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Comparison of the Academic Achievement of First-Year Female Honors Program and Non-Honors Program Engineering Students

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ABSTRACT

The purpose of this study was to compare the academic achievement of first-year female engineering students based on participation, or lack thereof, in the honors program. A single research question was developed for this study: "Is there a significant difference in academic achievement of first-year female engineering Honors Program students and non-honors program students?" The problem for this study was that many students in the Freshman Engineering program at Purdue University believed that participation in an honors program damaged students' grade point averages with its challenging curriculum. This was especially true for beginning female students entering a traditionally male-dominated career field.

Data regarding first- and second-semester (thus also annual) cumulative grade point averages were collected for the 268 subjects. A t-test for independent samples was used to determine if a significant difference existed in grade point averages; the results indicated a significant difference in the academic achievement of the first-year honors and non-honors female engineering students. First-year female engineering students participating in the honors program earned significantly higher grades than first-year female engineering students who did not participate in the honors program for both semesters of enrollment. Results of this study concluded that enrolling in a more challenging curriculum did not negatively impact the academic achievement outcomes of high-achieving, first-year female engineering students at Purdue University.

INTRODUCTION

The Department of Freshman Engineering, recently renamed the Department of Engineering Education, is the entry point for all engineering students at Purdue University. Approximately 20% of all engineering students at Purdue are female, one of the highest populations of female engineering students in the country (National Science Foundation, 1999; Society of Women Engineers, 2001). Furthermore,

approximately 10% of all freshman engineering students participate in the Honors Program, based on Honors course enrollment.

The Freshman Engineering Honors Program offers high-achieving students an opportunity to embrace and accept new experiences through a challenging curriculum and complementary co-curricular activities. Very little research has been published concerning high-achieving female college students within a traditionally male-dominated field. Therefore, this study was completed to analyze the relationship between gender and achievement at the higher education level.

NATURE OF THE PROBLEM

Historically, Freshman Engineering courses enrolled approximately 18-20% females; however, this trend endured an overall decline from 1995 through 2001. The Schools of Engineering at Purdue University sought to increase the enrollment of this underrepresented group. The Honors Program in Freshman Engineering desired to assist this effort by effectively recruiting, enrolling, and retaining a greater percentage of the highest-ability females. It was believed that attracting these students to a welcoming honors program that offered a supportive environment, a challenging, practical application of engineering concepts, and a realistic view of the engineering profession would accomplish this goal. No Freshman Engineering Honors Program research concerning the impact of honors curricula and female students was found in a search dating back to the inception of the program. A primary focus for this study was the females' discovery of their significant minority status upon entering Freshman Engineering. Informal conversations revealed that the female students, once they began attending classes, often had tremendous feelings of isolation in being a small fraction of their class population compared to the male population. Additionally, the females' relative lack of familiarity with technical computer applications, such as MATLAB and equations in Microsoft Excel, regularly placed them at a disadvantage to the males. The primary problem addressed in this study was the female students' hesitancy in enrolling in the Honors Program given so many new and complex transitional issues they had to face; they feared the challenging courses would result in a significant decline in their academic performance (grades) or that the years of being touted as "smart" were only an illusion.

One justification for the study was a regular occurrence of high-achieving females rejecting enrollment in the Honors Program, fearing that the challenging curriculum would damage their grade point averages. Other academically talented women, as stated by Noble and Smyth (1995), ". . . feel that they must choose between their academic talent and 'being found attractive and socially valuable'" (as cited in Nolden & Sadlacek, 1998, p. 106). We used this study to inform honors-eligible females of the true versus perceived challenges of enrollment in the Honors Program.

The Honors Program sought to provide a personally supportive and encouraging environment as well as a curriculum that was appropriately challenging. In *See Jane Win*, Sylvia Rimm (1999) stated, "Ideally women will be assertive enough not only to survive in what were formally male-dominated fields but also to modify those

fields to make them psychologically more comfortable for both men and women" (p. 185). The program leadership attempted to establish this concept as the environmental norm. The program underwent enhancements that included the addition of more hands-on/application-based projects, visits to engineering industry sites, co-ed team assignments, and the promotion of a strong peer group.

