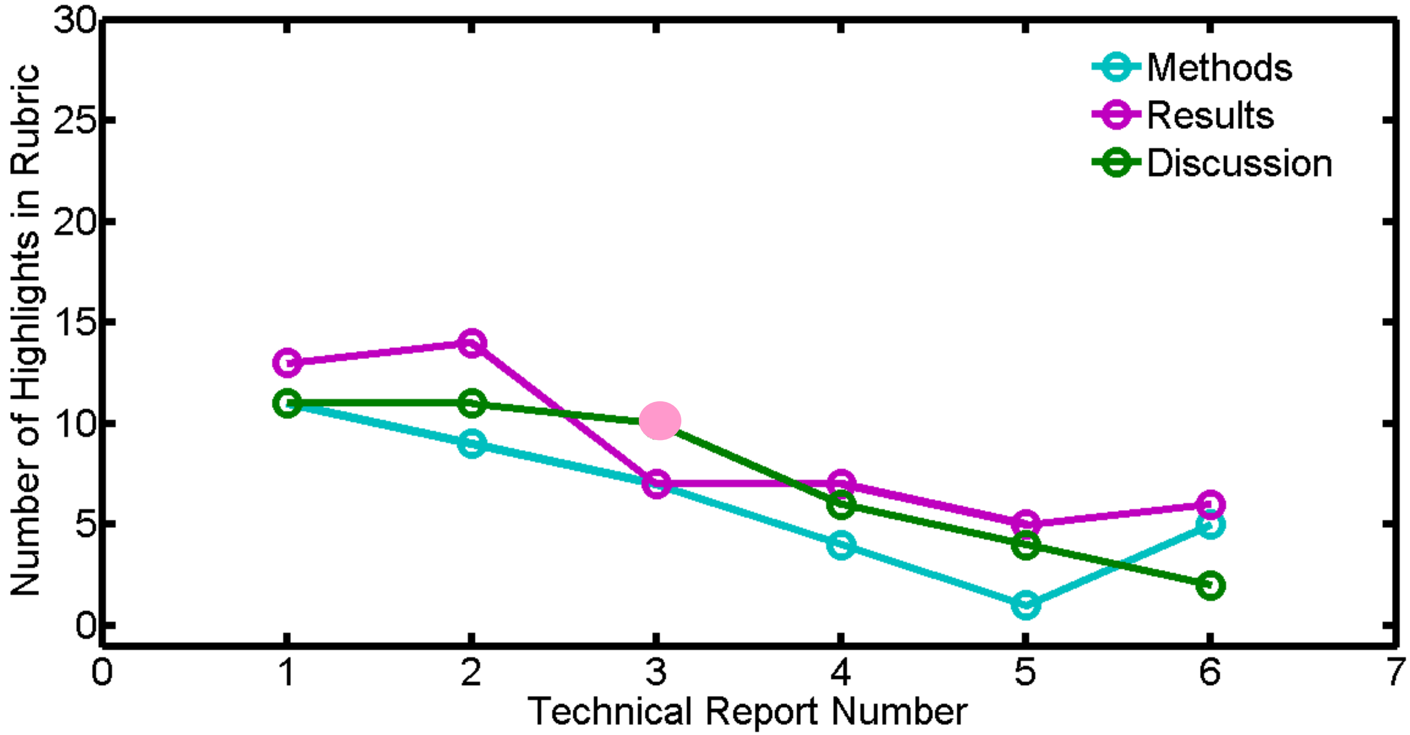
Development of scientific writing skills



* Dense and detailed feedback for the discussion section implemented in the third week

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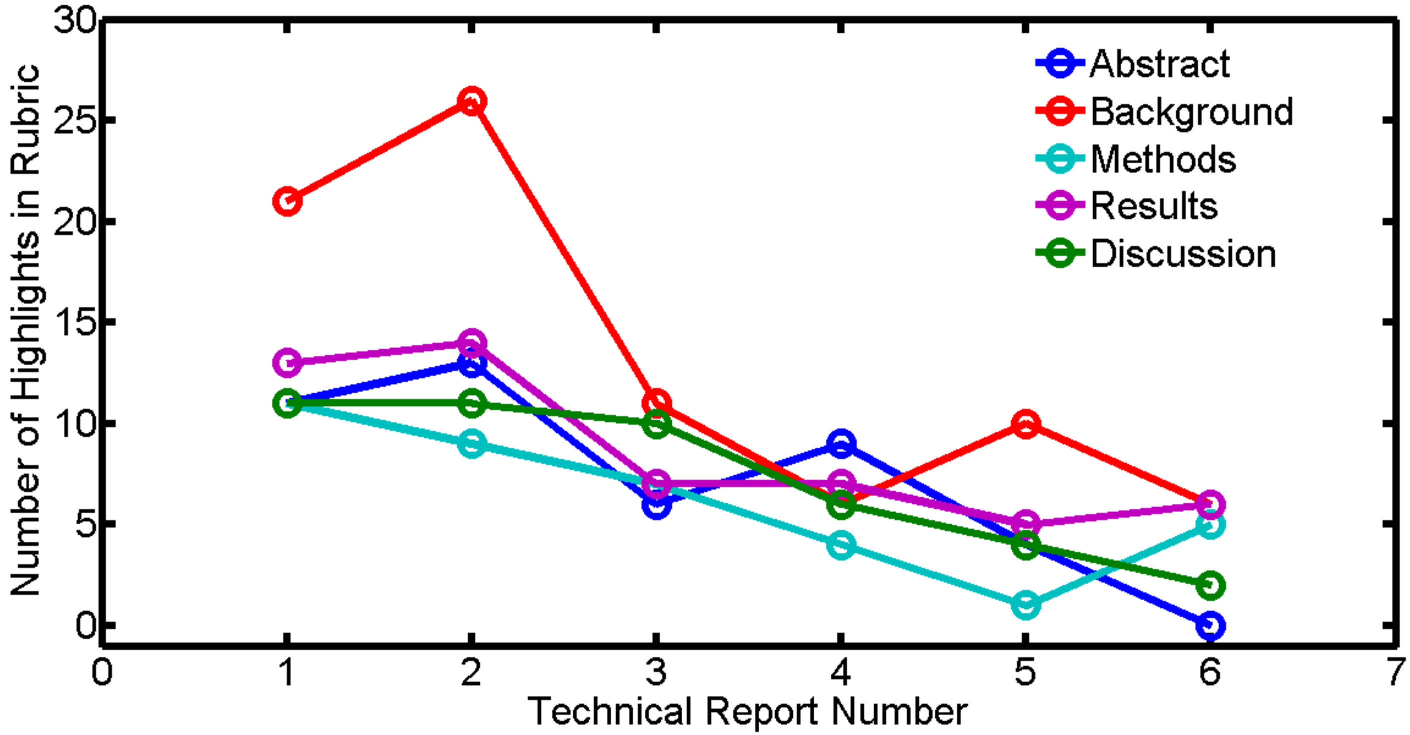
Development of scientific writing skills



- Improvement exhibited for all major components of the technical report

Discussion

- We find that student review of dense feedback is effective in supporting scientific writing skills
- Focused feedback is an effective approach to improve student writing
- We are interested in implementing these feedback interventions with larger sample sizes
- This work will be incorporated into a five year review of the undergraduate learning outcomes in the physics program
  - Application of this rubric as program assessment data

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Thank You!