I>CLICKER CASE STUDY: DEPARTMENT OF PHYSICS, AUBURN UNIVERSITY

Physics Professor increases course engagement and successfully assesses student comprehension of course topics

Challenge:

Without a vehicle to encourage independent textbook preparation before class, individual student comprehension of reading assignments could not be enhanced or tracked at the start of each lecture.

Solution:

i>clickers have revolutionized lectures by providing more interactivity and timely feedback in the classroom.

Benefits:

The professor can customize his methods of testing utilizing the various product options that fit the course structure.

Physics course utilizes i>clickers to create a more comprehensive understanding of course material, while removing the risk factor of answering questions incorrectly.

Motivation For Using i>clickers

- To enhance student learning
- To enhance teaching skills
- To engage students in a larger classroom
- To improve student participation during lectures
- To ensure student timeliness and attendance

Technology Implementation & Usage

Obtaining/Registering i>clickers: i>clickers are a requirement for the course. Students cannot obtain the 100 class participation points without an i>clicker response pad. Students can purchase the i>clicker response pad at the bookstore.

Taking Responsibility: Students are required to bring their i>clicker response pads to every class to participate.

> "Using clickers in the classroom forced me to create not only correct answers to questions but well thought-out incorrect answers designed to elucidate misconceptions among students. Creating these "good wrong answers" to questions was a time-consuming but valuable asset to my teaching effort.
>
> Marllin L. Simon, Department of Physics, Auburn University, Auburn

Classroom Application: To facilitate the use of in-class technology, the College of Science and Mathematics has made a significant investment to this cause. Each classroom has a dedicated online computer, a ceiling-mounted projection system, and a large automated projection screen.

PowerPoint is primarily used, which is also embedded into the i>clicker software and allows to efficiently project clicker questions and results. In addition, presentations are enhanced with Physlets animations or with animations from our text (known as "active figures"), which are in WebAssign and designed for classroom use. Every so often, "active demonstrations" are applied using the PASCO interface device and probes to collect information.

The project system enables seamless alternation between the PASCO "Data Studio" and i>clicker questions in PowerPoint. From time to time, virtual labs are also introduced. On top of this varied technology, IT support staff is readily available.

i>clicker Grading Policy: i>clicker responses comprise 10% of the course grade.

Daily Use/Questions Asked: i>clicker pedagogy is used 20–30 times during the semester. It is rarely used more than once on any given day, and tends to be used at the end of the class period (allowing time for discussion).

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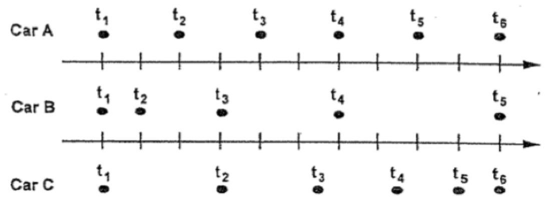
Question Examples: The i>clicker system can be used at the beginning of class to encourage promptness and to establish a baseline of background information and/or conceptual understanding (this is especially valuable if you intend to build on previous understanding). i>clickers can also be used during class to establish how well a point has been made. Additionally, the system can be used at the end of class to pull things together, emphasize the most important ideas one more time, and assess student learning. Typically, the system is used towards the end of class to assess the teaching strategy, hold students accountable for their learning, and offer a reward structure for the class.

Lecture-Lab-Recitation Questions

Pedagogy is ideally used in lecture, lab, and recitation (though time requirements make this difficult). The following sequence demonstrates how a collection of related concepts are used with a set of i>clicker questions designed for the 3 forums. Generally 10 questions are used per example.

Suppose you are looking down from a helicopter at three cars traveling in the same direction along a freeway. The positions of the three cars every 2 seconds are represented by dots on the diagram. The positive direction is to the right.



** Which car has the greatest average velocity during the time interval t1 to t2?*

A. CarA
B. CarB
C. Car C (ans.)
D. CarsBandC
E. None of these

Students must appreciate that the object with the greatest average velocity will have the greatest displacement (which is the distance traveled for this one-dimensional case).

