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NO QUICK FIXES: ADDING CONTENT ABOUT WOMEN TO ECOLOGY COURSE MATERIALS

Mary Wyer, Deena Murphy-Medley, Ellen I. Damschen, Kristen M. Rosenfeld, and Thomas R. Wentworth
North Carolina State University

This study reports on a three-semester model project designed to assess the impact of enriched content related to Women's and Gender Studies on students enrolled in an undergraduate ecology course. The two constructs of interest were (a) students' attitudes toward women in science and society and (b) students' assessment of the classroom climate for women. The data included 398 matched pretest and posttest survey responses from a control group, a minimal enrichment group, and an increased enrichment group. Findings indicated that, although small course revisions did not influence students' attitudes toward women in science and society, such revisions had a positive influence on students' assessments of the classroom climate.

Three decades after the passage of Title IX of the Education Act Amendments of 1972 mandating equal opportunity in U.S. education, women remain dramatically underrepresented among scientists and engineers (National Science Foundation, 2004). Despite unprecedented national funding levels in science education, students' interests in science undergraduate degrees have languished (Lucena, 2000; National Science Foundation, 2004). Even high-profile efforts to increase the representation of women among science, technology, engineering, and mathematics faculty have shown only slow and sporadic progress (Hopkins, 2006; Lawler, 2006). Special programs for girls and women have promoted science careers but program effects are seldom evaluated via controlled studies of educational or career outcomes (Davis & Rosser, 1996; Marra & Bogue, 2004; Rosser, 1997).

Women's and gender studies (WGS) curriculum transformation advocates have long argued that the invisibility of women in course materials perpetuates women's marginal status in society (Boxer, 1998; Schuster & Van Dyne, 1985). Researchers have demonstrated the impact of WGS on students, linking changes in students' attitudes and classroom experiences with WGS courses (Bryant, 2003; Harris, Melaas, & Rodacker, 1999; Stake & Hoffman, 2001; Stake, Roades, Rose, Ellis, & West, 1994; Stake & Rose, 1994). Utilizing WGS scholarship in the science curriculum has only just begun, but formal projects report mixed results. Some accounts describe resistance, resentment, and rejection, whereas others describe individual science faculty whose teaching and research are intellectually energized by the new scholarship on women and gender (Musil, 2001; Rosser, 1997; Subramaniam & Wyer, 1998). The impact of these efforts on students is unclear because controlled studies using WGS material in science classrooms are rare.

The model for WGS curriculum transformation in the humanities and social sciences has required rethinking of the grounding assumptions of course content. "Trying to add material about women to a conventional course is like adding the fact that the world is round to a course based on the assumption that the world is flat" (Schuster & Van Dyne, 1985, p. 4). In the decade since Fausto-Sterling (1992) called for "building two-way streets" between women's studies and the sciences, efforts to promote a transformed science curriculum have progressed slowly

Mary Wyer and Deena Murphy-Medley, Department of Psychology, North Carolina State University; Ellen I. Damschen, Department of Zoology, North Carolina State University; Kristen M. Rosenfeld and Thomas R. Wentworth, Department of Botany, North Carolina State University.

Ellen Damschen is now in the Department of Ecology, Evolution, and Marine Biology, University of California–Santa Barbara.

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Address correspondence and reprint requests to: Mary Wyer, Department of Psychology, Campus Box 7650, North Carolina State University, Raleigh, NC 27695. E-mail: mary_wyer@ncsu.edu

(Fausto-Sterling, 1992). The time has come to explore whether a more limited approach—dubbed "add women and stir" by Charlotte Bunch (1987, p. 140)—would provide some benefit to students.

