DALITE: Asynchronous Peer Instruction for MOOCs

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Abstract. This demonstration will feature the Distributed Active Learning Integrated Technology Environment (DALITE), a novel LTI compliant application which allows Learning Management Systems to include an asynchronous peer instruction component as a part of their course. It has been successfully used in three different MOOCs on the edX platform (Harvardx, MITx, McGillx). This tool not only enables a novel type of formative assessment based on student self-explanations, but also provides a rich source of peer-assessed natural language data for educational research.

Keywords: Peer instruction · Massive open online classrooms

1 Introduction

One of the most widely accepted active learning pedagogical strategies is Peer Instruction (PI) [10]. The typical script followed by a teacher using PI:

1. teacher displays a multiple choice question item to their class, asking students to individually indicate their answer choice for what they think is the answer. This can be done using flash cards, signalling with fingers, or with wireless clickers. The intention is to give all students, no matter how introverted or confused, an opportunity to elicit their prior knowledge, anonymously
2. once all answer choices have been tallied, the teacher asks students to discuss with their neighbouring peers, and encourages them to convince one another of their own answer choice. After this discussion, teachers prompt students to once again, individually, indicate their answer choice (which may now be different than before).

The benefits of this as a classroom practice, especially in comparison to conventional, lecture-style content delivery, has been documented in different contexts [5,6,8,9]. It is with this success in mind, that our team of physics teachers and education researchers, working at colleges in Montreal, Canada, set out to develop a homework tool that would be centred on the same foundations of

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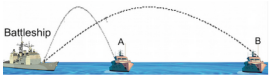
self-explanation, and intentional reflection surrounding a compare-and-contrast exercise. With the aim of delivering PI *asynchronously*, after several iterations [3,4] of Design Based Research [1], we present the most recent implementation of the Distributed Active Learning Integrated Technology Environment (DALITE).

2 DALITE

A DALITE question item proceeds as follows:

1. The question is displayed, and the student selects one of the multiple choice answers. They are then prompted to write a couple of sentences that explain why they selected their answer choice. These little paragraphs will from now on be referred to as "rationales" (Fig. 1).
2. Once a rationale is given, the system presents two sections of text: one for their answer choice, and one for another choice to the question (Fig. 2). Each section upto contains four rationales, written by previous students. The goal is to give students a chance to reflect on their thinking by providing them with an opportunity to compare and contrast other rationales, and maybe change their mind. The student is prompted to read the rationales from the two sections, and decide whether they would like to keep their answer choice, or switch. What's more, the student is asked to vote on one rationale out of the ones displayed, that they best like (They always have the option "I stick with my rationale").

A battleship simultaneously fires two shells with different initial speeds at enemy ships. If the shells follow the parabolic trajectories with the same maximum height shown below, which ship gets hit first?



A - ship A
B - ship B
C - Both ships get hit simultaneously
D - Not enough information is given

Rationale:

Fig. 1. DALITE: asynchronous peer instruction, part 1

The rationales displayed are anonymous, and can either be randomly selected from those in the database, or preferentially based on how many times they have been "upvoted" in the past. An important consideration is that any new question item requires a few "seed" rationales for each of the answer choice options, so as that the first students attempting it do not get an empty re-vote page.

*You answered **A**, and gave this rationale:*

The closer the ship, the sooner it gets hit!

Consider the problem again, noting the rationales below that have been provided by other students. They may or may not, cause you to reconsider your answer. Read them, and select your final answer.

- *A*
  - *"Battleship A must get hit first, since it is closer"*
  - *"they both have about the same maximum height, so since A is closer, it will get hit first"*
  - *I stick with my own rationale*
- *C*
  - *"the parabola of shell A has a different curvature than that of shell B, but the same x-intercepts. Hence mathematically they must land at the same time"*
  - *"The shells are fired at different speeds, but since they reach the same maximum height, the vertical component of their initial speed must be the same. Since "time in air" of any projectile depends only on initial vertical velocity, both shells spend the same amount of time in the air"*

Fig. 2. DALITE: asynchronous peer instruction, part 2

3 Scalable Asynchronous PI

In previous studies, we have shown that

- DALITE is as effective as in-class Peer Instruction for Quebec college level physics courses [4] (in terms of gain on the Force Concept Inventory [7])
- students appreciate the usefulness of the platform for formative assessment
- teachers are able easily integrate DALITE into "flipped-classroom" pedagogy
- weak students and strong students alike write rationales in DALITE that earn the votes of their peers [2]
- the tool provides a novel source of data for the Educational Data Mining, Learning Analytics, and Natural Language Processing research communities. Since students are constantly "up-/down-voting" their peers' rationales, there is a bootstrapping effect for the social annotation of constructed response data.

DALITE is now an open-source, Django-based web application, written to be compliant with the IMS Global Learning Consortium's *Learning Tools Interoperability (LTI)* standard, so that most major Learning Management Systems (LMS) can implement *asynchronous* PI, as an external resource. Over the past year, DALITE has been used on the edX platform as part of three different MOOCs (*Justice* from Harvardx, *Advanced Classical Mechanics* from MITx, and *Intro to Body* from McGillx). The tool is being successfully used in science items, but also contexts where there isn't necessarily a correct answer. In both *Justice* and *Intro to Body*, DALITE was used to elicit student opinions on ethical and scientific issues. The "up-voting" process allows instructors and students to easily determine which rationales are seen as most convincing by the participants of the course.

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