CIRTL Diversity Institute Literature Review

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CIRTL welcomes your feedback! Your input is critical to helping us improve this resource on classroom practices and the profile of underrepresented students pursuing STEM majors. Please take a minute to give us your thoughts on the Literature Review by filling out our online feedback form, available on the Diversity Resources website at: http://www.cirtl.net/DiversityResources/feedback/.

(2003). Communication. Retrieved September 15, 2004 from http://honolulu.hawaii.edu/intranet/committees/FacDevCom/guidebk/teachtip/teachtip.htm#communication

Summary: This section discusses inclusive communication practices for instructors. From basic politeness to examining assumptions and reevaluating course designs, this web site is a simple primer for instructors who are interested in creating a welcoming environment. The piece reprints the work of Barbara Gross Davis, Dineh Davis, Ruth Lieban, Gerald H. Ohta, Anne Sing, Hiroyuki Nagahara, Grace Tsutaoka, Thelma McLachlan, Vicki Ritts and James R. Stein. Other sections of this site include: 7 principles of good practice, communication, human development and how people learn.

Recommendation(s): Although much of this web site deals with inclusive language, the basis for creating a positive environment is making a commitment to examine any stereotypes that one may hold and question them. Although courtesy is important, the communication tools presented in this web site are intended to go beyond polite terminology. Developing awareness of what he or she is saying "between the lines"- verbally and non-verbally- can help an instructor improve his or her rapport with students, leading to improved relationships in the classroom.

Extended summary: "Culturally Effective Communication" defines ethnocentrism, discrimination, stereotyping, cultural blindness, and cultural imposition. The definitions allow an instructor to become a "culturally competent communicator" by "identify(ing) the belief systems of both the student and teacher to spot blocks to communication." "Diversity and Complexity in the Classroom" discusses ways of creating inclusive classrooms. Stereotyping is strongly discouraged. An instructor should view each student as an individual and treat him or her with respect. The instructor should attempt not to project any feelings, experiences, or expectations relating to any particular group onto any student. The author recommends that instructors "rectify any language patterns or case studies that exclude or demean any group," be sensitive to terminology and any aspect of the course that students are uncomfortable with, and discuss diversity at department meetings. The web site includes strategies for overcoming

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stereotypes and biases while leading lectures and discussions, advising, designing course content, and administering exams and assignments.
In "Do's and Don'ts of Inclusive Language," the authors give guidelines for addressing disabled students and using gender neutral language. "Six Ways to Improve Your Nonverbal Communications" discusses eye contact, facial expressions, gestures, posture and body orientation, proximity, paralinguistics and humor. The web site discusses how these activities can enhance classroom instruction.

Keyword(s):
Advising
Minorities
Women
Class discussion
Course content and curriculum
Culture
Communication
Inclusively
Stereotypes

(2003). Fostering diversity through excellence and equity. Retrieved October 1, 2004 from http://www.provost.utoronto.ca/English/Companion-Paper-6---Fostering-Diversity-Through-Excellence-and-Equity.html

Summary: This web site presents a candid picture of the history of diversity in higher education at the University of Toronto. It acknowledges both the impressive progress that has been made and the ongoing need for change in academic culture. The institution emphasizes that it is unwilling to compromise its academic standards, but still cultivates a diverse environment. The web site differs from most U.S. diversity web sites in 1) their consideration of men as an under-represented group in some fields, and 2) their emphasis on international students.