Theoretically, because of the long-standing cultural association of masculinity with scientific objectivity (Keller, 1985; Wyer, Barbercheck, Giesman, Öztürk, & Wayne, 2000), latent gender bias in course content favors men as scientists. Research suggests that women are discouraged from majoring in the sciences by an environment in which values, priorities, and working conditions are consistent with norms of masculinity (Glick, Wilk, & Perreault, 1995; McLean & Kalin, 1994; White, Kruczek, & Brown, 1989). When these norms are reflected in classroom content, they may affect persistence among women majors. For instance, recent evidence suggests a link between students' positive attitudes toward gender equality and high degree aspirations, a link that depends on both gender and field (Wyer, 2003a, b).

This study describes a three-semester model project that examined the effects of small content changes on students' attitudes and classroom experiences in an undergraduate ecology course required for many majors in the biological sciences. The project was designed to examine the assumption that adding WGS-enriched material to the course content would produce a measurable change in two key constructs: (a) students' attitudes toward women in science and society and (b) students' assessment of the classroom climate. The project emerged from an interdisciplinary collaboration among psychologists, zoologists, and botanists to develop, teach, and then assess the impact of course-enrichment material. Ecology provides a uniquely fitting opportunity to explore the possibilities and limitations of integrating feminist scholarship into the sciences because there are substantive continuities between ecological and feminist perspectives. For instance, research and theory in both ecology and WGS have actively formulated holistic and interdisciplinary theory and method. Both fields champion research agendas that focus on human well-being within human/environment interactions. In addition, both fields are committed to systematic empirical study within social, historical, and political context (Eisenhart & Finkel, 1998; Odum & Barrett, 2005; Reinharz, 1992; Ricklefs, 2001).

In the last two decades, attitudes toward women in science appear to have become more egalitarian, reflected in the fact that women have been well represented (above 40%) among biological science undergraduate degree earners, including ecologists, for over 20 years. Women have also been well represented among biological science doctorates for nearly 10 years (National Science Foundation, 2004). The observation that attitudes about women in science have become more egalitarian is also supported by standardized test results of 12th-grade students, which show that females and males now have similar 12th-grade science and mathematics preparation and performance (National Center for Educational Statistics, 2002; National Science Foundation, 2002). Despite equal participation, preparation, and performance, however, gender differences in attitudes toward girls and women in science persist among K–12 and undergraduate students, and girls' and women's attitudes are more positive than are boys' and men's (Greenfield, 1997; Stake, 2003; Wyer, 2003a).

Along with egalitarian attitudes toward women in science and society, another factor that may be important for undergraduate women students in science is classroom climate. In higher education, the concept of the educational climate emerged from feminist theory in the context of the American Association of University Women research report describing a "chilly climate" for women on college campuses (American Association of University Women, 1992; Hall & Sandler, 1984). In studies focusing on women, women students' perceptions of the college environment as chilly were related to their educational development and achievement (Hagedorn, Saidat, Anora, & Pascarella, 1997; Pascarella et al., 1997). Although these studies were directed at assessing the university-wide campus climate, rather than specific classroom experiences, the findings suggest that discouraging educational environments negatively affect students' educational outcomes.

At the classroom level, students' experiences extend beyond their exposure/reactions to course content to include the implicit and explicit messages they receive about their abilities and potential (Tinto, 1997). From a WGS perspective, the exclusion of women from course content thus represents an invisible curriculum that reiterates the cultural assumption that women are irrelevant to (and in) science, creating a de facto hostile climate. In particular, research on stereotype threat has demonstrated that evoking stereotypes even indirectly can provoke a decline in academic performance (Shih, Pittinksy, & Ambady, 1999; Steele, 1997; Steele & Aronson, 1995). In disciplines in which women have made significant though not widely recognized contributions, such as ecology, the absence of women in course content plausibly constitutes a chilly climate by reinforcing the stereotype that science is a man's world (Bleier, 1984; Keller, 1985; Rossiter, 1982, 1995). Women are not well represented in the content of most introductory ecology courses or textbooks, however well represented in the student population (Damschen et al., 2005).

