Why Use ConcepTests?

Peer instruction introduces the use of conceptual multiple choice questions, ConcepTests, that are initially analyzed by students working alone, and then in a pair or a small group. The use of conceptests has proved successful in:

- Increasing student engagement and improving student learning in physics (Mazur, 1997; Sokoloff and Thornton, 1997; Hake, 1998; Crouch and Mazur, 2001; Jones et al., 2001; Pilzer, 2001; Cox and Junkin, 2002; Crouch et al., 2008), chemistry (Kovac, 1999; Landis et al., 2001), math (Pilzer, 2001), geology (McConnell et al., 2006), genetics (Smith et al., 2009), and physiology (Rao and DiCarlo, 2000).
- Increasing student satisfaction with courses or instructors using ConcepTests (Mazur, 1997; Judson and Sawada, 2002; Meltzer and Manivannan, 2002; McConnell et al., 2003; Greer and Heaney, 2004). However, in some cases student satisfaction decreased (Piepmeier, 1998; Jones et al., 2001) or showed mixed results (Crouch and Mazur, 2001).
- Improving student attendance. Quantitative data (Judson and Sawada, 2002; McConnell et al., 2003; Greer and Heaney, 2004) and anecdotal reports (Landis et al., 2001) support interpretations that the use of this teaching method, especially when matched with an electronic response system, can lead to significant improvements in student attendance.

The teaching strategies used in the implementation of ConcepTests and peer instruction mirror the principles of good practice in undergraduate education defined by Chickering and Gamson (1987) and validated by extensive research (Sorcinelli, 1991). The proper execution of ConcepTests and peer instruction results in the application of their seven principles as follows:

1. ***Encourage student-faculty contact***. Peer instruction provides faculty with an opportunity to interact with students by facilitating small-group student discussions as s/he moves around the classroom. These less formal, more conversational, settings can highlight the easily recognized, low inference behaviors, such as enthusiasm, that students use to differentiate an outstanding teacher from an average one (Murray, 1983).
2. ***Encourage cooperation among students***. The social construction of knowledge is a common theme in much of the recent research on science education (Macdonald and Korinek, 1995; Bykerk-Kauffman, 1995; Ebert-May et al., 1997; Murck, 1999). Peer instruction provides an occasion for students to talk and listen to their neighbors in formal or informal teams to improve their understanding of critical concepts. This process helps form social bonds essential for the ready exchange of ideas between students in large classes (Wenk et al., 1997).
3. ***Encourage active learning***. The use of conceptests turns students from passive listeners into active participants who are involved in the construction of their own knowledge. The benefits of active learning methods in general can be seen in improvements in student attitudes about the science (Gibbons, 1994; Ebert-May et al., 1997; Reynolds and Peacock, 1998) and increases in standardized test scores (Mazur, 1997; Hake, 1998; Stokstad, 2001).
4. ***Give prompt feedback***. Formative assessment during class can measure student understanding immediately following the introduction of key concepts. The use of

conceptests and peer instruction compares favorably to other active learning methods as rapid feedback is possible with this technique. This is especially true for instructors using electronic classroom response systems (McConnell et al., 2003, 2006; Greer and Heaney, 2004) that can be programmed to display histograms of class responses before and after peer instruction.

5. ***Emphasize time on task***. Well-crafted conceptests can focus student attention on critical concepts rather than basic facts. As relatively small numbers of conceptests are posed per class, it is potentially straightforward for students to deconstruct the questions to recognize the principal ideas presented in each lecture. ***Communicate high expectations***. Conceptests can be created to address specific teaching and learning goals that target what students are expected to know and be able to do. The integration of conceptests into lecture sets higher expectations for student performance than simply taking notes and can challenge students to seek understanding of concepts, not just memorization of facts.
6. ***Respect diverse talents and ways of learning***. A traditional passive lecture environment is characterized by an instructor presenting information to a group of note-taking students (McManus, 2002). These settings are well suited to auditory learners who prefer to work alone and who will ask questions in class (Bykerk-Kauffman, 1995; Fleming, 1995). Unfortunately such students are a relatively rare species in audiences composed chiefly of freshmen and sophomores who are more likely to learn through visual cues or combinations of reading and writing (Fleming, 1995; Felder and Spurlin, 2005). Furthermore, students enter these classes at different cognitive stages and need opportunities to grow underdeveloped intellectual skills (McConnell et al., 2005). Peer instruction centered on conceptests teaches some students how to think critically while others can explore the depth of their understanding by taking on the role of peer instructors.

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