Some active-learning methods in science

	Pedagogy					
	Problem-based learning (PBL)	Process-oriented guided inquiry (POGIL)	Peer-led Team Learning (PLTL)	Just-in-Time Teaching (JiTT)	Student-Centered Active Learning Environment for Undergraduate Programs (SCALE-UP)	Classroom Response Systems (CRS. Or Clickers)
Brief description	Students work cooperatively in groups with a facilitator to solve open-ended complex problems	Students work in self-managed teams on specially-designed materials that go through a 3-phase learning cycle	Workshops led by students who have completed the course, outside of class time, on problems designed to build conceptual skills	Students complete web-based assignments before class, instructor reviews and prepares lectures based on student responses	Students sit at tables with networked computers, instructor circulates to work with teams and individuals on complex problems	Instructor poses a multiple choice problem vis projector, each student submits answer with handheld device, instructor's computer collects responses, allows for further lecture or discussion among groups
How much reworking from lecture format needed	Can be a lot or a little, depending on how many problems introduced	Completely reworked	None needed; all group work outside of class	Requires review of student responses before each class	Completely reworked	None needed, but amount of material covered may change
Class size limits	Ideally < 30, but larger possible	Ideally <30 but is being piloted in large classes	No restrictions	No restrictions	No restrictions, designed for >100	No restrictions
Most common disciplines	Medicine, biology	Chemistry	Chemistry, engineering	Physics, Geosciences	Physics, engineering	Physics, very widely used in all of STEM
Source of additional information	http://www.udel.edu/pbl/	http://www.pogil.org/	http://www.sci.ccny.cuny.edu/~chemwksp/	http://serc.carleton.edu/introgeo/justintime/	http://www.ncsu.edu/PER/scaleup.html	http://www.vanderbilt.edu/cft/resources/teaching_resources/technology/crs.htm

Other sources:

Eberlein T *et al* (2008) "Pedagogies of engagement: A comparison of PBL, POGIL, and PLTL." *Biochemistry and Molecular Biology Education* 36: 262-273.

McNeal A and D'Avanzo (eds.) (1997) *Student-Active Science: Models of Innovation in College Science Teaching.* Saunders College Publishing, Orlando FL

Narum J (2008) "Transforming Undergraduate Programs in Science, Technology, Engineering, and Math." *Liberal Education* 94(2): 12-19.

PKAL Phase IV – Empowering Faculty: Pedagogies of Engagement, www.pkal.org/activities/PKALPhaseVI.cfm (accessed Oct 2008)

Smith S *et al* (2005) "Pedagogies of Engagement: Classroom-Based Practices." *Journal of Engineering Education* 94(1): 1-15.

Wieman C (2007) "Why not try a scientific approach to science education?" *Change* 39 (5): 9-15.