Recommendation(s):
Extended summary: When it was first founded, the University of Toronto admitted no women and almost no members of visible minorities. In the 1880s, women were finally admitted; many of the first female Ph.D.s pursued degrees in the sciences. Today, the University's undergraduate population is 57% female and 47% "visible minority". (In Canada, there is a legal distinction between visible and "invisible" minorities.) The Greater Toronto area is the most ethnically diverse metropolitan area in Canada, and the University population reflects that fact. However, African-American and Native American students are still underrepresented. The University's definition of "visible minority" includes students from other nations, including Arab and Asian countries.
The University urges departments to practice "determined, hard-working, pro-active and

wide-ranging recruitment. [to adopt] "best practices" for recruiting visible minority and other candidates from under-represented groups, and [to be] considered and thorough in choosing the best candidate." The author cites a study from the American Association of Colleges and Universities that disproves the societal perception that a Ph.D. equals an easy job search for minority candidates. Female or minority faculty may face a "cold" or un-collegial climate or inequity in faculty promotions. LGBTQ faculty express concerns about homophobia. Diversity also extends into the intellectual realm. The author discusses the movement towards incorporating feminist and "non-Eurocentric" perspectives into classroom discourse. These approaches have taken hold in the social and health sciences more than in the physical sciences.
The University's goals, which are listed at the end of the text, focus on 1) hiring faculty and staff from under-represented groups, 2) increased disability accommodations, 3) achieving a student body representative of the Toronto area by 2010, and 4) creating "collegial" classroom climates and inclusive curricula. The author states clearly that the University does not intend to compromise its academic admission standards and believes that academically talented minority candidates are not in short supply.

Keyword(s):
International students
Minorities
University climate
Faculty
Recruitment
Retention
Discrimination
Culture

(2004). Teaching and learning @ UW: A handbook for teaching assistants. Retrieved September 15, 2004 from http://www.washington.edu/doit/Stem/

Summary: This web site is an excellent resource for instructors who have questions regarding accommodating disabled students in their classrooms. The site discusses rights and responsibilities, strategies for accommodation and inclusive classroom design, and case studies.

Recommendation(s): Virtually every aspect of a course can benefit from increased accessibility. These alterations often improve the experience of all students in the class by allowing more flexibility in their learning. Distance learning courses, internships, writing assignments and tests, videos, field assignments, science labs and course web pages can all be made accessible for students.

Extended summary: This web site informs instructors how they can make their courses more accessible to students with disabilities. Instructors should integrate "universal design" principles (such as equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, size and space for approach and use) in designing classrooms and academic activities. "Universal design means the design of instructional materials and activities that make the learning goals achievable by individuals with wide differences in their abilities to see, hear, speak, move, read, write, understand English, attend, organize, engage, and remember. Universal design for learning is achieved by means of flexible curricular materials and activities that provide alternatives for students with differing abilities. These alternatives are built into the instructional design and operating systems of educational materials-they are not added on after-the-fact." Examples of benefits from creating inclusive teaching methods for one group of students, as outlined in the website, indicate that other students can also benefit from such classroom practices. The website organizes solutions by type of environment (lab, etc.) as well as by type of disability. It explains the different types of disability and the associated accommodations. Case studies and a FAQ are provided. Links to various publications, videotaped resources, specific disability resources and other websites are also included.

Keyword(s):
Accessibility
Disability
Inclusively
Technology

AAAS. (2004). Making strides towards structural reform. Retrieved September 20, 2004 from http://ehrweb.aaas.org/mge/home.htm

Summary: This website, funded by the National Science Foundation (NSF), contains information on minority opportunities in graduate education in science, mathematics and engineering.

Recommendation(s):
Extended summary: This website, funded by the National Science Foundation (NSF), contains information on minority opportunities in graduate education in science, mathematics and engineering. The website contains links to special reports on increasing diversity in colleges, especially within SME fields. It also contains links to "information on minority graduate education issues and graduate school funding opportunities." The website provides an "annotated bibliography of articles and books on SME minority graduate education." The purpose of this website is to encourage faculty members and researchers to strive towards making the classroom and college environment more supportive of the needs of all students.

Keyword(s):
Mathematics
African-American
Latino
Minorities
Career
Graduate school
Networking
Science

Alexander, B. B., Burda, A. C., & Millar, S. B. (1997). A community approach to learning calculus: Fostering success for underrepresented ethnic minorities in an emerging scholars program. *Journal of Women and Minorities in Science and Engineering, 3*, 145-159.

