Analyzing the Quality of Interactions in a Technology-Enhanced STEM Education Classroom

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braincandy
Talking is thinking.

http://bit.ly/issr2018
References, resources, & sample activity

Perspectives & Framing

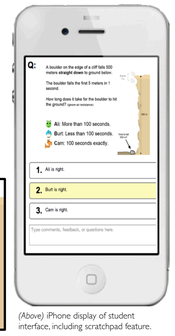
Background & Context

- Interactive talk between students in technology-enhanced STEM education contexts appears connected to improved student outcomes (Chi & Wylie, 2014; Henderson, MacPherson, Osborne, & Wild, 2015).
- However, more empirical work is needed to examine the nature and quality of talk between students in these settings, including why talking seems to lead to better outcomes, as well as how the quality of talk (and thus teaching and learning outcomes) might be improved.
- To begin to address this challenge, this project proposes to examine the quality of talk in a STEM education context supported by *Braincandy*®, a technology designed to facilitate classroom talk around students' prior conceptions of scientific understandings.

The *Braincandy*® Platform

(Above) Braincandy's instructor interface, optimized for highlighting questions to elicit discussions about prior conceptions of scientific topics.

(Right) Braincandy question display, including multimodal representation, and social framing of response choices.



(Above) iPhone display of student interface, including scratchpad feature.

Theoretical Framing

ICAP Classification	Description	Examples
Interactive	Dialogue in which learners produce a joint output containing unique contributions from each participant	Two-way discussion with others Building on contributions of others Critique alternative views when constructing own view
Constructive	Learner produces an output that contains information beyond what was already provided to them	Taking lecture notes in own words Self-explanation Written explanation One-sided verbal explanation
Active	Learner is doing something physically	Asking a clarification question Taking lecture notes verbatim Highlighting or underlining text Gesturing or pointing Manipulating an object
Passive	No explicit physical activity on the part of the learner	Observing lecture Reading text

Learning Deepens

Chi's (2009) ICAP hypothesis provides a framework for broadly classifying observable student-student and student-teacher exchanges in classrooms. Prior research examining peer instruction (*PI*; Mazur, 1997) through the lens of ICAP has revealed a connection between more interactive PI activities and positive student outcomes in secondary science classrooms (Henderson, 2013).

Proposed Methodology

Research Questions

- Within a technology-enhanced STEM education classroom, what are the qualities of teacher-student and student-student interactions during lessons designed to examine and evaluate student preconceptions about statistics?
- In what ways might the qualities of interactions be compared to learning outcomes realized by students during class?
- How might the nature and quality of student-student interactions and subsequent learning outcomes change as teacher-student interactions change in this context?

Data Sources

This pilot project will focus on a purposive sample of 32 students and one instructor utilizing Braincandy technology in an undergraduate statistics course at a public university in the U.S. Southwest. Three key data sources for project include video recordings of instructor-student interactions throughout each class period, audio recordings of student-student interactions, and surveys.

S-S Interactions

S1: What'd you put?

S2: I got…1 standard deviation?

S3: That sounds like a good answer //

S2: I'm not / I'm not sure //

S1: Why aren't you sure? Can you show us how you got it?

I-S Interactions

I: [Looks at computer] OK // So / I like most responses I'm seeing / though one seems a bit off…

SS: [Raises hand] I…think that was me. I put ten percent.

I: Does anyone see the issue here?

S2: If we're doing a two-tailed test / we shouldn't have…five percent on each side?

Survey Response

Q: How would you rate the overall quality of talk that you engage with in this class? Why?

A: I circled GOOD overall. I like that we have a chance to talk about our answers in class. I wish we had more chances to talk during class, but I understand sometimes we need to do lectures to understand the content better.

(*Left*) Sample transcript of student-student small group interactions. (*Middle*) Sample transcript of instructor-student interactions. (*Right*) Sample survey response.

Data Collection

Data to be collected once per month throughout Spring 2018 semester across an introductory statistics course (n=33) through in-class observations, video recording, audio recording, and survey methods.

(Top-left) Audio recorders placed throughout desks to capture student-student interactions. (*Top-right*) Wide-angle videorecording capturing instructor-student interactions; (Bottom-left) Tighter-angle videorecording focusing on instructor; (Bottom-right) Sample survey items.

Analytic Frameworks

Interaction Analysis

A systematic process for analyzing video- and audio-recorded data moving iteratively between ethnographic reflection and micro-analysis of interactions (Jordan & Henderson, 1995).

1. Identification of interactional "hot spots" for closer video analysis based on in situ observation;
2. Content-logging of broad interactional events recorded in videotape;
3. Collaborative viewing to identify broad "mental states" and "mental events" suggested by observed behaviors;
4. Individual viewing of recordings by members of research team to form broad assertions to be "tested" and revised through micro-analysis;
5. Expansion of content logs into more detailed transcriptions;
6. Video review sessions with selected participants;
7. Revision / refinement of initial assertions based on reconstruction of event through transcriptions, artifacts, field notes, and participant discussions.

ICAP Categorization

Qualitative coding (Saldaña, 2009) of observed student-student and instructor-student interactions based on classifications of ICAP framework (Chi, 2009), followed by comparison to student outcomes (Braincandy submissions) by the end of various course periods.

ICAP Classification (Provisional Coding)	Sample Transcript Data	Frequency (single-class)
Interactive	S1: [Looks at screen] I didn't get the same answer. S2: [Looks at paper] Does it matter how far off the answers are? S1: [Puts finger on paper] Well, why did you use this as your SD?	4
Constructive	I: Why might answer B be the best one in this situation? S3: [Raises hand] Well, here's how I came up with it…	5
Active	S4 [Typing into Braincandy Scratchpad]: Why is 0.05 the number we use for significance? What if we used a different one?	8
Passive	T: [Looks at screen].I've got someone asking me to go back a slide / and I don't know / which slide that was so … um / if you want me to go back a slide uh / that might be one that you vocalize / because I can't always look at it // S5: Two slides back // With the formulas? T: Ah / got it // OK, let me talk you through these one more time…	15

Distributed Teaching & Learning Analysis

For selected areas of S-S and I-S interactions (such as asking-answering questions and engaging in Braincandy discussions), we will apply an interpretive framework of Distributed Teaching & Learning Analysis (Holmes, Aguilera, & Tran, 2018), including, but not limited to, the following questions:

Participatory Roles Tool:
For a given pedagogical situation, ask which participants (human or nonhuman) are involved. Ask what teaching and learning roles they appear to be enacting, and whether these roles seem to change over time, contexts, or interactions. In some situations, the role of teacher and learner are fluid, and participants may exchange roles, or act in different roles depending on context. In other cases, one participant may depend on others in the situation, such as a commercial game which is played in the classroom accompanied by explicit instruction.

Evidence of Learning Tool:
For a given pedagogical situation, identify empirical evidence of learning outcomes, intended or unintended. Depending of the focus of the research, these can be observationally determined or analyzed through an "artifice" - e.g. a test, survey, or interview.

Designed Elements Tool:
For a given pedagogical situation, ask about the role that design plays and identify evidence for the degree of its impact on the situation. Ask about what kinds of choices a designer makes about what to include or exclude, what kinds of resources they make or curate and how they connect them for learners, and what kinds of assumptions they make about what learners need and where they should go next within the system.