The purpose of this study was to test the assumption that WGS-enriched course content would influence students' attitudes toward women in science and society and students' assessment of the classroom climate. The study tested two hypotheses: (a) changes in students' attitudes toward women in science and society will vary by gender and exposure to enrichment materials and (b) changes in students' assessment of the classroom climate will vary by gender and exposure to enrichment materials. Because gender differences in attitudes toward science, gender equality, and the classroom are well established in the research literature, it was expected that the enrichment materials would be more salient for women than for men at both enrichment levels for both hypotheses. Nonetheless, the study hypotheses leave open the possibility that men, as well as women, could be positively influenced by the new material. In addition, because it was expected that women in our study would have more positive attitudes toward women in science than did men, the study hypotheses leave open the possibility that the degree of change could differ by gender.

METHOD

Participants

The data used in this study were drawn from a cross-sectional opportunistic sample of three semesters of students in an introductory undergraduate ecology course offered at a major public research university in the southeastern United States. The course was required for a wide variety of life science majors. It was offered every fall and spring semester and included three 50-minute lectures and one 170-minute laboratory section each week. Students attended the same lectures but registered for separate laboratory sections. Over three semesters, students were surveyed in a total of 25 laboratory sections, including 9 control sections, 8 minimal enrichment sections, and 8 increased enrichment sections. Sections ranged in size from 11 to 22 students. A total of 504 students completed surveys in week 2 of the semester in Fall 2002, Spring 2003, and Fall 2003. A total of 459 students completed surveys in week 10 of those semesters. Students were assigned a confidential identification number that they used for both surveys to match their responses. From the completed surveys, the final sample included 398 matched pretest and posttest responses, with 35.6% in the control group, 32.6% in the Enrichment Level 1 Group (minimal enrichment), and 31.8% in the Enrichment Level 2 Group (increased enrichment).

All of the teaching assistants in the laboratory sections were women, and all were Caucasian. Among students in the final sample, 62.6% were women and 37.4% were men. By racial identity, 84.4% were Caucasian, 7.4% were African American, 3.6% were Asian, 1.4% were Hispanic, and 3.3% had other ethnic identities ($n = 365$; 91% of final sample). Nine percent of students in the final sample either did not answer the question about racial identity or answered it differently at pretest and posttest.

Treatment Conditions and Procedure

Two levels of enrichment were devised to integrate material into the already developed PowerPoint™ course materials. Students in the control sections were not exposed to the enriched materials but otherwise received the same course materials. The enriched content was selected for its congruity with the topic of the week and was mainstreamed into the presentations without emphasis or special attention. Content included such materials as a photograph and brief two-sentence biography of a woman who contributed to scientific knowledge about the topic under discussion, social biases in the interpretation of data, and language as value-laden. The new information was reinforced periodically with quiz questions that asked students to recall the new information and through in-class activities. In addition, a review session included reference to the new material within the context of an overview of all course material.

The study utilized a quasi-experimental nonequivalent control group design (Shadish, Cook, & Campbell, 2002). Gender and condition were between-subject factors and time of administration of the survey (pre and post) was a repeated measure. Laboratory sections were assigned to one of three conditions: control (semesters one and two), Enrichment Level 1 (semesters one and two), and Enrichment Level 2 (semester three). Enrichment sections were taught by two teaching assistants who were trained to teach the enrichment materials. These two teaching assistants taught both enrichment levels and did not teach control sections. Seven other teaching assistants taught control sections for the first two semesters and then were trained to use the enriched material for the third semester. All sections in all conditions utilized the same laboratory manual. The first level of enrichment exposed students in eight laboratory sections to the new material via PowerPoint™ slides and classroom activities, which represented approximately 5 to10 minutes (approximately 2 to 5%) per week of total laboratory content. At the second level of enrichment, all students enrolled in the course that semester (eight sections) were exposed to the new material in both lecture and laboratory settings. The second level of enrichment utilized the PowerPoint™ slides in the lectures and then repeated them in laboratory sections. Both lecture and laboratory exams included questions about the new material. The second level of enrichment represented approximately 10 to 20 minutes (approximately 5 to10%) per week of new material in lectures and in laboratory sections combined. (For more information on the intervention materials, see Damschen et al., 2005).

