Exploring the Use of Elaborative Interrogation in an Introductory Physics Course

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Abstract: Elaborative Interrogation, which has students read a passage from the text and respond to the prompt "Why is this true?" for a sentence from the passage, was employed in an introductory college physics course. We report initial results with regard to student accuracy and depth of reasoning, and detail the effect of sentence type on student responses. We also report the results of a reading survey that addressed students' reading habits during the course.

Introduction

Reading and comprehending science texts is a skill that is crucial to the future success of students in the STEM fields. STEM practitioners gain much of their knowledge through reading (Hurd, 1998), and professionals who are successful within their field employ many comprehension strategies in order to understand what they are reading (Holliday, Yore, and Alverman, 1994). However, little attention is paid to developing reading and comprehension skills within science courses (Felder and Brent, 1996).

One method that encourages students to read and comprehend the material in the textbook is the interrogation method, which prompts students to answer "Why is this true?" for a sentence in the passage that they have read previously (Smith, Holliday, and Austin, 2009). In this study, we explored the use of the interrogation method in an introductory physics course for non-physics science majors, not only to get students to read more often, but to better understand what they read. Specifically we posed the following research questions: (1) Do students use the textbook when answering interrogation questions? (2) How do student responses to the "Why is this true?" prompt vary with the sentence they are given to respond to? (3) How do student responses evolve throughout the semester and between homework and exams?

Theoretical Framework

Elaborative interrogation is a question-based reading strategy in which readers are prompted to read the text and then answer a "Why" question based on the reading (Levin, 2008). This method was developed to aid in the learning of scientific facts through the reading of science texts. Results of interrogation studies were encouraging, as the method showed increased comprehension over more traditional comprehension techniques such as rereading (Smith, Holliday, and Austin, 2009). We expand on elaborative interrogation research by bringing the method into every-day instruction and focusing on developing reasoning skills when answering the "why" questions. Additionally, in this study we investigated the choice of sentences for students to respond to in order to identify sentences that allow them to deeply reason and respond beyond a definition or formulae.

Methods

The Course and Textbook

The study was conducted in a large enrollment (180 students) introductory algebra-based physics course for science majors at a large university in the northeastern United States. The textbook used in the course was "College Physics" (Etkina, Gentile, and Van Huevelen, Pearson, 2013).

Each week, students were assigned homework with instructions to read the text and then answer two "Why is this true?" interrogation questions for given sentences from the text. Each homework assignment was graded, and the students were provided with minimal feedback. On the first exam and the final, interrogation sentences were also given. Two of the questions were exact matches to questions they had seen previously and the third was a similar question. A reading survey asking students to report what resources they used to answer the interrogation questions was also administered to students at the beginning and end of the semester.

Sentence Types

As this was an exploratory study, we gave the students multiple sentence types to respond to. The first type was a fact statement or definition. The second type of sentence was characterized as a simple phenomenon prompt. These sentences provide students with simple phenomena such as collisions. The final type of sentence was characterized as a complex phenomenon. These sentences provide students with complex, concrete phenomena or occurrences such as analyzing an elevator ride, or the floating of a boat.

Coding
Two independent coders evaluated each sentence for accuracy of physics, and depth of reasoning. Both were both coded on a 0-3 scale (3 being the highest). To check for reliability, both coders coded 20 percent of the student answers. Reliabilities of .93 and .89 were reached for accuracy and reasoning, respectively.

Findings

Comparing Responses Based on Sentence Type
We assigned a total of 7 fact statements, 17 simple phenomena, and 18 complex phenomena statements to the students throughout the semester. The mean reasoning score for the responses to fact statement sentences was 1.20, for simple phenomena, 1.32 and for complex phenomena, 1.87. Using an ANOVA we found that the level of reasoning students used when responding to complex phenomena statements was significantly higher than fact statements or simple phenomena (p-value < .01).

Accuracy and Reasoning Throughout the Semester
We first compared homework accuracy to the accuracy on identical and similar exam questions. We used t-tests to test the significance of the difference in scores between homework and the exam. There was a significant positive change between identical and similar homework and exam questions (growth from HW1 to Exam 1, .4318, $p < .01$, HW2 to exam 2, .30, $p < 01$). To assess change in reasoning throughout the semester, we compared reasoning ratings from the first homework and the last homework of semester 1. There was positive growth in reasoning (.20), however it was not a significant gain ($p = .093$)

Reading Survey
105 students responded to the survey administered in their lab sections. 35 students indicated that they used only the textbook to answer the interrogation questions, and an additional 47 students indicated they used some combination of the textbook and material from class. The remainder of the students indicated that they never used the text to answer the questions (23 students).

Discussion
The initial results of this study show that throughout the semester there was growth in both students reasoning and the accuracy of their answers. While it is plausible that there are other reasons for students' growth in accuracy and reasoning, such as the nature of the course, this result is promising nonetheless. To answer the interrogation questions correctly and completely, the students must understand the material and be able to reason as to why the sentences are true, which is an important goal of any science class. Additional work will have to be done utilizing a control group to further test the effect of the interrogation sentences.

With regard to sentence type, there is a clear difference between the answers students give to fact statement and simple phenomena as opposed to complex phenomena. The students reasoned deeper when responding to the complex sentences. Further work using cognitive interviews will be done to better determine why students reason more deeply when responding to certain sentences.

Finally, the main goal of this study was to get students to read and interact with the text with more depth and frequency. Based on the initial survey results, it appears that by having the students answer the interrogation questions we encourage them to spend time reading the text and using the information to answer the questions.

While further analyses need to be done to determine the strategies students use when answering the interrogation questions and the effect the method has on student learning and reasoning, it appears that elaborative interrogation is a method that at the very least engages students in active reading of the text.

References

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