FRESHMAN ENGINEERING HONORS STUDENTS AT PURDUE UNIVERSITY

Freshman Engineering Honors Program students were defined as those who earned a minimum 1360 SAT or 31 ACT, ranked in the top 10% of their high school graduating class, and voluntarily chose to participate in the honors program. Additionally, a few students who did not meet the minimum criteria for the Honors Program were permitted to petition into the program through a formal interview with one of the Honors Program directors. These students were informally considered for the program based on their level of motivation and desire for challenge. In the years selected for this study, approximately 160 students participated in the program each year. All females enrolled in Freshman Engineering but not in the Honors Program (regardless of qualification for the Program) were included in the "non-honors" sample.

Although the Honors or Honors-designated courses might have included accelerated or enriched components, the Honors and non-honors courses used the same texts and covered the same topics. An accelerated course was one that progressed at a faster-than-typical pace and/or included topics of a higher-level course, such as combining the content of two courses into one. Schiever and Maker (1991) state, "Enrichment refers to richer and more varied educational experiences, a curriculum that is modified to provide greater depth and breadth than is generally provided" (as cited in Davis & Rimm, 1994, p. 105). Often, both groups of courses were taught by the same instructor. Also, a few Honors-designated courses allowed enrollment by non-honors students.

LITERATURE REVIEW

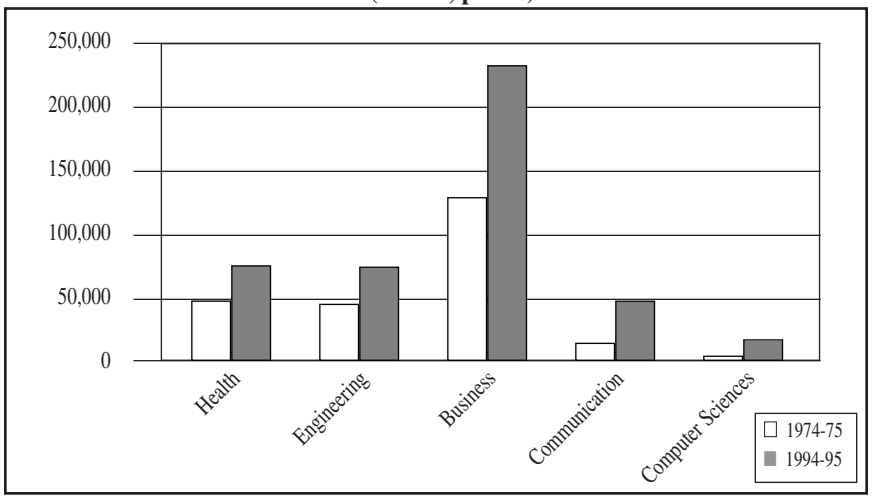
The topic of gifted students is one that has received substantial attention in the past; however, it primarily focused on elementary, middle, and high school students. This was substantiated by a 100-page annotated bibliography from the National Research Center on the Gifted and Talented (Logan et al., 1997). "The overwhelming weight of the literature on 'gifted learners' deals with the K-12 years; little attention is given to postsecondary efforts" (Robinson, 1997, p. 217). Few references were available concerning high-ability students in higher education. ". . . [D]espite the fact that most investigators are situated in institutions of higher learning—[they have] has not given much thought to gifted students in their own backyards" (234).

TRADITIONALLY MALE-DOMINATED CAREER FIELDS

During the launch of Title IX in the 1970's, female college enrollment almost reached equality with enrollment of males. However, females' enrollment in specific

programs was still discriminatory; Title IX alleviated this situation. Barriers to females' matriculation into traditionally male-dominated fields, such as science, engineering, and technology, were removed (Cohen, 1998, p. 199). Notable increases in female degrees are illustrated in Figure 1.