In laboratory (designed to follow the lecture)

In the lab setting, an ultrasonic motion sensor and Data Studio software is used to track the motion of various objects and then develop plots representing their position, velocity, and acceleration as a function of time. Students are required to develop an intuitive feel for these aspects of a moving object. The following plots amount to a graphical representation of the position, velocity, and acceleration of cars A, B, and C used during the lecture.

Course Overview

Course Title/Subject: College Physics (Physics 1500; algebra and trigonometry based) and University Physics (Physics 1600; calculus based)

Typical Enrollment/Student Information: ~100 students per class (this semester); these classes tend to range in size from 100 to 250 students. The total enrollment for all sections of each of these courses is about 500 students per semester. Physics 1500 is the first semester of a 2-semester sequence for students in the health sciences (pre-med, pre- vet, pre-dental, pre-pharmacy, pre-nursing, etc.), building sciences (pre-architecture and building science), science education, and a number of other smaller programs. Physics 1600 is the first semester of a 2-semester sequence for engineering students.

Course Structure: Each week, students attend three 50-minute lectures, one 2-hour recitation (primarily problem solving) session, and one 2-hour lab (very task oriented) session. The lab and recitation sections typically include a maximum of 24 students, and students have the same teaching assistant (TA) for both lab and recitation.

Course/Student Challenges: The following are the course challenges and their origins:

- Students tend to do what has worked in the past, such as memorizing equations. In fact, many students believe that doing well in a physics course simply requires memorizing equations and inserting numbers. This suggests that they are rarely asked to think—and as a result, many students do not know or have forgotten how to actively think.
- Students have difficulty understanding physics in terms of concepts. They are convinced that if numbers are just used, they could determine the answer. The fact that we need to develop an expression for the desired quantity based on a careful conceptualization of the problem is troubling to students.
- Because physics can be difficult, it is tempting to skip class—especially an 8:00 a.m. class. Students often fail to realize how important each day can be to the conceptual development of several related topics. If students miss 1 day, they miss that development, which results in a major gap in their conceptual understanding.
- When students do come to class, they have a tendency to simply generate notes in a glassy-eyed, unengaged manner. Students need to be engaged; if they are not, class is just an exercise in recording what occurred and what others thought and/or said.
- Students struggle with the idea of instant intellectual accountability. For example, they would have no problem being shown how to dribble a ball and then immediately demonstrating that they know how to dribble. The intellectual analogue to this, however, is not true. If they are shown a fundamental physical principal in a number of different contexts and are then immediately asked to demonstrate that they understand how to use this principal, they have a problem. They want time to study. This may result from a lack of engagement, and from the risk factor associated with giving a wrong answer.

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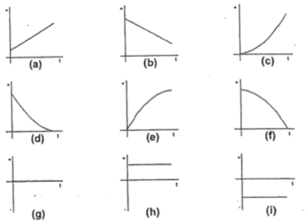

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** Which graph best represents the position vs. time for car A?*

A. Graph (a)
B. Graph (b)
C. Graph (c)
D. Graph (h)
E. None of these

After addressing many such questions in lecture and lab, there is a good idea of students' conceptual understanding of the first chapter about one-dimensional kinematics.

In recitation (to build on what is learned in lecture and lab)

Here, the content is used in a symbolic manner and to become more analytical (i.e., use equations and plug in numbers). To accomplish this, students are provided with information about the original drawing of the cars' position at different times.

Let's look at the motion of Car B in a more quantitative manner. We have already been informed that the dots are placed on the roadway every 2 seconds. In addition, we are now informed that the marks have been placed on the road every 10.0 m and that the acceleration is constant.

** Displacement of the car (in m) during the time interval t1 to t3.*

10
20
30
40
None of these

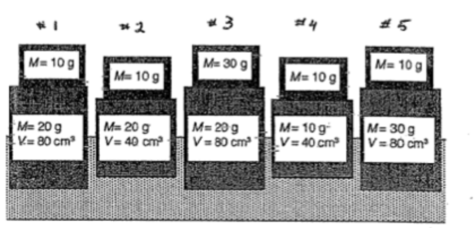
Ranking Task Questions.

