Clickers in Classroom

Findings from the Review of Research Literature

Teaching and Learning Technology Conference
Missouri S&T 4/25/2008

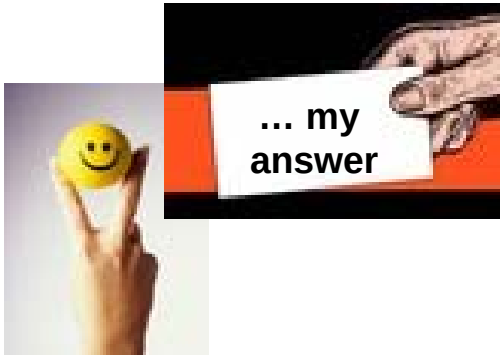
Dan Cernusca, Ph.D.
Instructional Design Specialist

What Clickers are?

- A personal response system more technology-driven than traditional:

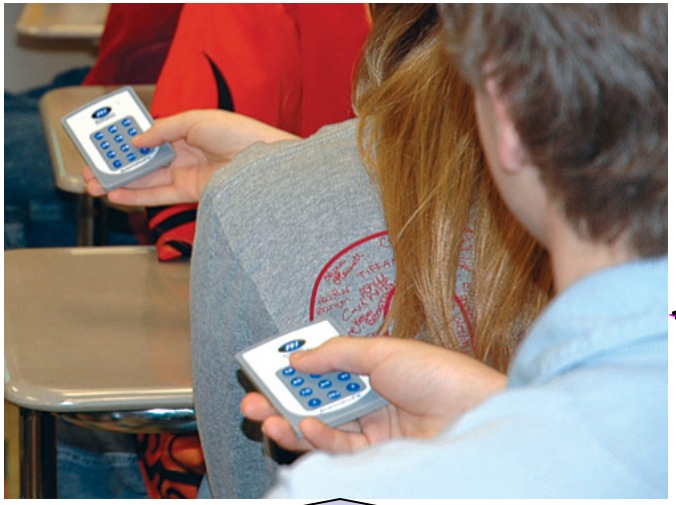
…but not quite as sophisticated as today's mobile handheld devices

No-Tech
Hand Rising



Low-Tech
Response Card

"10,000 Feet" Question: *Why Clickers?*



What we Expect

Transfer

What we Control…

Conceptual Understanding
Deep learning/
Discovery/
Conceptual growth

Active Instruction/ Engaged Learners:
Engagement/
Feedback/
Motivation

What we Target…

Clicker Research Literature - Structure

Nature of research	Type of research	Method & Design	Research context	
			Domain Specific	**Cross-Domain**
INVESTIGATION	***Conceptual***	Generic Clicker Issues	e.g., Physics Chemistry Math Biology Nursing, Business Computer Engineering	
		Case Studies		
		Conceptual Development		
	Empirical	Surveys		
		Quasi-experiments		
		Experiments		
		Qualitative/Mixed methods		
REVIEW				

Clickers in Classrooms

Findings from Conceptual Research

Effective Clicker Questions…

Are formative rather than summative (e.g. exam & homework);

- Clicker question should have a clear formative purpose:

  content (What? - *static cognitive skills: recall, recognize*)

  process (How? – *dynamic cognitive skills: analyze, synthesize*)

  learning strategy (Why? - *metacognitive skills: integrate, extrapolate*)

- Clicker questions should target misconceptions:

  Oops-go-back questions – follow with a clearer question on the issue;

- Qualitative questions usually superior to quantitative ones:

  Promote articulation and argumentation

Beatty, I. D., Gerace, W. J., Leonard, W. J., & Dufresne, R. (2006). Designing Effective Questions for Classroom Response System Teaching. *American Journal of Physics, 74*(1), 31-39.

