

Dear Lesson Study Participants,

Thirty-nine instructors attended *Lesson Study Day* on May 16, an impressive turnout at the end of the semester. An important topic during the morning session was how to design a lesson that makes student thinking open to observation and analysis. Below are some “tried and true” techniques that you might modify for your research lesson. The challenge is to externalize student thinking in ways that support the lesson’s goals.

**Instructional Techniques that Make Students’ Thinking Visible.** The following techniques make students’ thinking public during a class period.

*Think-Pair-Share* is used to involve students more actively with the material through interaction with peers in class

- The instructor poses a thought provoking question to the class.
- Each student writes a response in 1-2 minutes.
- Students discuss their answers with a classmate sitting next to them. The purpose of the interaction depends upon the instructor’s goal. Students might be asked to 1) convince the classmate that one’s own answer is best, 2) create a third answer that incorporates elements of both answers, or 3) determine the strengths and limitations of each student’s answer.
- Optional. The instructor asks several students to report their ideas to the entire class, and uses these to make additional points or highlight key ideas.
- Optional. The instructor asks students to answer the question again in light of their discussion.

Cooper, J.L. & Robinson, P. (2000). Getting started: Informal small-group strategies in large classes. In Jean MacGregor, James Cooper, Karl Smith & Pamela Robinson (eds.) *Strategies for Energizing Large Classes: From Small Groups to Learning Communities*. New Directions for Teaching & Learning. Number 81, Spring, 2000, Jossey-Bass Publishers.

Also see <http://www.wcer.wisc.edu/archive/cl1/CL/doingcl/thinkps.htm>

*ConcepTests* were developed by Harvard physics instructor Eric Mazur to assess patterns of student thinking and misconceptions in large classes. The technique is similar to think-pair-share.

- The instructor poses a “conceptual” question or problem presented in a multiple choice format.
- Students take a minute or two to decide on the best answer and then vote using a response system in class that tallies the students’ choices.
- Next each student explains/defends his or her answer to a classmate.
- After these paired discussions students vote again on the best answer.
- The instructor displays the results of the voting and explains the best choice, paying careful attention to the patterns of responses in the class.

Caveat. *ConcepTests* use multiple choice questions in which the response alternatives reflect different ways of understanding the concepts. To construct such a test, instructors need to know in advance the types of conceptual mistakes and misconceptions students are likely to have. In physics, student misconceptions in certain topic areas are well documented. A *ConcepTest* would be difficult to create if students’ theories and misconceptions of important concepts are not well known in your field.

Mazur, E. (1997). *Peer instruction: A user's manual*. NJ: Prentice Hall.

For information about the approach see <http://mazur-www.harvard.edu/education/educationmenu.php>

ConcepTests in mathematics <http://math.arizona.edu/~lomen/concepttests.html>

ConcepTests in economics <http://www3.uakron.edu/econ/MidwestConference/2004/index.html>

ConcepTests in chemistry <http://www.jce.divched.org/JCEDLib/QBank/collection/ConcepTests/>

**Think Aloud Pair Problem Solving (TAPPS)** engages students in a think aloud process. In a think aloud a student says whatever comes to mind and keeps talking for the duration of the task at hand. In TAPPS students participate in pairs; one acts as the problem solver, the other as listener. The problem solver reads the problem aloud and talks through his or her solution. The listener follows along and catches any errors that occur. The role of the listener is to ask for clarification but not to guide or correct the problem solver.

Think alouds work best when the task or problem evokes elaborate thinking. A question or task that has a simple or single answer is not a good choice for a think aloud. The prompt does not have to be a problem in the traditional sense. For example, think alouds have been used to explore students' thinking as they read and try to make sense of historical documents.

For information about TAPPS see <http://www.wcer.wisc.edu/archive/cl1/CL/doingcl/tapps.htm>.

Think alouds in history, see Wineburg, Sam (2001). *Historical Thinking and Other Unnatural Acts: Charting the Future of Teaching the Past*. Temple University Press, Philadelphia.

The **Minute Paper** is a technique in which students write a brief answer about their learning during the class period. Traditionally, the minute paper is used at the end of the class period (e.g., What was the most important thing you learned today?). But a minute paper could be used at any point in the class to monitor student thinking. For example, the instructor could ask students to explain their understanding of a key idea at a turning point in the lesson (e.g., Now that we have just discussed this topic, take a minute to write about what concept "X" means to you.)

Optional. The written answers could be used as the basis for class discussion. The instructor can ask several students to read and explain their answers.

See Angelo, T.A & Cross, K.P. (1993). *Classroom Assessment Techniques: A Handbook for College Teachers*, Second Edition, Jossey-Bass Publisher, San Francisco.

**Summary.** Any of these techniques can help you better observe student thinking during class. Ideally, the techniques are instructionally purposeful and support changes in student thinking. For example, the ConcepTest is part of an instructional approach called Peer Instruction designed to promote conceptual change and deeper understanding of physics. The ConcepTest question prompts students to articulate their current understanding of an important concept. Then, they test out their understanding by explaining their answer to a peer. At this point students may notice gaps in their own thinking or notice how the peer's account is more complete or clarifies a point in a different way. Finally, the instructor uses the feedback from the tallied responses to elaborate on the concept. Rather than simply announce the right answer, the instructor can explain the concept in terms of different types of understanding. The instructional sequence is intended to promote conceptual change by having students articulate and examine their own ideas and then try to reconcile them with alternative views.