Which learning outcomes and teaching methods are instructors really emphasizing in STEM courses?

ABSTRACT This study investigated differences between STEM and non-STEM classes in instructor selection of course objectives and student self-perceptions of learning, motivation, and work habits, as well as student ratings of teaching and the course. STEM instructors employ teaching methods strongly associated with student progress on the learning objectives they emphasize. Moreover, students report the greatest progress on those objectives. However, students in STEM classes report making less progress than non-STEM on relevant learning objectives.

Statement of the Problem

The need to develop student capabilities in science, technology, engineering, and mathematics (STEM) is well documented. Nonetheless, many capable college students either do not pursue or eventually drop out of STEM majors. Attrition in STEM has been attributed to instructor reliance on lecture and failure to engage students in active learning (Sawatsky, Eagen, Garcia, Hurtado, & Chang, 2012). Introductory STEM courses focus too much on acquiring content knowledge and too little on critical thinking (Handelsman et al., 2004). The current study investigated differences between STEM and non-STEM classes in instructor selection of course objectives and student self-perceptions of learning, motivation, and work habits, as well as student ratings of teaching and the course.

Method

Archival data were analyzed from student ratings collected in 283,176 undergraduate (STEM) and graduate (non-STEM) classes from 2007-2011 in all regions of the continental U.S. These were compared with ratings in 1,380,013 non-STEM classes. Approximately 40% of institutions were master’s level, 20% baccalaureate, 22% doctoral, 2% associate, and 5% other. STEM classes included 45% science, 25% math, 14% computer science, and 13% engineering.

Students completed The IDEA Center’s Student Ratings of Instruction Diagnostic Form. Faculty completed the IDEA Faculty Information Form. See the times at http://www.thedesideracenter.org/services/students-ratings/sample-form-student-ratings-instruction. Technical information may be found at http://www.thedesideracenter.org/sites/default/files/technotes-12.pdf

How much learning are students reporting on those learning objectives? Students in STEM classes reported less progress on all 12 IDEA learning objectives than those in non-STEM. STEM students reported the greatest progress on those objectives. However, students in STEM classes report making less progress than non-STEM on relevant learning objectives.

Results

Which learning objectives are emphasized in STEM classes?

Over 85% of STEM instructors emphasized (i.e., rated as either essential or important to the course), “gaining factual knowledge” (obj1), “learning principles/theories” (obj2), and “applying material to improve thinking and problem solving” (obj6). STEM instructors were less likely than non-STEM ones to emphasize “creativity” (obj4, 24% vs. 40%) and “communication skills” (obj7, 36% vs. 62%).

Which teaching methods might be employed to support greater student learning?

STEM instructors consistently used all teaching methods less frequently than did non-STEM instructors. However, in over 70% of STEM classes, instructors employed teaching methods that stimulated student interest, established rapport, and structured the classroom experience, which are highly correlated with the learning objectives they emphasized.

What are summary ratings of STEM courses?

Ratings of the excellence of the teacher and excellence of the course were lower in STEM. More troubling were the consistently lower ratings on attitudes toward the field of study. This has implications for general education classes where many students get their first exposure to STEM.

Student course characteristics in STEM courses

Students in STEM and non-STEM classes reported similar levels of motivation to take the class. However, STEM courses were perceived as more difficult.

In spite of this, students in STEM courses reported putting forth no more effort than students in non-STEM.

Conclusions

STEM instructors employ teaching methods strongly associated with student progress on the learning objectives they emphasize. Moreover, students report the greatest progress on those objectives. However, students in STEM classes report making less progress than non-STEM on relevant learning objectives. STEM instructors should increase how frequently they apply appropriate teaching methods, and STEM students should raise their effort level. These findings may have implications for public policy in STEM fields.

References


Steve Benton, Ron Brown, Dan Li / The IDEA Center