Instructional Strategies for Clickers Classroom

Traditional strategy:

- attendance and “ice breaking” clicker questions
- lectures augmented with 3 to 5 formative clicker questions
-“right” answer provided with the posting of the histogram

Peer/group-learning strategy (Mazur):

- mini-lecture;
- associated clicker question (ideally one to reveal misconceptions)
- posting of the actual histogram
- group activity discussing the posted histogram;
- same clicker question posted again;
- new histogram posted along with the “right” answer;
- if needed, more clarifying material presented by the instructor

Instructional Strategies - continuing

Question-Driven Instruction :

- Reverts Mazur's peer-learning strategy
- Introduces question cycles as the core part of the course;

The question-driven instructional cycle:

- start with a question (conceptual, not recall)
- engage student in small-group work;
- collect answers – post histogram;
- whole class discussion;
- closure by the instructor as needed:
  e.g., mini-lecture, general observations, one more topic-related clicker question

Beatty, I. D., Gerace, W. J., Leonard, W. J., & Dufresne, R. (2006). Designing Effective Questions for Classroom Response System Teaching. *American Journal of Physics, 74*(1), 31-39.

Clickers in Classrooms

Findings from Empirical Research

Clicker vs. Non-Clicker Classroom

Context: Lectures on clinical topics for Year 5 medical students;

Design:

- Cohort stratified by gender and then randomized in 2 groups;

- Two faculty thought both topics with and without clicker;

- 4 measures of performance/ behavior:
  1) **multiple-choice assessment tool;**
  2) course evaluations;
  3) instructor survey; and
  4) classroom observations;

Duggan, P. M., Palmer, E., & Devitt, P. (2007). Electronic Voting to Encourage Interactive Lectures: A Randomized Trial. *BMC Medical Education, 7*(25).

Clicker vs. Non-Clicker Classroom - continuing

Findings:

- no significant difference in students' performance outcomes on tests;

- for one faculty, student evaluation significantly increased when clicker used

(traditionally this faculty used passive lectures; the other active lectures)

- classroom observations showed that:

students were more active in clicker lectures for both instructors;

Weaknesses:

- There is no description of clicker strategies for the two instructors;

the implicit [wrong] assumption: regardless of how the clicker questions are developed and deployed the impact on learning is the same;

- Both instructors were exposed to clickers for the first time; their perception of technology could significantly bias the effectiveness of tool use;

Clicker questions vs. WebCT quizzes

Course: Chemistry for nursing;

Experimental design with 4 groups:

1) Clickers; 2) WebCT quizzes; 3) Clickers & WebCT; 4) Control group

Prior knowledge:

Group Assessment of Logical Thinking (GALT)

Exit performance:

Teacher-written exams &

Standardized test: American Chemical Society exam (ACS);

Bunce, D. M., VandenPlas, J. R., & Havanki, K. L. (2006). Comparing the Effectiveness on Student Achievement of a Response System versus Online WebCT Quizzes. *Journal of Chemical Education, 83*(3), 488-493.

Clicker questions vs. WebCT quizzes - continuing

Findings

For teacher-written exams:

- *WebCT quizzes* group performed significantly higher than any other group;
- *Clicker* group performed significantly lower than any other group;

For ACS standardized test:

- Clicker group performed significantly higher than any other group;

Weaknesses

Only 41 students for all experimental treatments;
small group size – questionable power and effect size;

No explicit discussion about the nature and structure of clicker questions;

No explicit discussion about the relationship between:
clicker questions and teacher-written exam questions;

Clicker activity used a group activity while
WebCT quizzes involved an individual activity;

Peer-learning With and Without Clicker Technology

- Theory-driven research: “Conversational Framework”;
- Isolates the impact of clicker technology: same instructional strategy (active learning/peer-instruction) for both treatment and control group;
- Each group was both control and treatment group

  - switched between Use and Non-Use of clickers;

Major findings

- *limited incremental impact* on improving class satisfaction:
  - Students that used clickers in the first half, found the course significantly less interesting when the clickers were removed;
  - students who started without clickers found the course equally interesting in both segments

Carnaghan, C., & Webb, A. (2007). Investigating the Effects of Group Response Systems on Student Satisfaction, Learning and Engagement in Accounting Education. *Issues in Accounting Education, 22*(3), 341-409.

