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Notes

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3. Correspondence concerning this article, including requests for additional course materials (syllabus, reading list, and learning activities), should be sent to Stephen B. Fried, Department of Psychology, Park College, 8700 N.W. River Park Drive, Parkville, MO 64152.

Unique Challenges in Teaching Undergraduate Statistics

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The statistics instructor faces 4 major challenges unique to this course: motivating students to study material they think is uninteresting, handling math anxiety, dealing with performance extremes, and making the learning memorable. We discuss each challenge along with solutions offered in the literature.

If psychology students could choose to drop one required course from their curriculum, it would probably be statistics.

This may be because the content of statistics is so different from that of many other psychology courses—it is math related. We discuss four challenges unique to teaching statistics to undergraduate psychology majors: motivating students for the subject matter, handling math anxiety, dealing with performance extremes, and making learning memorable. We reviewed the literature on statistics teaching and learning to find ways of addressing these challenges.

Motivating Students

The subject matter of statistics does not spark interest and curiosity the way the subject matters of other psychology courses do. Thus, instructors need to make deliberate efforts to enhance motivation.

Active Learning

Learning by doing is more fun than learning passively. One effective way to promote active learning is to have students generate their own data, either by collecting data outside of class (with Institutional Review Board approval) or by providing data as participants (Stedman, 1993; Thompson, 1994). First, the instructor should provide guidelines to ensure that the data set will include certain types of variables. Then, students can decide what questions to answer, what data they need to collect, and how to collect the data. Students should be more interested in calculating and interpreting statistics if doing so allows them to answer their own questions. Other examples of active learning in statistics include locating and critiquing consumer-oriented research and writing explanations of statistical results (Beins, 1985, 1993).

Mastery Learning

In mastery learning, the goal is to achieve mastery of the material rather than simply to perform well on an exam. Typically, students receive mastery criteria, study the material, take an exam, get feedback, retake the exam, and so on, until they meet the mastery criteria (Friedman, 1987; Mevarech, 1983). Mastery learning can help motivate students by setting up a clear goal state and a route for getting there (Mevarech, 1983).

Math Anxiety

Math anxiety is an emotional state of dread of future math-related activities (Hembree, 1990). It interferes with statistics learning by making students so nervous they cannot concentrate and by lowering motivation, which, in turn, lowers effort and achievement (Lalonde & Gardner, 1993). Hembree (1990) suggested that instructors cannot easily eliminate math anxiety through classroom interventions. However, Lalonde and Gardner's work suggests that reducing math anxiety even situationally could increase motivation, effort, and ultimately achievement. Two possible methods of reducing math anxiety are tutoring and relieving exam pressure.

Tutoring

Students with math anxiety should benefit from tutoring that either focuses on basic math skills or gives them more exposure to the material that makes them anxious (Hembree, 1990). In general, tutoring can help students prepare on a regular basis for class work and exams, which should give them more confidence to try difficult problems.

Relieving Exam Pressure

Two methods of relieving exam pressure are providing unlimited time and allowing repeat examinations. If it is impossible to provide unlimited time during the day, instructors can consider giving evening exams or take-home exams.

Repeat examinations could be used even outside of the mastery learning context (Friedman, 1987; Ward, 1984). Students take an exam, receive feedback, and retake an alternate form of the exam. Knowing that there is a second chance should relieve some anxiety during the first testing. Having taken a similar exam already and having restudied the material should relieve some anxiety during the second testing. Two drawbacks are that repeat examinations consume class time that could be used for teaching, and they increase instructor time needed to construct and grade exams.

Performance Extremes

Performance extremes in statistics seem larger than in other courses (Hudak & Anderson, 1990). It is difficult to address the remedial needs of the low achievers while challenging the high achievers. Recommendations include peer tutoring, concrete presentation, and a proactive approach.

Peer Tutoring

Peer tutoring enhances learning for both high and low achievers (Ward, 1984). The high achievers (who tutor) benefit by actively using their new knowledge. By explaining the material to others, they can identify weaknesses in their own knowledge and remediate those deficiencies. The low achievers (who receive tutoring) benefit from extra individual attention beyond what they get from their instructor.

