Engaging Students in Learning: An Application With Quantitative Psychology

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In response to calls for more engaging and interactive pedagogy, we simultaneously implemented 4 rousing learning activities: peer-mentored learning, student reports of what was clear (or not) from a previous lecture, consult corners where student groups provided course-informed solutions to problem-based scenarios, and applied projects presented to the class. Students in several sections of a quantitative psychology course responded positively, reporting significantly less anxiety and greater self-efficacy regarding quantitative topics at the end of the semester compared to the beginning. We provide suggestions for applying these learning activities to other psychology courses.

Educators have urged curriculum changes to generate enthusiasm and long-term interest in learning (e.g., Halpern, 2003). Specifically, more engaging curricula, pedagogy, and empirical research are needed to transform current practice (e.g., Springer, Stanne, & Donovan, 1999). The literature suggests at least four options that could be applied to quantitative psychology and other fields to help instructors to reduce negative attitudes and to enliven the learning process, including incorporating peer mentors, constructive learning, cooperative small-group learning, and applied projects.

Recruiting similar-age peer mentors can help in implementing innovative curricula (Topping & Ehly, 1998). Peer mentors serve as role models while freeing up professor time for class topics. Mentors also can offer specific guidance on challenging tasks, providing positive learning experiences for students and mentors. For example, Landrum and Nelsen (2002) emphasized that undergraduate mentors benefit others as well as themselves with increased confidence, ability, and comfort with statistics and research.

Another way to engage students is to have them identify the body of knowledge in a topic area and to work through issues that seem unclear (Angelo & Cross, 1993). Opportunities for students to sketch out and construct an integrated understanding of the knowledge in a particular subject domain provide a powerful foundation for long-term constructive learning (Vermunt, 1998).

Small-group learning, where students cooperatively attempt to address issues in their subject area, can engage students in problem-based learning. By interacting with other students in a noncompetitive atmosphere, students learn to work together and come up with a meaningful solution to a problem drawn from course content (e.g., Leshowitz, DiCerbo, & Okun, 2002).

Finally, encouraging active, hands-on learning through projects that students develop to apply the main concepts of a course immerses students in the learning process. Students develop more understanding of the material when they are actively involved with specific projects (e.g., deWinstanley & Bjork, 2002; Harton, Richardson, Barreras, Rockloff, & Latané, 2002).

Change is particularly needed in quantitative psychology courses, which students often approach with low confidence and high anxiety (Conners, Mccown, & Roskos-Ewoldsen, 1998). These problems are particularly true for women. Despite efforts to encourage participation of women and men in science-based disciplines, gender differences continue with men endorsing math and science studies more than women (Lips, 2004). To address this bifurcation, recent literature suggests that both women and men can become more interested in science and math when instructors adopt a user-friendly and interactive approach (e.g., Eccles, 1997).

Learning Activities

We developed several learning enhancement activities, drawing on learning environment studies emphasizing small-group learning (Springer et al., 1999), increasing self-concept, and reducing anxiety (Townsend, Moore, Tuck, & Wilton, 1998). First, we used peer mentors to facilitate small groups, provide more interaction opportunities for students, clarify course material, and provide feedback on assignments. Second, we held weekly sessions after each topic lecture where students provided written feedback on what was clear and not clear to them (adapted from Angelo & Cross, 1993). Third, before exams, students formed small, cooperative groups to consult with each other to solve problem-based scenarios that we constructed based on course content. Fourth, we involved students in active, hands-on learning of the principles taught in class through individually applied projects analyzing a portion of survey data collected from the students or conducting research based on a student's ideas and data. Our study was unique in implementing four effective learning activities simultaneously to all students, thereby providing several different strategies for engaging in the course.

Hypotheses

We predicted that (a) students would demonstrate improved attitudes toward math over the semester, (b) there would be no gender differences due to the active learning, and (c) students would provide positive subjective feedback on the learning activities.

Method

Participants

We invited students from the University of Rhode Island who were enrolled in several sections of a quantitative psychology course to participate in the study. Students earned extra credit for completing a pre- and postcourse survey of skills and attitudes. Of 174 students enrolled in the courses, 129 completed both surveys and comprised the final sample (i.e., 74% participation rate). Most were women (80%), although as 3 students did not report their gender, we conducted some analyses on data from only 126 participants.

Student ages ranged from 19 to 43, with a mean of 21.4 years. The ethnic composition was 94% White, 3% African American, 1% Hispanic, and 2% listed as other. University class standing was 61% sophomore, 25% junior, 11% senior, and 3% fifth-year senior or graduate student. Average course grades were 79% for women and 82% for men.

Measures

We assessed precourse math skills with a 30-item test, adapted from a 25-item test created by Gravetter and Wallnau (1996). The five extra items, added to discourage ceiling effects, provided a small set of data points from which students calculated ΣX, ΣX^2, the median, the mean, and the variance. Coefficient α was .81, revealing a reasonably internally consistent scale.