Figure 1 Historical Difference of Female Enrollment in Traditionally Male-Dominated Fields (Cohen, p. 323)



WOMEN AND ENGINEERING

Engineering historically and presently remains one of the most male-dominated fields with approximately 80% of bachelor's degrees conferred on men (Cohen, 1998). Gender played a large role in Purdue's Freshman Engineering Honors Program primarily because engineering had and still has one of the smallest female populations of all majors in higher education. Generally, engineering programs are approximately 85-95% male; ". . . males continue to predominate by a 6 to 1 . . ." ratio in expressing an interest in majoring in engineering (Davis & Rimm, 1994, p. 317). Likewise, only 2.7% of female college freshman planned to major in engineering, and only 2.4% indicated engineering as a probable career choice. The National Science Foundation reported that "Only . . . 4% of all Ph.D. engineers are women" (as cited in Davis & Rimm, p. 314).

HISTORY OF HIGH-ABILITY STUDENTS AND HONORS PROGRAMS

Literature addressing the historical background and current trends in post-secondary honors programs was limited in the 1990's. This phenomenon seemed ironic considering that "gifted adolescents become gifted adults" (Bireley & Genshaft, 1991, p. 187). "Surprisingly few statistics are available about the numbers of students or proportions of colleges involved" (Robinson, 1997, p. 228). A large segment of

this research focused on prospective college students, admission requirements, and standardized test scores. This research was relevant to the Freshman Engineering Honors Program because it not only focused on the eligible program population but also distinguished differing types of high-ability students.

HIGHER EDUCATION AND SELF-ESTEEM

A major factor in the progress of females through higher education is how they interpret and internalize success and failure. "When girls bring home the A [grade], they attribute their success to effort. When girls get bad grades, they attribute failure to lack of ability: I'm just not smart in math [or science]" (Sadker & Sadker, 1994, p. 96). Conversely, males attribute success to ability; failure is transferred to or blamed on others.

First-year females and males from the top of the class reported equal estimations of their own intelligence. "But by their sophomore year of college the women had lowered their opinions of their own intellect while the men had not. By the time these top students were college seniors, not a single female valedictorian still thought her intelligence was 'far above average' even though most were planning to enter graduate and professional schools" (Sadker & Sadker, 1994, p. 159). Numerous researchers stated that these impacts ". . . may stem from stereotypes that may affect academically talented women more negatively than men [and that] include: fear of success, lack of assertiveness, avoidance of quantitatively-based majors and careers, and external vs. internal attribution of ability" (as cited in Nolden & Sedlacek, 1998, p. 107). "Although the women continued to earn high grades in college—slightly higher than the men, in fact—they saw themselves as less competent" (Sadker & Sadker, 1994, p. 159).

"The first *B* grades . . . may signal a significant problem for the student who does not know how to study challenging material, how to resist the temptations of too much socializing, or how to ask for help. Rather than eliciting a sense of challenge, such a grade may elicit a sense of failure in a student who has never received such grades before" (Haas, 1992; Robinson, 1997, p. 224). This occurrence is typical in a first-year engineering program where students are faced with one of the most demanding and challenging curricula in higher education. This issue is compounded for female students who generally internalize failure (Sadker & Sadker, 1994).

GENDER INEQUALITIES

National organizations have taken notice of gender inequalities, specifically in relation to curriculum. "The National Coalition for Women and Girls in Education has repeatedly noted that the National Education Goals [of 1991] cannot be met without specific attention to girls" (American Association of University Women, 1992). Females consistently earned higher test scores and grades than males in junior high levels, but this trend continuously deteriorated within the high school, university, and graduate school levels. Causes could include unequal prerequisite instruction, lack of role models, and gender bias of the tests. In *Failing at Fairness: How Our Schools Cheat Girls*, evidence was presented that bias in teaching grew with each level of

education, becoming the most blatant in undergraduate and graduate courses (Sadker & Sadker, 1994).

Sadker & Sadker (1994) stated, ¨Whether one looks at preschool classrooms or university lecture halls, at female teachers or male teachers, research spanning the past 20 years consistently reveals that males receive more teacher attention than females" (p. 118). Gender discrimination can still be found today in textbooks, teacher instruction, classroom interactions, exams, standardized tests, and scholarships.