Summary: The Wisconsin Emerging Scholars (WES) program offers a more culturally oriented approach to the study of calculus. Students taking Calculus I were recruited to participate in sections comprised of half underrepresented ethnic minority students and half white students. Minority students in the special sections generally performed better than minority students in the regular sections, and the experience for everyone involved was usually positive. Problems did arise when the section contained only a handful of minority students or only students of one particular minority.

Recommendation(s): Many minority students drop out of science and math programs after taking Calculus or never enter such programs in the first place. To prevent this, Calculus should be taught in a more culturally relevant method with emphasis on student centered learning and group problem solving. Creating special emerging scholars programs can help accomplish this goal.

Extended summary: Alexander, Burda, and Millar argue that certain minorities are underrepresented in the STEM disciplines in part because they fail or are afraid of Calculus. Students who fail to utilize group problem solving strategies often fail at Calculus, and many underrepresented minority students either lack a cultural background that emphasizes group collaboration or feel too isolated to find groups. Emerging scholars programs can be used to alleviate these problems.
Over several semesters, students taking Calculus I, II and III were recruited to take an extra 2 credit workshop comprised of half underrepresented ethnic minority students and half white students. In practice, the desired number of underrepresented students could not always be recruited so the ratio was rarely 50-50. Similarly, recruiting a diverse group of minority students to a particular section was also difficult, sometimes leading to problems. In one instance, a section was half white students and half African

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American students. Both groups became very isolated and felt as if the class was all about race and not about Calculus.
Nevertheless, students in the WES sections showed an increase in performance, and most felt it was a good experience. The section taught students group problem solving skills, a trait that will be necessary for their future studies. It also allowed students to feel like they are not "in it alone."

Keyword(s):
Mathematics
Minorities
Retention
Communication
Collaborative learning
Active learning
Group work

Alexander, B. B., Foertsch, J., Daffinrud, S., & Tapia, R. (1998). *The Spend a Summer with a scientist (SaS) program at Rice University: a study of program outcomes and essential elements for success.* Madison, WI: The LEAD Center, University of Wisconsin-Madison.

Summary: The Spend a Summer with a scientist (SaS) program offers paid summer internships to underrepresented minority graduate and undergraduate students which include research experience with a mentor/advisor as well as mentoring experience with high school students. The program has been successful at both recruiting and retaining minority students in STEM fields.

Recommendation(s): Summer programs like SaS should be replicated to encourage minority students in STEM. The SaS program can serve as a guide of "what to aim for." While programs may take several years to become successful, they are worth it. The most important factor is to have administrators who are patient and flexible.

Extended summary: Alexander et al. argue that a critical disparity between minority and non-minority students in STEM disciplines occurs between graduating from college and enrolling in graduate school. The SaS program emphasizes a two pronged effort to overcome this disparity. The first effort is to provide undergraduates with research experience and mentoring opportunities in a community of underrepresented students. In addition, graduate students are given financial and social support to continue their studies.
The program succeeds with undergraduates by giving students motivation who would have otherwise never even thought of themselves as "graduate school material." It succeeded with graduate students by encouraging them to continue their efforts.

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Central to both successes was the role of the program director. With someone at the helm who had the influence of fellow faculty as well as institutional leverage, the program and its participants were seen as a legitimate part of the larger research community. Students were given the chance to form a mentored relationship with this individual, helping them to share this feeling of importance.
The program focused students' participation around research projects. These projects were integral to the success of the program because they allowed students to have meaningful experiences with faculty while working on real problems and being introduced to the world of academia. More generally, a sense of community was created between the students that allowed for them to share experience with students of similar backgrounds while having numerous opportunities to both mentor and be mentored.

Keyword(s):
Retention
Graduate school
Minorities
Undergraduate
Career
Mentoring

Alha, K., & Gibson, I. (2003). Using ICT to improve the gender balance in engineering education. *European Journal of Engineering Education, 28*(2), 215-224.

