

Exploring the Role of Technology-Supported Peer Instruction in Student Understanding and Interaction in College Physics Classrooms

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Abstract: Growing numbers of studies report positive gains in knowledge and conceptual understanding related to using Clickers as part of collaborative approaches to instruction. Our study examined the implications of modifying how students are encouraged to collaborate during such instruction. We present results of an ethnographic study involving two college-level physics classes. Using discourse analysis techniques, our results indicate that requiring different goals for clicker-mediated questioning produced differential student interactions and outcomes. Implications will be discussed.

Introduction

Student Response Systems, more often known as Clickers, have been widely used in post-secondary classrooms in North America. Clickers are a wireless device, which enables interaction between teacher and students by asking students to vote, discuss and compare their answers. Empirical studies have reported positive impacts of Clickers, including significant knowledge gain (Hake, 1998) and generally improved learning (Scriven, Chasteen & Duncan, 2009). Nonetheless, it is important to reiterate that clickers are not magic bullets (Lasry, 2008) but are effective if properly implemented with approaches such as Peer Instruction (Mazur, 1997). At the same time, the socio-cognitive literature suggests that the discourse produced around collaborative activities is a critical aspect of learning (Stahl, 2006). Our study aimed to examine these processes more closely and determine whether modifying the degree to which students were required to collaborate influenced their learning or the learning environment. Specifically, we looked at the implications of implementing two different approaches to peer instruction (PI) using clickers: (1) asking students to individually vote after short term discussions (*individual vote* treatment) and (2) requiring them to collectively vote after working together to come to consensus (*consensus vote* treatment). We were particularly interested in identifying factors that afford richer and more meaningful discourse, as well as study the implications of modifying the collaboration required in this activity.

Theoretical Background

Through socio-cognitive and socio-cultural lenses, learning can be described as a change that occurs from interactions with others and the context (e.g., Vygotsky, 1978). When such frameworks are applied to pedagogy the result is often the design of small group or whole class, cooperative and collaborative activities. Such activity relies on collective actions and development of *common ground* (Clark & Schaefer, 1989) and the convergence of meaning – i.e., *grounding*. We view consensus as a possible form of grounding. While it is now commonly taken that collaborative activities can promote learning, there is little in the education literature about the role that intentional grounding activities might have in determining ways collaborative discourse plays out.

Research Context

The study was a quasi-experimental design consisting of two introductory physics classes taught by the same teacher at the college level in an urban area in Canada. “Class A” consisted of 24 students (M=14, F=10) and “Class B” consisted of 30 (M=13, F=17), all between the ages of 17 – 19 years. The teacher employed the clicker-supported peer instruction where students are presented with a brief lecture (7-10 minutes) followed by a *ConceptTest*. A ConceptTest is a multiple-choice conceptual question designed to have answers reflecting well-documented misconceptions, alongside the correct answer. After individually answering a ConceptTest question, students are asked to turn to a classmate with a different answer, discuss the correctness of their answer in a small group, and individually vote their answer again – i.e., traditional PI approach. Class A students engaged in this traditional approach (individual vote); whereas Class B students were asked to come to consensus during their small group discussion and vote as a group (consensus vote). In both treatments, groups were made up of approximately 3-4 students. This clicker-mediated PI activity was regularly given to the students throughout the fall term in 2008. Learning gains were measured by the Force Concept Inventory (FCI; Hestenes, Wells, & Swackhamer, 1992) administered as a pretest and posttest.

Although the ANOVA results on the FCI data indicated no significant difference between the treatment groups in terms of their conceptual knowledge gain ($p=.65$), the researchers could not help but notice qualitatively significant differences in student discussion and dynamics between the two classes that employed different modes of clicker instruction.

Qualitative and Discourse Analysis

Observation data were recorded in field notes by the principal researcher during in-class observations: 18 sessions from Class A and 16 sessions from Class B. The field notes were edited and transferred to electronic form after each class. The field notes mainly recorded approximate times of notable activities, who initiated the activities (e.g., students or teacher), and descriptions of the activities. Finally, a case student group was selected from each class, which we will name SG-A and SG-B. The class discussions of these two groups were audio-taped and transcribed.

The analysis of the field notes suggested that students in Class B participated more actively in the class activity than students in Class A. For example, we identified student questions and comments as an indication of participation. These two items were identified in the field note data, coded as such and tabulated for the respective classes (Table 1). Specifically, Class B (consensus vote) students were twice as likely to initiate questions directed at the teacher compared to their peers in Class A (individual vote). Interestingly, the reverse was true for the student-led comments. Graphical representations will be shown on the conference poster.

Table 1: Descriptive statistics of student participation in Class A & Class B over 15 classes each.

| Student generated participation | Class A | Class B (Consensus PI) |
|---------------------------------|---------|------------------------|
| Questions over 15 classes | M = 2.8 | M = 6.6 |
| Comments | M = 0.6 | M = 0.2 |

To further examine if there were any qualitative differences between the ways that the groups structured their interactions based on the different types treatments – individual vote vs. consensus vote – we selected several instances where both classes were required to discuss the answers to the same conceptual questions. The students in SG-A (individual vote) did not change much from the beginning to the end of the course. They presented their arguments in a systematic fashion and their interactions produced an almost “turn-taking” structure. Meanwhile, the interaction of students in SG-B (consensus vote) produced a very different structure, which might be characterized as an agentic-development. That is, students took on different roles as the course progressed and demonstrated an increasing sense of commitment to correctly answering and understanding the ConcepTest questions. Excerpts will be presented on the conference poster.

Discussion

This study explored the impacts of different types of peer instruction mediated by Clickers in an introductory physics course. The quantitative data did not reveal significant differences in the FCI results and exam grades of the two classes; however, findings indicated that students in Class B (consensus vote) spent more time on discussing physics concepts than those in Class A (individual vote). Furthermore, students in Class B showed more signs of active participation in collaborative discourse than those in Class A.

The findings suggest that forcing students to reach a consensus and vote in a group may play an important role as a stimulus to encourage them to collectively externalize their thinking and engage in grounding activities. In doing so, a deeper commitment to understanding is fostered and even perhaps a deeper sense of the available resources within the class community.

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