DALITE: Bringing “peer-instruction” online

Elizabeth S. Charles, Chris Whittaker, Sameer Bhatnagar, Dawson College, 3040 de Maisonneuve W., Canada,
Email: echarles@dawsoncollege.qc.ca, cwhittaker@dawsoncollege.ca, sbhatnagar@dawsoncollege.qc.ca
Michael Dugdale, Nathaniel Lasry, John Abbot College, 21275 Rue Lakeshore, Canada,
Email: michael.dugdale@johnabbott.qc.ca; lasry@johnabbott.qc.ca
Kevin Lenton, Vanier College, 821 Sainte-Croix, Montreal, QC H4L 3X9
Email: lentonk@vaniercollege.qc.ca>

Abstract: Approaches such as Peer Instruction (PI) have resulted in improved conceptual understanding. PI engages students in discussion at the conceptual level and focuses their attention on explanation and reflection. The Distributed Active Learning and Interactive Technology Environment (DALITE) is a virtual learning environment, conceived from principles of PI. We report on this design-experiment and the ongoing efforts to improve DALITE’s functionality for instructors as well as its impact on student’s conceptual learning.

Introduction

Approaches such as Peer Instruction (PI; Mazur, 1997) have resulted in improved conceptual understanding of physics (Crouch & Mazur, 2001). PI engages students in discussion at the conceptual level and focuses on student’s deep understanding by requiring them to engage in a form of reciprocal teaching (Palincsar & Brown, 1984) and by explaining and reflecting on their understanding. Specifically, those conceptual understandings that require restructuring of certain beliefs and ideas because they are not consistent with the canonical (i.e., normative) explanations of phenomena – i.e., conceptual change (e.g., diSessa, 2006). Such intentional reflection is believed to facilitate conceptual change (Sinatra & Pintrich, 2003). In doing so, at the deepest levels, PI requires students to compare their understanding to the explanation and arguments put forward by other students. Additionally, it distributes to students the responsibility of arriving at criteria and standards for what is a good explanation or argument, compared to normative ways of thinking within the discipline.

PI has a history of being used extensively in post-secondary lecture halls with hundreds of students and dozens of teaching assistants who facilitate the types of discussions that can arise from diverse answers and points of view. When there is less support, as is the case in smaller classrooms or when students are at home, PI has not been seen as an option. Starting with the premise that the strength of PI, as an instructional approach, is the intellectual engagement described above, the challenge was to recreate these benefits for instances outside of the typical large classroom scenarios. Our solution was to design an online asynchronous system modeled on the PI approach, which also draws on what we know about conceptual change. We call this system the Distributed Active Learning and Interactive Technology Environment (DALITE). In this poster we will address what was learned from the first full implementation of the system, the data collected and how they are guiding the next design iteration. The overarching question guiding this design-experiment (Brown, 1992) is how do we design a system to engage students in meaningful reflection and understanding of the principles and the networks of concepts that are fundamental to understanding science at the post-secondary level.

What is DALITE?

DALITE is an asynchronous virtual environment that engages students in thinking and producing deeper levels of understanding in science. It maintains a social context while scaffolding a variety of cognitive processes including, categorization or sorting, comparison and evaluation, and linking of concepts and principles through knowledge mapping. Throughout, students are encouraged to engage in reflective and metacognitive processes that involve writing their explanations, reviewing their work as well as that of others, and exploring links and connections between concepts. Additionally, it provides support for motivational processes through the feature of showing the work of peers and asking for students to actively contribute to the database. A typical DALITE script can be summarized by the following TARR flow:

- (T)ag question
- (A)nswer question
- (R)ationalize answer
- (R)ethink answer in light of competing answer/rationale combinations

Specifically, students are presented with a multiple-choice question; before answering the questions, students are asked first to choose appropriate concept (T)ags that help to categorize the question. They then proceed to the selection of an (A)nswer and asked to provide a (R)ationale for their answer. At that point they are presented with their answer choice, their rationale, and other possible rationales for this answer choice. This is all juxtaposed with another answer choice, and rationales for that other answer choice for the (R)ethink stage.

If their answer is incorrect, they are presented with rationales for the correct answer as well as their incorrect answer; the aim of this comparison is to present the contrast and cognitive dissonance of traditional PI. If their answer is correct, they are presented with rationales for the correct and the most popular wrong answer; the aim of this comparison is to test for fragile understanding or lucky guessing. Students are then asked to re-choose an answer for the original question: either their original answer, or the other answer that was just presented to them, based on the reading of these rationales. Lastly, they are presented with a normative rationale of an expert, but are not given "the" answer; the aim of this decision being to delay feedback and increase self-regulation of criteria and standards.

Methods

This study uses a design-experiment methodology. In this particular instantiation, DALITE was implemented as a tool to deliver homework assignments (pre-instruction and post-instruction). Participants were first year science majors, ages 17-19, enrolled in one of five sections of an introductory physics course at one of three Anglophone colleges in Quebec. The pretest scores on the standardized physics concept questionnaire, the Force Concept Inventory (FCI), were used to compare between sections. There were five teachers, each taught a different section. All sections used DALITE in addition to regular course homework assignments. Efforts made to maintain equivalences across pedagogical approaches included weekly group meetings between researchers and teachers. The FCI posttests, along with other qualitative measures, were also collected. The process of reiterative improvement is based on the data collected by DALITE's database – answers, rationales and tags.

Results

General results and student feedback are encouraging. However, to address our research question we look closely at three data sets: (1) the frequency and nature of students' change from incorrect to correct answers, (2) the quality of their rationales and peers' rationales, and, (3) the degree to which the selected tags were able to discriminate between correct and incorrect answers. Data set one: shows that when used as a pre-instruction the students were more likely to gain positively from the exercise of reading rationales. When used as post-instruction, there was a smaller impact. Implications for the next iteration: the difficulty level of the questions needs to be more carefully tailored to the timing of the assignment; and, when used as post-instruction students are less willing to change to the correct answers after reading correct rationales. The latter needs further investigation. Data set two: we have begun a content analysis of the rationales, identifying five different categories. Design implications are to sort rationales into categories and build a heuristic that identifies when and if they are used as part of the database. Data set three: the analysis of tags show they are not discriminating sufficiently between correct and incorrect answers. Design implications: involve greater emphasis on the in-class working with the tags including their use in concept mapping activities. This modification is currently being implemented.

Discussion

Overall the PI features of DALITE are promising. However, the data from the first implication have pointed to several important changes for the next iteration. Most important among these related to the tags. Currently the tags reflect concepts and essential features of the problem. Future work will examine the levels of granularity and a possible reconceptualization with a focus on tags representing "interactions" – e.g., elements of a System Interaction Models (SIM) approach (see the work of David E. Pritchard at MIT).

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Aknowledgements

We thank the software designers <Edu.8.ca> for their contributions. Funding provided by grants from the *Ministere de l'Education* (MELS & MESRST), Quebec; (Chantier 3/SALTISE ; PAREA PA2011-06).