Teacher/student interactions also displayed injustices. Instructors were more likely to call on male students and give them more structured and positive feedback. Professors ". . . make more eye contact with men, wait longer for them to answer, and are more likely to remember their names" (Sadker & Sadker, 1994, p.171). Teachers were more likely to ask girls easier questions, give boys more time to answer, "protect girls from mistakes, avoid criticizing them, take care not to hurt their feelings, and reward them for dependency" (Horgan, 1995). "From grade school to graduate school, girls receive less teacher attention and less useful teacher feedback. This imbalance in instructional attention is greatest at the college level" (Sadker, Sadker, Fox, & Salata, 1994). These actions had strong detrimental effects on women. Female students were more likely to become voiceless, "...develop higher expectations of failure, and lower self confidence" (AAUW, 1992). In fact, "Women's silence is loudest at college, with twice as many females voiceless" (Sadker & Sadker, 1994, p. 170).

As females became the majority collegiate population, some might have perceived the issue of gender discrimination to be resolved. Sadker and Sadker (1994) indicated the persistence of discrimination. "Girls are the majority of our nation's schoolchildren, yet they are second-class educational citizens. The problems they face—loss of self-esteem, decline in achievement, and elimination of career options—are at the heart of the educational process. Until educational sexism is eradicated, more than half our children will be shortchanged and their gifts lost to society" (p. 1).

WOMEN IN HONORS

Davis and Rimm (1994) discussed the high-ability female student population: "The education of gifted women has been a low priority throughout history, a matter that has led to wholesale female underachievement. Many gifted girls have been, and continue to be, systematically discouraged by peers, family, and sometimes teachers and counselors from using their talent in productive ways" (p. 313). Although there was slim research addressing the issues of gifted/talented/honors students at the higher education level in the 1990's, even less research existed concerning high-achieving/high-ability female engineering students. As Robinson (1997) stated, "Attention to the gifted learner at the college level represents uncharted territory and a new frontier" (p. 217). Research that did exist illustrated why proper support is necessary for high-ability female students (Maker, 1986; Perrone, 1986). Nancy Robinson (1997) stated, ". . . college women who previously have been in the most intensive educational programs for gifted students hold higher career aspirations. . . suggesting that the conjunction of educational support and career choice is a critical one" (p. 226).

HONORS CURRICULUM

The Freshman Engineering Honors Program at Purdue University utilized designated courses employing both acceleration and enrichment. These courses were designed to accomplish the goals described by Robinson: ". . . combine elements both of acceleration—by teaching to higher order levels of conceptualization and discourse—and enrichment—by covering more material than is assigned in nonhonors courses" (Robinson 1997, p. 234).

SUMMARY

Research on women in higher education has focused more on differentiation between genders than on the challenges and successes of high-ability females. Therefore, this research study on Honors and non-honors female engineering students should not only aid honors program leaders and academic advisors in working with high-ability students but also supplement research concerning high-achieving women in higher education.

METHODOLOGY & PROCEDURES

The population for this study included all current first-year female engineering students enrolled in Freshman Engineering at Purdue University. This population generally accounted for 16-20% of the females enrolled in the engineering program.

For each of the two selected sample groups, grades and grade point average data were obtained from the Purdue University Office of the Registrar's historical database. The samples were categorized into two distinct segments encompassing the 2000-01 academic year. The first sample was the females participating in the Honors Program for both the fall and spring semesters. The second sample included females who were not participating in the Honors Program during the selected academic year. Non-participation in the program was traced to ineligibility or lack of interest. A third sample of females who either petitioned into the Honors Program or withdrew from it following the first semester was excluded from this study. It was determined that exclusion of this sample would provide more homogeneous results and therefore assist in determining future course placement policies and program eligibility requirements. At the time of this study, it was unknown why these females chose not to participate or why other females found participation in the honors program so important or meaningful.

Freshman Engineering Honors Program data indicated that 42 females participated in the Honors Program each semester. Non-honors females numbered 226 for the fall and 222 for the spring semester. The numerical differences in non-honors females for the two semesters were attributed to university withdrawals and changes in academic majors. The excluded sample of students who withdrew from or petitioned into the Honors Program consisted of seven students. In summary, the final sample for the fall term equaled 268 while the spring term consisted of 264.