Summary: This paper describes a seminar that took place at Oulu Polytechnic in Finland on the topic of distance learning (known as ICT in Europe) and its effects on the representation of women in engineering in many countries. ICT-based teaching "permits comprehensive use of resource-based learning, provides flexibility in learning and facilitates wide support for individual communication and networking." The authors consider ICT advantageous for women in technical fields.

Recommendation(s): Female engineers and scientists should develop a "strong and influential presence in the early secondary school years in order to inform and encourage students of the wider career opportunities offered by an engineering/technological education." Professors should emphasize "interdisciplinary and innovative aspects of engineering" in addition to the technical content.

Extended summary: The paper first compares the participation rates of women internationally in engineering fields. The data indicate that women are generally less represented in engineering in most countries relative to science and mathematics/computer science. The authors state that cultural and social differences are responsible for the different participation rates. Women in several countries are beginning to enter engineering due to increased job opportunities. Gender stereotypes

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are established in secondary schools; engineering and technology are depicted as male oriented fields.

Career choices of women were influenced by career advisors and by school visits from university and professional engineering organizations. Career advisors usually discouraged women from pursuing a career in engineering, as indicated by a survey conducted on female students in third year engineering programs. Also, math and science (especially physics) skills at secondary school played an important role in students' decision to enter the field of engineering.

ICT, unlike traditional pedagogical methods, encouraged women at the Open University in the UK to enter the field of engineering. Women prefer the flexible learning environment and the "confidentiality of teacher/student communication that e-learning offers." An increasing number of women have enrolled for new courses and degrees introduced through ICT such as biomedical engineering, bioelectronics and general engineering. The students consider these courses to be job-enhancing opportunities.

The authors discuss at length various programs and networking organizations that exist for female engineers in Europe. They also quote supportive testimony from an employer and from female students on the positive aspects of being a female engineer.

Mentoring and networking programs offered online by some of the European organizations were beneficial to female students. Female students felt little discrimination on the basis of their gender in these online forums. Such forums also allow for surveys and research on gender issues.

The authors note that instructors feel that ICT-based teaching is more time consuming. Hence, it is possible that the most qualified instructors will opt for classroom-based teaching. The authors question whether ICT-based learning is indeed as good as classroom-based learning.

One critique of this article is that removing women from the pressures of a mostly male academic environment and providing them with confidential e-mail communication with professors may not prepare them for professional interaction with men. In addition, as the article mentions, accommodations for women's family responsibilities must, in the end, rest with their future employers. If the employers are not amenable to change, women, especially in Eastern Europe, may not be able to follow up on their career potential. If women feel that they must go online in order to find discrimination-free environments, what does that say about the traditional classroom?

Keyword(s):

Women
Special programs
Technology
Engineering

Alldredge, J. R. (2003). *Association of course performance with student beliefs: An analysis by gender and instructional software environment.* Paper presented at the Third Conference of the European Society for Research in Mathematics Education, Bellaria, Italy.

Summary: This paper confirms other researchers' ideas (Rosser 1993) that women will learn more effectively in scientific environments that emphasize context. It also notes that women are more anxious than men are about their ability to succeed in math. However, the study shows that math courses can have an equalizing effect in which people's grades are not related to their confidence by the end of the course. In other words, students with low self-confidence in math can still earn high grades. However, math anxiety does adversely affect female students' scores. This effect can be ameliorated by choosing context-oriented instructional software.

Recommendation(s): Include a combination of context-based and theory-based approaches in math and science teaching in order to appeal to both men's and women's preferred learning styles.

