Comparing Educational Tools Using Activity Theory: Clickers & Flashcards

Edward Price[1], Charles De Leone[1], & Nathaniel Lasry[2]
[1]Dept. of Physics, CSU San Marcos; [2]John Abbott College, Montreal Canada

Introduction

Educational technology has been important in physics education and PER. Activity theory (AT) [1-4] is a structured framework with an explicit emphasis on tools. We use AT to compare clickers and flashcards [5] as tools for Peer Instruction [6].

Prior Work: Clickers or Flashcards

A recent study [5] compared learning gains in two concurrent mechanics classes.
Both groups were taught using Peer Instruction by the same instructor.
One group responded using clickers, the other with flashcards.
There was no sig. difference in the clicker and flashcard groups' learning gains.
Teaching with clickers flashcards was different, eg, ability to archive student responses
"The pedagogy is not the technology by itself."
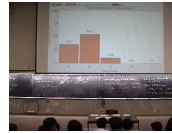
Activity Theory

An activity system is a subject acting in a community in relation to an object; interactions between subject, object, and community are mediated by tools, rules, and a division of labor.

AT provides a framework for understanding human activity with an explicit focus on tools, which mediate our interactions with the world
AT locates the subject within a community of people sharing the same object. The subject's actions are shaped by participation in the community.
Rules (implicit and explicit) prescribe how to go about the activity.
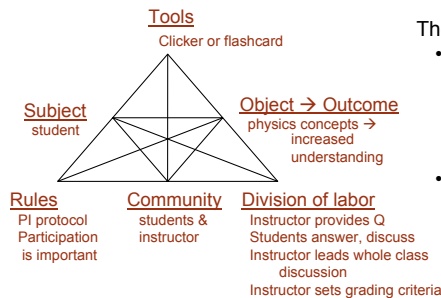A division of labor describes the actual roles of the participants.

An Activity Theory Look at Clickers and Flashcards

Student Perspective

The activity has the same essential features with either flashcards or clickers, suggesting that similar outcomes should result. This is consistent with the student learning outcomes in [5].

However, unlike flashcards, clickers
  - quickly and accurately collect students' responses
  - automate public sharing of the results
  - preserve a record for grading or future reference.

Tools
Clicker or flashcard

Subject
student

Object → Outcome
physics concepts → increased understanding

Rules
PI protocol
Participation
is important

Community
students &
instructor

Division of labor
Instructor provides Q
Students answer, discuss
Instructor leads whole class discussion
Instructor sets grading criteria

These differences may lead to differences in other aspects of Peer Instruction:
• Using clickers to award points
  - Points for participation may reinforce the norm that participation is important.
  - Points for correctness may support norms emphasizing answers over solutions
  - Changes in these norms (rules) could affect the way students approach and discuss the question, which may undermine the instructor's goals [7].
• Clicking a button versus holding up a card –
  - May impact class norms about whether participation is a low-risk activity.
  - Students may be less willing to commit to a response if unsure.

AT does not predict consequences deterministically. Rather, AT analysis suggests possible impacts different tools may have on an activity.
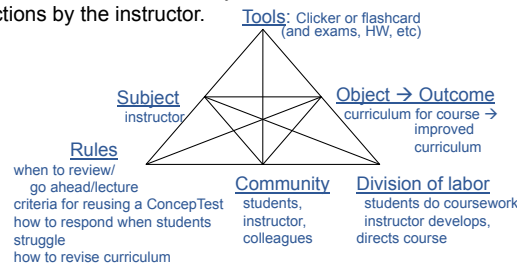*AT can guide efforts of instructor, researcher, and curriculum designer to ensure activities meet their goals*
AT may suggest modifying the tools, rules, or division of labor; eg, an instructor concerned with students' comfort in participating might provide all-white flashcards rather than color-coded ones.

Instructor Perspective

Both clickers and flashcards allow the instructor to carry out the Peer Instruction protocol during class and thereby obtain information on student thinking. However, the clickers' ability to preserve a record of student responses enables new possible actions by the instructor.

Clicker-generated records facilitate decision-making after class:
• How to conduct the current course
  - when to cover or skip a topic
  - what homework to assign
  - whether to review a concept
• Changes to future courses, based on data
  - Should a topic be approached differently?
  - Did students understand the concept in the time allotted?
  - Is a concept question worth including?

Tools: Clicker or flashcard (and exams, HW, etc)

Subject
instructor

Object → Outcome
curriculum for course → improved curriculum

Rules
when to review/
go ahead/lecture
criteria for reusing a ConcepTest
how to respond when students struggle
how to revise curriculum

Community
students,
instructor,
colleagues

Division of labor
students do coursework
instructor develops, directs course

It is *possible* to record data with flashcards.

Clickers *easily* provide evidence of student thinking, making it easier for an instructor to use evidence to inform teaching.

This may increase the chance of a change in the instructor's views about teaching, learning, and the effectiveness of instructional modes.

Conclusions

We find that activity theory helps clarify the differences and similarities between clickers and flashcards. It also provides a way to explore effects in activities beyond the immediate student participation in Peer Instruction. Finally, we expect that activity theory can be a useful approach for a broad range of issues in physics education research.

References
1. Y. Engeström, *Learning by Expanding: An Activity-Theoretical Approach to Developmental Research,* Helsinki: Orienta-Konsultit, 1987.
2. M. Cole, *Cultural psychology: A once and future discipline,* Cambridge, MA: Harvard University Press, 1996.
3. B. A. Nardi, *Context and Consciousness: Activity Theory and Human-computer Interaction,* Cambridge, MA: MIT Press, 1996.
4. V. Kaptelinin, B. A. Nardi, *Acting with Technology: Activity Theory and Interaction Design,* Cambridge: MIT Press, 2006.
5. N. Lasry. *Phys. Teach.* **46,** 242-244 (2008).
6. E Mazur, *Peer Instruction: A User's Manual,* Upper Saddle River, NJ: Prentice Hall, 1997.
7. CU Science Education Initiative and UBC Carl Wieman Science Education Initiative, *Clicker Resource Guide,* http://www.cwsei.ubc.ca/resources/files/Clicker_guide_CWSEI_CU-SEI.pdf Accessed June 28, 2010.