DATA COLLECTION & ANALYSIS

Academic data for the selected samples consisted of grade point averages. All data were collected through the Office of the Registrar; therefore, the data were considered reliable. Data were collected for all first-year female engineering students and were categorized based on participation (or lack thereof) in the Honors Program for the fall and spring semesters of the 2000-01 academic year. Fall- and spring-semester grade point averages as well as cumulative annual GPAs were obtained for both samples.

Data were analyzed through the use of t-tests for independent samples and calculated with Excel spreadsheets. A two-tailed t-test for independent samples was used to determine if there was a difference in grade point averages of the two samples. The level of significance was established at the .05 level.

LIMITATIONS

Since Honors Program participants were required to enroll in only seven credit hours of Honors or Honors-designated courses, participation in the Honors Program could not be linked directly to overall academic achievement. Significant positive or negative academic impacts might in fact be attributed to enrollment in a general course. Also, some Honors-designated courses were open to enrollment of non-honors students, so the academic outcomes of those courses could not be directly attributed to Honors Program participation. Further, some students might have had the capability to be successful in higher-level courses, but because they were not eligible for the Honors Program, they did not have the opportunity to demonstrate that ability. Finally, students eligible for the Honors Program matriculated with higher standardized test scores and class rank than the vast majority of the student population. Therefore, it was assumed that those students' higher admissions data would potentially correlate to higher academic achievement in college regardless of enrollment in a higher-level curriculum.

RESULTS

The final analysis consisted of three t-tests for independent samples comparing the grade point averages of the two samples following their first and second semesters of enrollment as well as the cumulative average for the academic year in Freshman Engineering. Semester data were presented to determine if a single semester's curriculum would have an overwhelming effect on the cumulative results. The cumulative results from the 2000-01 academic year were tested. Figures 2 and 3 illustrate the differences in grade point averages for Honors and non-honors students for the fall and spring semesters, as well as the cumulative academic year.

FALL 2000 TERM

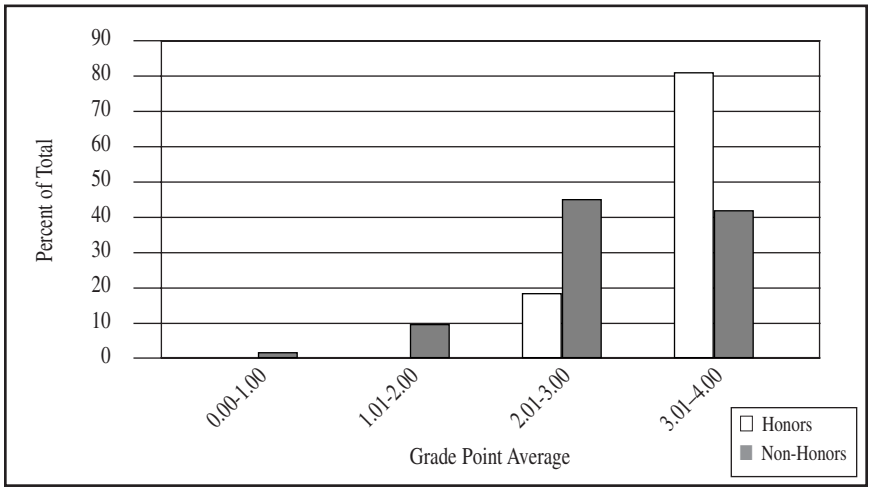
For the first-year female Engineering Honors Program students (n = 42), the mean grade point average for the fall 2000 semester was 3.59 while the non-honors sample (n = 226) mean grade point average was 2.94 based on a 4.00 scale. At the

.05 level of probability, the critical value of t was 1.9689 while the p value was 2.9969^{-08}. There was a significant difference in the academic achievement outcomes of first-year female engineering Honors and non-honors program participants.