Extended summary: The authors examined the following research questions: "1) Is there an association between pre-course beliefs and course performance? 2) Does evidence of association remain stable throughout the course? 3) Does the association differ for females and males? 4) Does the association depend on the instructional software used?"
The experiment took place in an introductory algebra-based statistical methods course. Two-thirds of the students were female and the class was academically diverse. Both sections had the same instructors and used the same textbook. The course sections were divided into two groups. Each group used a different instructional software package. The first instructional software, ActivStats, places a greater emphasis on context than is traditional in statistics courses. The second software, CyberStats, is more mathematically abstract.
The survey measured general confidence, math concern, previous math performance, and gender. The authors developed the first two variables, General Confidence and Math Concern, through statistical factor analysis. General Confidence correlated with grades at the beginning of the course, but this relationship diminished with increasing student competence. For female students, confidence was related to course grades only when the CyberStats (abstract) software was used. On the other hand, male students' confidence was related to their grades only when the ActivStats (applied) software was used. This difference indicates that a combination of approaches can accommodate the academic preferences of both genders and is preferable to either approach used alone.
The authors found that students with higher Math Concern performed less well on exams, even after adjusting for SAT scores. Using ActivStats (the contextual program) reduced the effect of Math Concern on women's performance.

Keyword(s):
Technology

Mathematics
Learning styles
Women

Alters, B. J., & Nelson, C. E. (2002). Perspective: Teaching evolution in higher education. *Evolution, 56*(10), 1891-1901.

Summary: Traditional science teaching methods, which view students as the recipients of information rather than as active participants in learning, often fail in addressing misconceptions about science. This is especially true when professors are teaching concepts such as evolution, where students are likely to have preconcieved ideas about the subject. Professors should put science in context using historical examples and visual aids, address common misconceptions, and involve students in discussions that encourage them to think critically.

Recommendation(s): Teaching science without sufficient context encourages rote memorization and poor retention of course material. It is important to understand students' existing perspectives, some of which are based in popular culture and others of which are based in superseded concepts. Well-written multiple choice questions can isolate these misconceptions. The authors also recommend putting science in a historical context, assigning concept maps as homework, reducing content in favor of in-depth learning, teaching critical thinking, and understanding the importance of religion to students.

Extended summary: Faculty who view their teaching as content transmission may not realize the extent to which students forget lecture material. Students often retain as little as 20% of the material they have studied. This includes important scientific concepts.

Many students do not encounter evolutionary concepts until they reach college. Public understanding of evolution is considered "lacking" by many researchers. Although people usually state that they understand evolution, closer examination reveals fundamental misunderstandings of the current science.

Common misconceptions include the assumption that "theory" means "unproven" – a popular use of the word -- when, in science, "theory" means "widely accepted." Students also think that environment, rather than genetics, causes traits to change; that evolution exists in response to need; that genetic variation is not fundamental to evolution; and that traits change progressively in a population, rather than in individuals. Students also misunderstand the terms "adaptation" and "fitness" because their conventional meanings are different from the scientific meanings.

The authors recommend a constructivist approach to learning. Such an approach

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involves encouraging students to think critically about their current assumptions. Student-student discussion around these issues can facilitate learning. Active learning increases student retention of scientific information. Student use of concept maps aids instructors in identifying misconceptions and increases student comprehension and participation. Teaching the historical sequence of evolutionary concepts also improves student understanding.

The authors also point out that science cannot disprove the existence of the supernatural, and remind educators that their goal is science literacy, not naturalism.

Keyword(s):
Biology
Science
Communication
Collaborative learning
Course content and curriculum
Religion
Assessment
Active learning

Armstrong, E., & Thompson, K. (2003). Strategies for increasing minorities in the sciences: a University of Maryland, College Park, model. *Journal of Women and Minorities in Science and Engineering, 9*(2), 159-167.

Summary: Minority undergraduate science majors who participated in a Maryland enrichment program were retained in both the sciences and at the university at a somewhat greater rate than non participating students (86% vs. 72%). Participating students' graduation rates were also higher than those of non participants. This article reports the 5-year results of the Prefreshman Academic Enrichment Program (PAEP) at the University of Maryland, College Park. PAEP was designed to increase and retain the number of minorities in life sciences majors. The six-week program, targeting freshman deemed poorly prepared mathematically, consisted of involving students in hands on learning in small group settings, providing course survival training and introducing them to the academic and social components of the university.