Quantitative attitudes. We assessed three attitudinal scales. Quantitative anxiety, adapted from the revised Mathematics Anxiety Rating Scale (Plake & Parker, 1982), had four reliable items (i.e., coefficient $\alpha = .91$.), modified to pertain to "statistics" and not just "mathematics." Quantitative self-efficacy, adapted from an 18-item Math Self-Efficacy-Tasks Scale (Betz & Hackett, 1983), had three relatively reliable items (i.e., coefficient $\alpha = .71$). Perceived hindrances assessed the degree of endorsement to several obstacles (e.g., learning problems) that students perceived would hinder them in their ability to perform well in quantitative methods. Coefficient α was .81, indicating adequate internal consistency.

Quantitative performance. Two measures assessed course performance: homework and exam averages. Internal consistency reliability was moderate (coefficient $\alpha = .76$).

Procedure

To encourage high-level understanding and knowledge, we developed a project focused on *learning enhancement activities rousing noesis* (LEARN) in quantitative psychology. (*Webster's Third New International Dictionary* defines the Greek word *noesis* as "the highest kind of knowledge … of ideas; cognition especially when occurring through direct knowledge," 1971, p. 1533). For the LEARN project, we drew from curriculum efforts discussed in the introduction to develop four learning activities: peer mentoring throughout the course, weekly clear and not sessions, consult corners before exams, and applied projects at the end of the semester.

Peer mentoring. Peer mentors who recently completed a course in quantitative psychology readily agreed to serve as LEARN role models during and outside of the classroom throughout the semester, receiving independent study credit for their mentoring. We chose mentors for their interest and expertise in the topic as well as their enthusiasm and compassion for helping others get excited about learning.

Clear and not (C&N) sessions. Each week, students took turns collecting information from other students at the end of a lecture. Subsequently, selected students worked outside of class to provide a concise summary on clear lecture points and elucidating unclear concepts by drawing on lecture notes, information from class texts, and even outside reading. The instructor carefully reviewed C&N summaries before sharing them with the class, thereby helping to ensure that the material was accurate as a study guide or reference of the topic.

Consult corners. During class, small groups of students consulted with each other before each exam, suggesting various ideas from course material to provide a solution to an instructor-generated problem. For example, one scenario asked students what quantitative method (e.g., two-sample independent *t* test) would be appropriate to assess whether men and women differed in their level of interest in studying mathematical material, along with recommendations and limitations. A student representative from each group presented the group's solution either in oral or written reports.

Applied projects. Students conducted their own applied projects outside of class to demonstrate understanding of class concepts. At the end of the semester, students in small classes gave oral reports and provided a brief handout for other students. In large classes, students prepared a desktop poster with a two- to four-page summary of their project for class perusal.

Design

We conducted a pre- and posttest quasi-experimental design to assess any changes in math anxiety, self-efficacy, and perceptions of hindrance factors across the semester, controlling for initial skills. We also investigated possible gender differences and solicited feedback from students to assess subjective reactions to learning activities.

We applied all four learning activities to all students in the study, which is consistent with educational reform programs that call for comprehensive approaches (Halonen et al., 2003). Although an experimental design that randomly assigned students to an activity versus a control classroom would have been useful for building causal evidence, it would have been difficult to implement in a college setting and we chose instead to use a pre- and posttest quasi-experimental design that controlled for initial levels of attitudes and skills for all students.

Results

To test the first hypothesis that there would be significant differences in attitudes over the semester, we conducted a repeated measures MANCOVA across pre- and postcourse attitude measures, using precourse math skills as a covariate and the three quantitative attitudes (anxiety, self-efficacy, and perceived hindrances) as dependent measures. After controlling for the level of initial precourse math skills, we found small, yet significant differences from pre- to postcourse in the combination of quantitative attitudes: Wilks's $\Lambda = .97$, $F(3, 251) = 2.84$, $p = .04$, $\eta^2 = .03$. Follow-up ANCOVAs, controlling for the covariate of initial precourse math skills, revealed that over the semester there were significant effects for two of the three variables. Quantitative anxiety significantly decreased (precourse $M = 3.22$, postcourse $M = 3.09$), $F(1, 253) = 6.43$, $p = .01$, $\eta^2 = .01$, and quantitative self-efficacy significantly improved (precourse $M = 3.74$, postcourse $M = 3.99$), $F(1, 253) = 5.45$, $p = .02$, $\eta^2 = .02$. There was no significant difference between means for perceived hindrances (precourse $M = 3.22$, postcourse $M = 3.09$), $F(1, 253) = 1.48$, $p = .23$, $\eta^2 = .01$. In each ANCOVA, the covariate was significantly related to the quantitative attitude, such that improvements in quantitative anxiety and self-efficacy occurred over and above the effect of precourse skills.