SPRING 2001 TERM

For those first-year female Engineering Honors Program students (n = 42), the mean grade point average for the fall 2000 semester was 3.26 while the non-honors sample (n = 222) mean grade point average was 2.67 based on a 4.00 scale. At the .05 level of probability, the critical value of t was 1.9691 while the p value was 1.57261^{-05}. There was a significant difference in the academic achievement outcomes of first-year female Engineering Honors Program and non-honors participants during the spring 2001 semester (Figure 2).

Figure 2 Spring 2001 Incremental Grade Point Averages



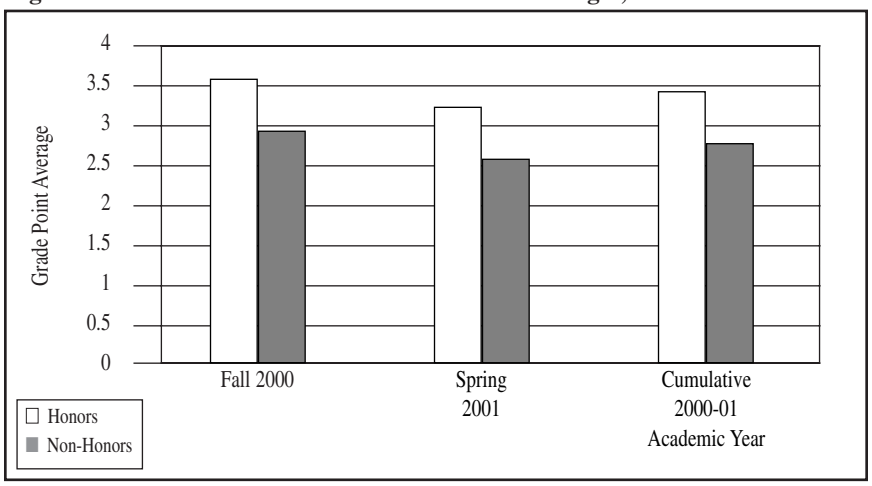
CUMULATIVE ACADEMIC YEAR 2000-01

Regarding cumulative academic achievement results for the first-year female Engineering Honors Program students (n = 42), the mean grade point average for the 2000-01 academic year was 3.42 while the non-honors (n = 227) mean grade point average was 2.80 based on a 4.00 scale. At the .05 level of probability, the critical value of t was 1.9689 while the p value was 3.20945^{-08}. There was a significant difference in the academic achievement outcomes of first-year female engineering Honors and non-honors participants for the 2000-01 academic year (Figure 3).

DISCUSSION

The purpose of this study was to determine whether there was a significant difference in academic achievement between first-year female engineering Honors and non-honors program participants. The literature concerning females in traditionally

Figure 3 Honors and Non-Honors Grade Point Averages, 2000-01



male-dominated academic fields stated the females were typically an underrepresented population and were required to endure educational environments that catered primarily to male students. The body of research regarding higher education honors programs was relatively slight in the 1990's when the Purdue Freshman Engineering Honors Program was designing this study; the research then stated that high-ability students do need to be appropriately academically challenged in order to remain engaged in academic pursuits and to fulfill their intellectual, career, and life-long potential. Therefore, the results of this study aided the Honors Program leadership in expanding and enhancing program components based on gender needs. As Nolden & Sedlacek (1998) stated, ". . . there are differences between men and women that should be taken into account when developing programs for academically talented students" (p. 109).

As the results indicated, females participating in the Honors Program achieved at higher academic levels than did females who did not participate in the Honors Program. However, the higher academic performance cannot be attributed solely to Honors Program participation; it could at least be partially credited to those students' higher admission qualifications and likely superior academic preparation and motivation.

RECOMMENDATIONS FOR FURTHER RESEARCH

Further studies are needed to determine if those students who were eligible for the Freshman Engineering Honors Program but for whatever reason chose not to participate achieved at the same level as the Honors Program participants. Such a study could determine if engineering students who begin college with the same academic background and preparation achieve at consistently higher levels or if their new environment and peer group have a significant impact on their academic achievement.

