Student-Centered Teaching Methods

(adapted by C. Sealfon from Table 2 of the PCAST report)

Types of active learning with feedback	Description	Examples of studies that demonstrate enhanced learning
Small group discussion and peer instruction (also called "Think-Pair-Share" or "ConcepTests") (example)	Students think about the answer to a question posed by the instructor, and then discuss the question among each other. The instructor selects students to explain the consensus to the class.	Anderson et al. (2005); Armbruster et al. (2009); Armstrong et al. (2007); Beichner et al. (1999); Born et al. (2002); Crouch and Mazur (2001); Fagen (2002); Lasry et al. (2008); Lewis and Lewis (2005); McDaniel (2007a, 2007b); Rivard and Straw (2000); Tessier (2004 and 2007); Tien et al. (2002)
Effective use of clickers (examples/videos)	Hand-held electronic devices can allow students to anonymously vote on answers to multiple-choice questions in real time. Clickers are usually most effective when used with peer instruction.	Smith et al. (2009, 2011)
One-minute papers (example)	Given an open-ended question, students spend one minute writing their answers on index cards, which are collected by the instructor. Often given at the end of class, the questions ask students what was the most important concept they learned or what remains unclear.	Almer et al. (1998); Chizmar and Ostrosky (1998); Rivard and Straw (2000)
Interactive lecture demonstrations (ILDs) (example)	Students make predictions about the outcome of a classroom demonstration. They then observe the experiment or demonstration, describe the results, and discuss and reflect on the observed outcome.	Crouch et al. (2004); Sharma et al. (2010)
Case studies (examples)	Students draw inferences and make decisions given a detailed description of a scenario (often based on a true story).	Preszler (2009)
Concept mapping (example)	Students create a visual representation (similar to a flow chart) that identifies and shows the interconnections among various ideas related to a specific topic or problem.	Foncesca et al. (2004); Prezler (2004); Yarden et al. (2004)
Tutorial worksheets (example)	Students work through guided-discovery worksheets that lead them through a chain of logic to solve a problem or overcome a conceptual difficulty. Students complete the exercises in small groups, while the instructor circulates among the groups to ask targeted questions or to facilitate discussion (as needed or at specific “check points” in the worksheet).	Ambrose (2004); Finkelstein and Pollock (2005); McDermott et al. (1994); Prather et al. (2004)

Problem-based learning (example context-rich problems)	Students work in groups to solve complex, multifaceted, and realistic problems, researching and learning necessary background material as needed.	Capon and Kuhn (2004); Heller et al. (1992); Preszler et al. (2007)
Just-in-time teaching (examples)	Students submit answers to questions about pre-class reading online, due a few hours before class. Answers are graded based on completion and effort, not correctness, and inform the instructor's lesson plans.	Marrs and Novak (2004)
Analytical challenge before lecture (also called "invention activities") (example--scroll to p.4)	Students make predictions or attempt to answer questions before learning about the answers in class. The effort is more important that the accuracy of the attempted answers.	Schwartz and Bransford (1998)
Computer simulations and games (example game) (example simulations)	Students use interactive computer simulations or online games to visualize phenomena, test predictions, receive prompt, targeted feedback to refine their intuitions, and conduct and analyze virtual experiments.	Harris et al. (2009); McDaniel et al. (2007); Traver et al. (2001)
Group tests	A test is given twice to the same students. The first time, students answer the questions individually (as in a normal test) and submit their answer sheets. Then students are allowed to work in groups and re-take the same test. The two scores (individual and group) are averaged.	Cortright et al. (2003); Klappa (2009)
Problem sets in groups	Students work on problem sets in teams, and submit one set of solutions per team.	Cortright et al. (2005)
Random calling	The instructor informs the class that students will be selected at random to respond to a question (perhaps using a shuffled deck of index cards with students' names). Then, the instructor poses the question to the class, and remains silent for tens of seconds to allow everyone to think through an answer. After a sufficient pause (or perhaps after peer instruction), the instructor selects a student at random to share thoughts about the answer. Then, the instructor calls on another student at random to comment on the first student's response.	Buck (1997)
Writing with peer review	Students evaluate each other's writing using a rubric or criteria provided by the instructor.	Pelaez (2002)

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