The pretest and posttest surveys were administered to students in the second and tenth weeks, respectively, of their laboratory sections. The surveys were distributed, conducted, and collected by a researcher who was not one of the laboratory instructors. Students were told that the survey was part of a National Science Foundation effort to understand undergraduate science education. Students were told that their responses were confidential and that data analyses would take place at the group level rather than individual level. They were told that their participation was voluntary and that they could withdraw from the survey at any time. They were also encouraged to respond frankly to the items in the survey.

Measures

Attitudes toward women in science and society. The analysis included measures to capture students' global attitudes about women in society and more specific attitudes about women in science. Six items from the 15-item

Attitudes toward Women Scale (AWS; Spence, Helmreich, & Stapp, 1973; Spence & Hahn, 1997) were used to capture students' global attitudes toward women.[1] Seven items were adapted from the Women in Science Scale (WiSS; Erb & Smith, 1984) to assess students' attitudes about women in science specifically, as reworded by Mulkey (1989). Cooperating colleagues crafted one new item to explore students' image of male scientists as especially dedicated, "Men make more sacrifices than women do to become scientists."[2] All responses were measured using a 6-point Likert scale ranging from 0 (*strongly disagree*) to 5 (*strongly agree*). Items from the AWS included statements such as: "The intellectual leadership of a community should be largely in the hands of men" and "Women should worry less about their rights and more about becoming good wives and mothers." Items from the WiSS included statements such as "A woman with a science career will have an unhappy marriage" and "Women are as capable of becoming scientists as men are." Both the AWS and the WiSS have been used in several contemporary studies (e.g. Bailer, 1998; Stake, 2003; Stake & Malkin, 2003). Both scales have demonstrated internal reliability, construct validity, and good test-retest reliability (Erb & Smith, 1984; Spence & Hahn, 1997). Higher values indicated more positive attitudes. Mean scores were generated for each individual. Measures of internal consistency for both scales were acceptable at pre- and posttest. For the AWS, at pretest $\alpha = .81$ and at posttest $\alpha = .82$. For the WiSS, at pretest $\alpha = .81$ and at posttest $\alpha = .83$.

Classroom climate. The students' perceptions of classroom climate were measured using eight items focusing on gender adapted from the Perceptions of Prejudice Scale (Hagedorn et al., 1997; Pascarella et al., 1997). The scale was developed originally with a focus on women to explore the widely accepted but untested hypothesis that a chilly campus climate diminished women's self-confidence and inhibited personal and intellectual growth (Pascarella et al., 1997). The items were derived from the much cited chilly climate work of Hall and Sandler (1982, 1984). The scale items were recast/reworded to address the classroom rather than the campus as a whole and all eight items related to gender were included. The statements in the revised version of the scale included statements such as "I have never been singled out in this class or treated differently than other students because of my gender" and "One seldom hears negative words about women while attending this class." Students responded on a 6-point Likert scale ranging from 0 (*strongly disagree*) to 5 (*strongly agree*). An exploratory factor analysis yielded an eight-item scale and indicated a one-factor solution. Four criteria were used to assess the factor solution: (a) a scree test, (b) eigenvalues greater than 1.0, (c) factor loadings greater than .30, and (d) review of item total correlations. Mean scores were generated for each individual. Measures of internal consistency were acceptable at pre- and posttest. At pretest $\alpha = .80$ and at posttest $\alpha = .82$.

Grades and course evaluations. Each student's final course grade (0 to 4.3) and each laboratory section's mean score from students' course-evaluations (5-point scale ranging from 1 (*poor*) to 5 (*excellent*) were collected from departments and included in the data analysis as covariates.