Concrete Presentation

About half of college students have not achieved the Piagetian stage of formal operations (Chiappetta, 1976). These students will have difficulty thinking hypothetically to understand concepts like probability and sampling distributions (Hudak & Anderson, 1990). Cantu and Herron (1978) showed that students both with and without formal operations acquired concrete concepts more easily than abstract concepts, although the difference was larger for students without formal operations. Thus, a concrete level of presentation will benefit all students, but particularly those without formal operations. Instructors can illustrate the concept of sampling distribution, for example, by assembling a population of toy

figures, assigning each a score on some variable, and randomly drawing samples of size n .

Proactive Approach

Reaching both strong and weak students may require a proactive approach, in which the instructor seeks out high and low achievers. Instructors can give high achievers special projects, such as writing a computer program to perform a statistical test, or writing press releases to report on statistical findings (Beins, 1993). Learning is more active, motivation is enhanced, and students go beyond the course material. Instructors can personally urge low achievers to get tutoring and to hand in homework assignments. The instructor and student may agree that the instructor will check the student's tutoring attendance and homework assignments closely and regularly. The proactive approach is time consuming for the instructor but a teaching assistant can help.

Making Learning Last

Many instructors of upper level courses note that students remember little of what they learned in statistics. One reason is that statistics is like a new language, with unique vocabulary and syntax. Lalonde and Gardner (1993) showed parallels between statistics learning and second-language learning and argued that, with limited exposure, students do not achieve fluency. Perhaps only if instructors intentionally infused statistics throughout the psychology curriculum would students show good retention (see Low, 1995). However, there are ways to increase retention from one semester's material.

Achieving Initial Understanding

Students will not remember what they never learned, so all of the previous ideas are applicable to making learning last. Also, a distinct organizational scheme of course material may help, particularly when students are aware of the organization. Magnello and Spies (1984) suggested that, to foster organized knowledge acquisition, instructors should present course material in terms of organizing concepts (i.e., families of tests and forms of data).

Providing Memory Cues

Stories, visual images, cartoons, videos, and demonstrations can help make learning more interesting and can provide memory cues (e.g., Hong & O'Neil, 1992; Ziv, 1988). For example, the demonstration of sampling distribution using toy figures may be memorable and as such, may help students remember the concept.

Understanding Common Misconceptions

Common misconceptions in statistics include the use of representativeness and availability heuristics in reasoning about probability (e.g., Garfield & Ahlgren, 1988; Hope &

Kelly, 1983; Konold, Pollatsek, Well, Lohmeier, & Lipson, 1993) and faulty categorization and translation of word problems (Garfield & Ahlgren, 1988; Hansen, McCann, & Myers, 1985). Konold et al. (1993) suggested that to overcome overuse of heuristics, students should get more explicit instruction in probability concepts. Explicit instruction has also improved students' ability to categorize problems (Quilici & Mayer, 1996; Ware & Chastain, 1991).

Conclusions

We have presented several research-generated solutions to the unique challenges of teaching undergraduate statistics. It would be difficult to implement all of them in one semester. However, instructors can choose solutions that suit them and their students and make additions in future semesters.

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Notes

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Content Analysis Project for Research Novices

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Students can utilize content analysis techniques to examine societal trends of stereotyping in the media. In this article, I describe the steps in such a research methodology and indicate criteria instructors may use for evaluation. Students believed the project developed and adequately measured their analytic, research, and organizational skills and increased their knowledge of social psychology.

How are young African American men portrayed in rap videos? One of my African American students, using content analysis, found aggression and materialism to be the most prevalent characteristics portrayed. In a social psychology course, I assign a content analysis research project to document stereotypes portrayed in the media. This project requires no sophisticated technology, but teaches novices, through iterative feedback, to do psychological research. In content analysis, a researcher examines artifacts (e.g., words, visual images, the use of color) for the occurrence of particular categories or events. For example, to determine attitudes and conceptualizations of lesbians, students could analyze televised and textual materials, rather than using the more typical survey approach that is fraught with problems due to nonprobability sampling, small sample sizes, poorly constructed questions, and time invested in data gathering. Similar to other psychological research designs, systematic observation and clearly operationalized variables are of integral importance. Unlike other research designs, the content analysis methodology allows students to test societal-level hypotheses without

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