The Ranking Task Activities (part of Tasks Inspired by Physics Education Research, or TIPERS), provides a question with several contextually similar situations, which differ in the value of 1 or more physical quantities (eg, speed and mass of a swinging object). The tasks are modified by asking for the greatest, least, and two identical situations. This forces students to consider and rank at least 5 situations.

For instance, when addressing the chapters dealing with fluids, a series of demonstrations are setup based on Archimedes' Principle and then are used with the following (clicker- friendly) modification of a Ranking Task:

Shown below are five wood blocks which have different masses and different volumes. These blocks are floating in water. On top of these blocks are additional masses which provide a load for each of the blocks.

Note: The blocks are not drawn correctly in terms of the depth the wooden blocks are in the water.



1. For which case is the buoyant force on the block in the water the greatest?
   A. Case #1 B. Case #2 C. Case #3 D. Case #4 E. Case #5
2. For which case is the buoyant force on the block in the water the smallest
   A. Case #1 B. Case #2 C. Case #3 D. Case #4 E. Case #5
3. For which two cases is the buoyant force on the block in the water the same
   A. #1 and #2 B. #2 and #3 C. #3 and #4 D. #4 and #5 E. #1 and #5

Course Overview Continued

Course Grading Policy: Following are the graded components of the course and the associated reward structure.

Course Component	Points	% of Overall Grade	Grade Distribution
Laboratory	100	10%	A= 90-100%
Recitation	100	10%	B=80-89.9%
Web Assigned Problems	100	10%	C=65-79.9%
Web Assign Active Figures	100	10%	D=50-64.9%
In-Class Participation*	100	10%	F<50.0%
Four 1 Hour Exams	400	40%	---
Final Exam	100	10%	---
Total	**1,000**	**100%**	

Extra Credit Problems 40.0 4.0% (nearly half a letter grade)

*NOTE: "In-Class Participation" refers to i>clicker pedagogy, which is implemented with i>clicker technology.

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Results

Successes

- **Obtain Formative Assessments** i>clickers provide students with a formative assessment of their comprehension of course material. Correlations between exam and quiz grades are examined with i>clicker results - proving that i>clicker questions provide students with formative feedback about their understanding of course content.

- **Generate Assessments in Real Time** i>clickers provide formative assessments in real time to the lecturer over the course of a semester. As a result, students' comprehension is assessed as content was being addressed, making for more efficient use of class time.

- **Increased Interactivity** Students actively participate in answering questions throughout course lectures, increasing overall engagement. 100% in participation was observed during courses, as all students used their i>clickers throughout the duration of material covered.

> “Knowing that I was going to ask a question at the end of class to determine how well a concept was internalized by students kept me more focused and intent on presenting the concept not only carefully but multiple times and in multiple ways.
>
> Marllin L. Simon, Department of Physics, Auburn University, Auburn

- **Created Collaborative** Environment Due to the encouragement for students to discuss questions among themselves before answer submissions, a collaborative learning environment is created, previously difficult with course sizes of 120+ students.

- **Improved Attendance** Before i>clickers, 60% to 70% of students came to class on a typical (non-exam) day, while after i>clickers, 85% to 90% of students were in attendance. On a survey given to students, about 71% of General Chemistry students and 57% of Organic Chemistry students indicated that they came to class more often because of clickers.

Conclusion

i>clickers have been enormously successful. They have revolutionized lectures by providing more interactivity and timely feedback in the classroom. i>clickers have also engaged students, improved learning, created a more collaborative classroom, increased attendance, and allowed delivery of more efficient lectures.

With the benefits derived from using i>clickers in course lectures, it is remarkable to also see more and more of fellow colleagues using them as well. Moving forward, there is no doubt that i>clickers will continue to be recommended from one department to the next.

According to feedback obtained from students:

General Chemistry students thought that clickers:

- helps students achieve deeper conceptual understanding (98% agreement)
- makes class more interesting (94%)
- improves student grades on tests and exams (82%)
- fosters peer collaboration (80%)
- encourages students to come to class better prepared (59%)

Organic Chemistry students thought that clickers had:

- helps them learn organic chemistry (96%)
- encourages them to work collaboratively (88%)
- helps students to clarify concepts (81%)
- makes class more interesting (79%)

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