RESULTS

A mixed model, repeated measures analysis of variance (ANOVA) was utilized to compare changes in mean values for each scale from pretest to posttest, by gender and condition (control group, Enrichment Level 1, Enrichment Level 2) for 398 paired responses in 25 sections.[3]

Mean values for AWS and WiSS were moderately correlated with one another at both pretest ($r = .58$, $p < .001$) and posttest ($r = .62$, $p < .001$). Mean values for the Classroom Climate scale correlations with the AWS and WiSS were as follows: for the AWS scale at pretest ($r = .14$, $p = .004$) and posttest ($r = .20$, $p < .001$), and for the WiSS at pretest ($r = .25$, $p < .001$) and posttest ($r = .34$, $p < .001$).

The first hypothesis predicted that changes in attitudes toward women in science and society from pretest to posttest would vary by gender and condition. This hypothesis was tested using 2 × 3 × 2 (gender × condition × time) repeated measures analyses of variance (ANOVAs) for both the AWS and the WiSS. The hypothesis was partially supported. A main effect of gender was found for both the AWS, $F(1, 394) = 170.77$, $p < .001$, and the WiSS, $F(1, 394) = 72.20$, $p < .001$. No other main, interaction, or pretest/posttest effects were found. Women had more positive attitudes than did men on the AWS (women, $M = 4.34$, $SD = .58$; men, $M = 3.41$, $SD = .92$) and on the WiSS (women, $M = 4.60$, $SD = .54$; men, $M = 4.13$, $SD = .70$).

The second hypothesis predicted that changes in students' assessments of the classroom climate would vary by gender and condition from pretest to posttest. This hypothesis was partially supported. A 2 × 3 × 2 (gender x condition x time) repeated measures ANOVA revealed a significant interaction effect of condition and time on students' assessment of the classroom climate, $F(2, 389) = 3.44$, $p = .03$. Though women in general had higher final course grades than did men (women, $M = 3.11$, SD .87; men, $M = 2.77$, $SD = .88$; $p = .0002$), this was not related to changes in students' assessments of the classroom climate, $F(1, 85) = .32$, $p = .57$.

The interaction effect of condition and time does not by itself describe the significance of changes for each condition, only that changes from pretest to posttest were related to condition. Subsequent analyses utilized a Tukey-Kramer adjustment for multiple comparison of means with unequal sample sizes, which corrects for an experimentwise error rate (Hayter, 1984). With the Tukey-Kramer adjustment, changes from pretest to posttest in students' assessment of the classroom climate were significant for both enrichment conditions: Level 1 Enrichment means from pretest to posttest, $F(1, 66) = 5.72$, *adj.* $p = .03$ ($M = 4.24$ vs.

4.48, respectively); Level 2 Enrichment means, $F(1, 66) = 31.30$, *adj.* $p < .001$ ($M = 4.21$ vs. 4.63, respectively). In contrast, control means did not differ from pretest to posttest ($M = 4.24$ vs. 4.35, respectively). Because it is necessary to test for the significance of differences in the degree of change across the conditions, the analysis also contrasted the interaction effects of time with condition. There was no significant difference in the degree of change between the control group and Level 1 Enrichment, $F(1,66) = 1.45$, $p = .23$. Although both enrichment conditions produced a positive and significant change in students' assessments of the classroom climate over time, the difference between the two levels in this change effect approached, but did not reach, significance, $F(1, 66) = 3.07$, $p = .08$. Students' assessments of the classroom climate changed most in the Enrichment Level 2 condition and this change effect was significant when contrasted to the control group, $F(1,66) = 9.04$, $p = .004$.

Because these condition effects could have been confounded with section-specific teaching effects, each section's average course evaluation score was included in the Tukey-Kramer analysis as a between-section posttest covariate. Course evaluations were nonsignificant, $F(1, 21.3) = 2.22$, $p = .15$.

