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Using the ICAP Framework to Map Student Opportunities for Engagement in Massively Open Online Courses

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Abstract

The interactive, constructive, active, and passive (ICAP) cognitive engagement framework (Chi & Wylie, 2014) has been used broadly to explain student outcomes based on level of cognitive engagement. In this paper we explain the development of an ICAP codebook used to evaluate online courses with the goal of understanding the opportunities students have to cognitively engage with online course content. The development of the codebook and initial results of applying the codebook to mathematics and physics massively open online courses are reported; inter-rater reliability computed using Krippendorff's Alpha is 0.803.

Introduction

For years educators, instructional designers, and learners have been codifying courses based on a set of design standards connected with best practices from the research literature (Baldwin et al., 2018). These evaluations are often focused on assessing actions and pedagogies from the instructor or designer perspective and do not capture the critical feature of potential for student cognitive engagement. The level and type of student cognitive engagement with educational materials has been shown to be directly related to student learning outcomes (Chi et al., 2018). The interactive, constructive, active, passive (ICAP) cognitive modes of engagement framework (Chi & Wylie, 2014) provides a connection between cognitive engagement and success of active learning practices in higher education classrooms (Freeman et al., 2014).

Using the ICAP framework as a starting point, this work aimed to develop an evaluation tool that could be applied across online courses within the higher education context and provide designers and researchers with a resource to map and understand the opportunities students are provided to cognitively engage with the content in an online course. Working in the context of massively open online courses (MOOCs) allowed the team to develop a codebook focused on the designed course materials within a single globally deployed platform, while also affording the opportunity to explore across disciplines.

Method and Materials

Using a qualitative approach to coding online course materials (Miles & Huberman, 1994), the research team employed an iterative codebook development process (Altheide et al., 2008). Following two development cycles, the final codebook was applied to the content of two edX courses Calculus 1A: Differentiation (Calc1A) and Mechanics: Kinematics and Dynamics (Mech1). The fourth author developed Calc1A; the second and third authors are involved in the development of Mech1. The overall process for the development, reliability testing, and results from the application of the codebook are discussed in detail below.

Procedure

The starting point for the codebook was an adaption of prior applications of ICAP to K-12 contexts for MOOC courses. The iterative codebook development cycle involved the following steps: 1) select course content to code; 2) code the content independently; 3) discuss results until consensus; 4) revise codebook; 5) apply revised codebook and return to step 3. We identified different types of course content in MOOCs (e.g. multiple choice, video, etc.) We decided to focus on coding based on inferring instructor intent for student cognitive engagement as opposed to assessing student enactment. Consistent with ICAP's designation of reading and lectures (Chi & Wylie, 2014), text and video in the MOOC were assigned to the *Passive* (P) mode. The *Interactive* (I) mode was not considered due to little directed collaboration in the selected MOOCs.

For the first development cycle, we selected the first unit of Calc1A as the coding target. We separately coded this unit and our group's discussion resulted in the first codebook, best characterized by several key decisions: assigning standard codes for common item types; partitioning learning items within a submission button into a codable unit (referred to as a "content block"); giving precedence to higher ICAP modes in a content block composed of items of multiple ICAP modes; considering coding of content blocks as context-dependent.

The second development cycle developed the codebook's applicability throughout a course and across disciplines. For the former, the first three authors coded the subsequent unit of Calc1A. For the latter, the last two authors coded the first unit of Mech1. Discussion led to key revisions to the codebook: we developed rules about graphing and sketching exercises to parse interactive graphical items in Calc1A; we clarified the boundary between Active and Constructive modes by adopting process standards from the *National Council of Teachers of Mathematics* (NCTM, 2020) to implement into the codebook. This work resulted in a more discriminating and broadly applicable codebook that allowed for calculations of IRR and course distributions of ICAP modes. A final round of coding established inter-rater reliability (IRR) (Zaiontz, 2020).

Results

Within the next unit of Calc1A, the first three authors independently coded 228 content blocks: 73 (32.0%) were coded passive, 128 (56.1%) active, and 27 (11.8%) constructive. Inter-rater reliability was computed using Krippendorff's Alpha to be 0.784 (Zaiontz, 2020). Within the first unit of Mech1, the last two authors independently coded 79 content blocks: 36 (45.6%) were coded passive, 24 (30.4%) active, and 19 (24.1%) constructive. Krippendorff's Alpha for Mech1 is 0.881 and 0.803 across Calc1A and Mech1.

This work explicitly revealed that the content of different courses is broken into different levels of granularity. The Mech1 course had longer videos, therefore fewer passive items in total, although the passive items accounted for a larger percentage of the total content. The Calc1A course had twice as many passive elements (shorter and more interspersed with active recall-type questions), thus had five times as many active exercises. The total number of constructive activities was similar, although they were constructive for different reasons. Most problems in Mech1 were deemed constructive based on complexity of problem solving; in Calc1A, due to new reasoning or creating new connections.

Discussion

This work helps designers and researchers alike by demonstrating how the ICAP framework has been applied to map MOOC course content. This codebook can be used by course designers to assess if the intent of their content design engages students at different cognitive levels. Using such maps of content opens the door for future work focused on comparing the way different courses use passive, active, and constructive exercises throughout the course design, and how the mapping of cognitive engagement differs in different fields, for different topics, and between different types of assessments.

The codebook was developed to map the intent of instructional designers. We are interested in combining the results of this mapping with the MOOC data of student behavior, determined from time on task, proportion of correct answers, and average number of attempts. Future work includes developing best design practices to better align intended student engagement with enacted, and mode distributions that enhance learning and learner retention.

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