CONCLUSIONS

In addressing the stated research question, this study concluded that first-year female engineering students who participated in the Honors Program achieved at significantly higher academic levels than the non-honors participants. This was illustrated by the consistently higher semester and cumulative grade point averages of the Honors Program participants. The difference in mean grade point average for the 2000-01 academic year was 0.62, for the fall term 0.65, and for the spring term 0.59. Therefore, on average the first-year female Engineering Honors Program participants earned a higher grade point average than the non-honors students by more than half of a letter grade.

IMPLICATIONS

The results and conclusions of this study indicated that first-year female students who participated in the Freshman Engineering Honors Program had significantly and consistently higher grade point average (> .50) than non-honors females. While the study did not prove (and was not designed to prove) that the Honors Program was the cause of the higher grade point averages, it does imply that female students need not fear endangering their GPAs when they participate in the Honors Program.

The results of the current study provided valuable data to faculty, advisors, and students concerning the potential impact of participation in the Honors Program. As indicated through the literature review, late adolescent females too often fear risk-taking such as enrolling in a challenging curriculum of a demanding academic department at a world-renowned research university. These results provided faculty and advisors with credible evidence to assist high-ability females in deciding to enroll in the Honors Program.

REFERENCES

American Association of University Women. (1992). Three perspectives on curriculum. *How Schools Shortchange Girls.* Washington, DC: American Association of University Women Education Foundation.

Bireley, M., & Genshaft, J. (Eds.). (1991). *Understanding the gifted adolescent: Education, developmental, and multicultural issues.* New York, NY: Teachers College.

Cohen, A. M. (1998). *The shaping of American higher education.* San Francisco, CA: Jossey-Bass.

Davis, G. A., & Rimm, S. B. (1994). *Education of the gifted and talented* (3rd edition). Boston, MA: Allyn and Bacon.

Haas, P. F. (1992). Honors programs: Applying the reflective judgment model. *Liberal Education, 78*(1), 20-23.

Horgan, D. D. (1995). Girls in the classroom and beyond. *Achieving Gender Equality.* Boston, MA: Allyn and Bacon.

Logan, K. S., Rizza, M. G., Gubbins, E. J., Gavin, M. K., Kloosterman, V. I., Schuler, P. A., Vahidi, S., & Suroviak, C. E. (1997). A compendium of research-based information on the education of gifted and talented students. *The National*

Research Center on the Gifted and Talented, pp. 1-101. Retrieved May 30, 2001, from the National Research Center on the Gifted and Talented website on the World Wide Web: PDF: http://www.gifted.uconn.edu/nrconlin.html

Maker, C. J. (Ed.). (1986). *Critical issues in gifted education.* (Vol. 1). Austin, TX: ProEd.

National Science Foundation. (2000). *Full-time first-year undergraduate enrollment in engineering programs, by sex, and by race/ethnicity: 1987-97.* Retrieved February 2, 2002, from the National Science Foundation website on the World Wide Web: PDF: http://www.nsf.gov/sbe/srs/nsf00327/start.htm

Nolden, D. & Sedlacek, W. E. (1998). Gender differences in attitudes, skills, and behaviors among academically talented university freshmen. *Roeper Review, 21* (2), 106-109.

Perrone, P. (1986). Guidance needs of gifted children, adolescents, and adults. *Journal of Counseling and Development, 64,* 564-565.

Rimm, S. (1999). *See Jane win.* New York, NY: Crown.

Robinson, N. M. (1997). The role of universities and colleges in educating gifted undergraduates. *Peabody Journal of Education, 72*(3-4), 217-236.

Sadker, M., & Sadker, D. (1994). *Failing at fairness: How our schools cheat girls.* New York, NY: Touchstone.

Sadker, M., Sadker, D., Fox, L., & Salata, M. (1994). Gender equity in the classroom. In J. I. Goodland & P. Keating (Eds.). *Access to Knowledge: The Continuing Agenda for Our Nation's Schools* (pp. 321-328). New York, NY: College Board.

Society of Women Engineers. (2001). *Statistics about women in engineering in the USA: Undergraduate enrollment in engineering.* Retrieved February 2, 2002, from the Society of Women Engineers website on the World Wide Web: http://www.swe.org/SWE/ProgDev/stat/stathome/html

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