Recommendation(s): Set up an intensive academic program in which workshops, lectures, tutoring, help and survival skills are offered (including on-site housing). Create learning communities aimed at facilitating the transition of the student to the institution while fostering collaborative learning.

Extended summary: The College of Life Sciences at the University of Maryland discovered a strong correlation between math proficiency and freshman grades in

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introductory biology and chemistry courses. This led the College to institute math placement testing and, for those doing poorly, required non-credit remedial math prerequisites before allowing students to take introductory chemistry. This intervention approach yielded mixed results: While it improved students' success in sciences courses, it delayed their program completion and increased their likelihood of dropping out of the program entirely. Subsequently, the College instituted an intensive, optional 6-week "Prefreshman Academic Enrichment Program" (PAEP) offered to students with poor math preparation.

PAEP is a day-long, 6-week program involving mathematics workshops, lectures and problem sets as well as college survival skills workshops for new freshmen. Students therefore participated in both academic activities and worked extensively in small cooperative, self-help groups in which they took an active role in their learning process. Students additionally stayed in close contact during their first as well as subsequent academic years and apparently formed close learning communities helping to alleviate a sense of isolation. The authors compared PAEP participating students with other students with similar SAT scores who did not participate in the PAEP. Participating students performed better than non-participating students and graduated at higher rates.

Beyond noting that the sense of community helped to diminish feelings of isolation, the authors did not assess the extent to which the learning community itself may have independently contributed to the program's results. They did not discriminate program results between academic activities offered and the processes of having the students work extensively in the small cohorts mentioned above, nor the effect of their continuing participation during the their academic careers in the such informal learning communities.

Keyword(s):
Special programs
Academic preparation
Minorities
Mathematics
Undegraduate
Retention
Academic achievement

Asirvatham, M. (2004). Enriching science through diversity. Retrieved March 31, 2004 from http://www.colorado.edu/ftep/diversity/div12.html

Summary: This is a short opinion piece drawn from personal experience in which the author points out that science offers a platform for uniting students regardless of backgrounds. She focuses on concrete methods of embracing diversity in the science classroom and discusses the importance of international teaching assistants and laboratory work. The value and utility of this article is that the author provides a helpful list of one sentence, easily grasped, teaching tips, reprinted below:

Recommendation(s): 1. Remind students that science is a human endeavor and requires contributions from many different people to solve problems that could affect all of us. Incorporate scientific issues that affect society at the local, national, and global level.
2. Make a special effort to emphasize the contributions of a diverse group of scientists.
3. Treat all students with respect, show that you really care about their learning, and strive to provide an atmosphere where all students feel comfortable to ask questions.
4. When calling on students in class, try to include as many different students as possible. Be sensitive to cultural differences.
5. Use a variety of teaching styles and instructional technology to address the different learning styles in the diverse classroom.
6. Encourage study groups which bring together students from diverse backgrounds, to foster mutual respect and cooperation.
7. As part of TA training, encourage teaching assistants to embrace diversity and facilitate interactions in the laboratory that are beneficial to the learning process.
8. Address the special needs of women, minority and disabled students by providing information on resources such as the Minority Arts and Sciences Program or Disabled Student Services.
9. Encourage students with special needs to see you during office hours, and offer to visit dormitories to facilitate informal interactions with your students.
10. Offer review sessions, especially welcoming those students who are shy or intimidated to approach you in a large group.

Extended summary:
Keyword(s):
Teaching
Culture
Course content and curriculum
Inclusively
Accessibility/disability

Atkin, A. M., Green, R., & McLaughlin, L. (2002). Patching the leaky pipeline: Keeping first-year college women interested in science. *Journal of College Science Teaching, 32*(2), 102-108.

Summary: A one credit, two semester orientation course was offered for women who had yet to decide a major but were interested in a STEM field as part of a larger firstyear experience program (FYP). The course included activities which emphasize selfinquiry and reflection and was designed to provide a smooth transition in the fall semester and then career and major exploration in the spring.