Peer-learning With and Without Clicker Technology

Major findings - continuing

- Clicker effects *limited to exam questions similar* to classroom clicker questions;

- Clickers have *positive effect on performance* for both low and high ability students;

- Students were *more comfortable* participating and answering questions when clickers used, but *less comfortable* asking questions;

Weaknesses

- small class size (below 40; one exception: 72)
  - facilitated the implementation of traditional peer learning … but
  - hard to transfer to large groups;
- students part of a co-op honors program
  - rises questions about the transfer of results to heterogeneous large groups ;

Clickers in Classrooms

Empirical Research Tools (Surveys)

Surveys for Clicker Research

- **Trees, A. R., & Jackson, M. H. (2007).** The Learning Environment in Clicker Classrooms: Student Process of Learning and Involvement in Large University-Level Courses Using Student Response Systems. *Learning, Media and Technology, 32*(1), 21-40.
  - Developed two scales: learning (5 items) and engagement (6 items);
  - Administered these scales at the end of the semester for 3 disciplines (physics, communication, astronomy);
  - Highlights of the results/conclusions:
    - use of clickers meaningful if students already understand the role of feedback and accept the benefits of active learning;
    - interactivity in classroom highly dependent on instructor's pedagogy
  - Major weakness - no explicit discussion about:
    - the nature of the questions used by each instructor, and
    - the relationship between questions and the pedagogy (instructional strategy) used be each instructor;

Surveys for Clicker research - continuing

MacGeorge, E. L., Homan, S. R., et al. (2008). Student Evaluation of Audience Response Technology in Large Lecture Classes. *Educational Technology Research and Development, 56(2),* 125-145.

- Developed an instrument with 6 scales:
  Audience Response Technology Questionnaire;
- Evidence of construct validity presented for three of the six scales
- Survey administered online three times/semester for three courses (communication, forestry, leadership)
- Major weakness:
  - Final scales not balanced (# of items vary);
  - No explicit link to the clicker strategies used in each course;
  - No analysis of the relationship of this instrument and student performance outcomes

Conclusions

Clickers enhance not replace good teaching & learning strategies

- instructors need to believe in the benefits of active instruction approaches
- students need to understand the role of feedback and accept the benefits of active learning

Clicker questions need to have a formative purpose:

- provide feedback to both students and instructor
- be different from exam and homework ones
- expand focus from content to process and to learning strategy issues

Clicker technology can increase student participation and satisfaction:

- students are more comfortable participating and answering questions
- student evaluation in clicker courses are more positive

Clicker researchers started to develop more comprehensive tools:

- to survey students' learning, engagement, and attitude
- to understand the impact of this technology on the instructional process

Other useful research papers:

Descriptive:

Cline, K. S. (2006). Classroom Voting in Mathematics. *Mathematics Teacher, 100*(2), 100-104.

Miller, R. L., Santana-Vega, E., & Terrel, M. S. (2006). Can Good Questions and Peer Discussion Improve Calculus Instruction? *PRIMUS. Problems, Resources, and Issues in Mathematics Undergraduate Studies, 16*, 1-9

Surveys:

Preszler, R. W., Dawe, A., Shuster, C. B., & Shuster, M. (2007). Assessment of the Effects of Student Response Systems on Student Learning and Attitudes over a Broad Range of Biology Courses. *CBE-Life Science Education, 6*, 29-41.

Sharma, M. D., Chan, B., & O'Byrne, J. (2005). An Investigation of the Effectiveness of Electronic Classroom Communication Systems in Large Lecture Classes. *Australian Journal of Educational Technology, 21*(2), 137-154.

Review:

Barber, M., & Njus, D. (2007). Clicker evolution: Seeking Intelligent Design. *CBE-Life Science Education, 6*, 1-20.

Caldwell, J. E. (2007). Clickers in the Large Classroom: Current Research and Best-Practice Tips. *CBE-Life Science Education, 6*(1), 9-20.

Simpson, V., & Oliver, M. (2007). Electronic Voting Systems for Lectures Then and Now: A Comparison of Research and Practice. *Australian Journal of Educational Technology, 23*(2), 187-208.

Online Resource**:**

Classroom Response System Bibliography

Author: Vanderbilt Center for Teaching

Source:

http://www.vanderbilt.edu/cft/resources/teaching_resources/technology/crs_biblio.htm

Highlights:

- Two major categories of papers:
  (1) General Audience; (2) Discipline-specific Audience

- Over 100 citations, many of them with active links to the actual paper;

- Well maintained resource with up-to-date citations;

Contact Information

Dan Cernusca

Missouri S&T
202 Norwood Hall
320 W. 12th Street
Rolla, MO 65409

dcernusca@mst.edu