We tested the second hypothesis that active learning would result in no gender differences with a between-groups MANOVA with gender as the independent variable and the nine study scales (i.e., precourse math skills; pre- and postcourse quantitative anxiety, self-efficacy, and perceived hindrances; homework average; and exam average) as dependent variables. Results revealed no significant differences between female and male students on this set of variables: Wilks's $\Lambda = .94$, $F(9, 116) = .86$, $p = .57$. Because it is difficult to "accept the null hypothesis" of no significant differences, we conducted a power analysis and found that with the sample size of 126 students, an alpha of .05, and an effect size of $f = .25$ (i.e., square root of $(1 - \Lambda)/\Lambda$), the power of our test was greater than .99 (Cohen, 1988). The high power and lack of significance suggested that gender was not a salient factor in our study.

For the third hypothesis, we examined whether students provided positive feedback about the course. An examination of the comments revealed that the majority (more than 70%) of student comments were positive. Using a test of proportions, we found that the proportion of positive responses (.70) was significantly different from chance (.50), with $z = 4.54$, $p < .001$, and a medium-large effect size of .20 (Cohen, 1988). Table 1 presents a representative subset of student comments with suggestions (in parentheses) to address several student criticisms.

Discussion

Students reported less anxiety and greater self-efficacy in a quantitative psychology course that used engaging learning activities. Furthermore, we ruled out initial math skill levels as a potential explanation for improved attitudes because we statistically controlled skills in the analyses of covariance across time. Similarly, we ruled out gender as a relevant factor due to a failure to obtain significant differences between men and women on any scales. The lack of gender differences was encouraging given recent findings of occasional gender differences with respect to science-related topics (Lips, 2004) and a call for more equity in science curricula (Lederman, 2003). We cautiously speculate that using cooperative and engaging activities helps improve learning attitudes for both men and women, thereby providing a more equitable learning environment than in traditionally taught courses.

Table 1. Positive (+) and Negative (–) Student Feedback on the Four Learning Enhancement Activities

Peer mentor
- + Mentor was very knowledgeable.
- + Mentor helped clarify course material.
- + Mentor was helpful with interpreting material.
- + Mentor was very concerned about students.
- + Mentor was very helpful with homework assignments.
- – Mentor sometimes needs to go slower. (Remind mentors to slow down.)
- – Mentors might need more practice interpreting and planning. (Build this in.)

Clear and not sessions
- + Helps shy students ask questions.
- + Allowed concepts to jell in my mind.
- + Helped me realize others were also having trouble with some lecture points.
- + Very refreshing to realize how much was actually clear from the lecture.
- + Please keep; Reports were great for exam review and a general study guide.
- – I'd like to have less oral sessions. (Consider using e-mail reports.)
- – Sessions were sometimes repetitive with class lecture. (Most liked this aspect.)

Consult corners
- + Interesting hearing how others address problems.
- + Very helpful in clarifying material; would like more of them.
- + Great examples to highlight and would also make a good exam.
- + We all surprised ourselves at what we knew.
- + Great integration and good practical application.
- – I'd like more input from mentors during consults (Could involve mentors.)
- – I'd like more time for these (Could consult outside class and present in class.)

Applied projects
- + Excellent: forced one to apply what was learned.
- + I loved hearing others' areas of interest and what they did.
- + Applied projects were helpful and interesting, too.
- + Presentations gave nice closure.
- + Great combination of learning activities.
- – Too many oral presentations on the last day—strained attention spans. (Could try "poster" table presentations—more interactive, less straining.)

Note. Suggestions given in parentheses for identified problem areas.

These findings are consistent with theoretical frameworks (e.g., Boyer Commission on Educating Undergraduates in the Research University, 1998; Halpern, 2003) that advocate having students actively participate in projects that stimulate critical thinking and interest. Results are also consistent with previous empirical research that has emphasized peer interaction (e.g., Topping & Ehly, 1998), active writing about course material (e.g., Dunn, 2000), small-group learning (Peterson & Miller, 2004), and active-learning projects (e.g., Weis, 2004). Our study contributes to the literature by simultaneously implementing and elaborating on several activities that faculty can apply to stimulate active student learning, particularly with courses (e.g., statistics) that can foster stress and low confidence.

We recognize we cannot establish causality from our study in that all students received the four learning enhancement activities, making it difficult to attribute findings to any specific factor (e.g., course content, a particular learning activity, student maturation, outside assistance). Nonetheless, it is reasonable to assume that the learning activities, which constituted a large portion of the course, played some role in improving students' attitudes toward quantitative learning (e.g., McKeachie, Pintrich, & Lin, 1985).

We suggest that other courses could use these learning enhancement activities to engage students while increasing their confidence and lessening their trepidation in the learning process. Peer mentors could help in a wide range of courses—particularly those with highly technical material (e.g., physiology, statistics). Courses in which students must master a certain body of knowledge (e.g., introductory psychology, testing and measurement) could hold regular queries as to how much is clear and not clear after each section. Similarly, consult corners could help involve students in selecting which personality theories or clinical approaches applied to specific case studies. Finally, projects may help students apply learning or research procedures to address an important issue (e.g., health promotion through increased exercise habits). Future studies could adapt some of the LEARN activities to other courses and environments, to generalize findings beyond our course in quantitative psychology.

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Notes

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