DISCUSSION

Those who teach WGS courses are familiar with the positive changes in students' attitudes and experiences that result from exposure to feminist scholarship and teaching. This study was designed to assess if even small amounts of new content in an ecology course could produce changes. Though our findings are modest, they provide a much-needed empirical beginning to explore what can and cannot be changed with minimal amounts of WGS material in science courses. Students' attitudes toward women in science and society proved to be unresponsive to the "add women and stir" enrichment, at either a minimal or increased level. Students' assessments of the classroom climate were more positive over time at each level of enrichment. However, the lower level of enrichment did not produce a significant change when contrasted to change in the control group. The higher level of enrichment did produce significant change when contrasted to the other conditions. This finding is consistent with related findings in a companion study by Damschen et al. (2005), which reports that students in enriched sections of this project's ecology course demonstrated a greater gain from pre- to posttest in knowledge of women scientists who had contributed to ecology, compared to students in control sections.

Although students' attitudes about gender equality in science and society may be resistant to small changes in course content, students' assessments of classroom climate (and students' knowledge about women's contributions to science) appear to be sensitive to the new content if they receive at least 10 to 20 minutes a week of this material. Neither course evaluations nor grades were responsible for the condition effects on students' assessment of the classroom climate. There were no differences between pretest and posttest for those in control sections. The differences between pretest and posttest for those in the Level 1 Enrichment classes were significant, but the degree of change was not significant when contrasted to the control condition. There was a significant difference between the degree of change in the Level 2 Enrichment condition and the control condition. This Level 2 Enrichment effect suggests that the "add women and stir" approach to curriculum transformation in the sciences could have benefits if the additions constitute a sufficient percentage of course material. Because students' attitudes about women in science and society reiterate and reproduce widely held social attitudes about women, they may need to be addressed with sustained and complex challenges, such as those provided in women's studies courses. However, students' experiences with the classroom climate plausibly are more open to circumstances, because each course offers newly encountered and interpreted possibilities. The small but significant effect of WGS content suggests that students notice the focus on women in the content and that they interpret this as a signal of a positive classroom climate, if they receive at least 10 to 20 minutes a week of the enriched material.

There are several limitations to our study. Study variables did not include measures of the educational outcomes that may result from exposure to the new material, such as increased commitment to degree completion, increased degree aspirations, or increased career commitment. Moreover, the intervention at the heart of the study did not include classroom discussion of issues related to the new material. It is possible that even brief discussions would have consolidated students' learning and awareness about inequality in general, thereby promoting changes in attitudes as well as assessments of the classroom climate. Because the enriched material represented only a small fraction of students' coursework, our study is a very conservative measure of the possibilities for curricular innovations in a fully inclusive science classroom.

Nonetheless, our findings contribute in two important ways to knowledge about the promise and problems of integrating feminist scholarship into the sciences. We have provided evidence that adding WGS material to course content can warm the classroom climate for all students, women and men, and we have generated benchmark data for ecology by which to begin comparing students' attitudes toward women in science and society in ecology to those of students in other disciplines. In future research, it would be useful to explore the effects on students' long-term career goals of WGS-enriched science courses. Indeed, our findings in no way preclude the possibility that a WGS curriculum transformation initiative remains the surest route to diversity within the scientific community.

Wherever and whenever the biological sciences and WGS share educational goals and content, integrative initiatives can encourage commitments to gender equity in science, enliven discussions of course content, and enrich teaching and learning. Yet opportunities for scientists to learn or teach the new material are extremely limited. In a very real sense, our institutional status quo promotes scientists' ignorance of the processes and practices that lead to women's invisibility and marginality in science. There is no quick fix for this state of affairs; however, innovative educators working across disciplinary boundaries can make a very good start.

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NOTES

1. A review of a draft survey instrument by colleagues flagged five items as outdated. Four other items were dropped due to low item-total correlations.
2. The WiSS originally included 27 items, 15 of which were not specific to science and were dropped. Of the remaining 12, 3 were dropped due to low item-total correlations and 3 were flagged as outdated or worded ambiguously.
3. For a discussion of the use of repeated measures ANOVA with mixed models in SAS®, see Littell, Henry, and Ammerman (1998).

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