Recommendation(s): First year female students considering STEM fields can be encouraged to pursue them with a program that emphasizes self-reflection and collaborative work. Such a program should provide opportunities for women to connect with the larger university community and beyond. Intensive individual advising is also key.

Extended summary: Atkins, Green, and McLaughlin suggested that many women leave STEM disciplines between their first and second year. They argued that the existing gender gap in STEM results from different "precollege experiences for boys and girls rather than differences in ability." The researchers then described how the orientation course attempted to overcome such differences by both helping women to have a realistic and optimistic picture of being female in a STEM field and equipping them with tools necessary for professional and academic success. The tools for academic success included time management skills, academic goal setting, understanding university policy and utilizing university resources. Participants were required to meet with a study group both inside and outside of class.
Within a community of women interested in STEM, students explored gender issues and stereotypes. They were also given the opportunity to interact with female rolemodels. Having volunteers from the university community and guest speakers serve as role models was vital to the program's success.
The authors argue that similar programs could and should be replicated elsewhere, as much more work is needed to ensure the success of women in STEM majors and careers. One of the largest obstacles to overcome implementing a program such as this is the huge time commitments and resources needed from members of the university community.

Keyword(s):
Women
Undergraduate
Mentoring
Retention
Stereotypes
Sexism

Ayre, M., & Mills, J. (2003). Implementing an inclusive curriculum for women in engineering education. *Journal of Professional Issues in Engineering Education & Practice, 129*(4), 203-210.

Summary: This paper presents a persuasive justification for an inclusive engineering curriculum. The authors report the results of their efforts to incorporate inclusive practices in engineering education at the University of South Australia. The authors collaborated with faculty in the engineering department through informal sessions and staff workshops to develop inclusive curricula through "improving the understanding and practice of faculty, and developing guidelines to assist them in restructuring their courses." Extensive examples from a civil engineering course illustrate inclusive teaching practices.

Recommendation(s): First, "include(e) examples and applications of theory from a range of cultures." Then, design a curriculum that effectively communicates engineering principles to students, taking into consideration the following factors: The learning environment, Assessment, Using inclusive resources/content, Incorporating inclusive teaching and learning methods, and Applying inclusive principles to the aims and objectives of the program and course.
The authors caution against the following instructional problems, which contribute to a "chilly climate":
Assuming that all students have prior practical experience with mechanical and electronic devices and appliances, "Lack of excitement in the content or presentation of the course," "Apparent lack of relevance in the curriculum content," Use of a limited set of teaching methods that are applicable only to a few learning styles, "[Allowing] disruptive behavior of majority groups (e.g., white male students throwing paper planes)," and Ignoring an uncomfortable classroom atmosphere (racism, sexism, or other types of prejudice).

Extended summary: Australian universities are seeking to increase diversity on their campuses. Increasing the number of women in engineering helps to alleviate labor shortages in the engineering profession, "brings in new talents, and provides access to wider markets," and helps women gain access to the "advantages and privileges that accrue to the professional engineer."
Typical engineering courses are, the authors believe, "obsess(ed) with the technical, the mathematical, and the scientific [with] an almost complete neglect of social, political and environmental issues." They think that this deficiency discourages female students and other minority students from pursuing engineering. To effectively teach diverse students, the authors say, faculty must begin to adopt new teaching practices, question their assumptions about students' backgrounds, be aware of their use of examples and metaphors, and observe their patterns of attention in the classroom.
The six stages of inclusive curriculum development, as outlined by Rosser, were used to implement a curriculum transformation in the engineering department of University of South Australia. The project aimed "to raise awareness of the issues and influence institutional and departmental policy to produce guidelines, to provide staff development, and to develop and collect resources to assist the growth and extension of inclusive curricula after the formal project ended." Workshops for instructors helped faculty to create their curricula. The authors discussed the term "inclusive" with faculty and explained the ways in which a non-inclusive curriculum poses problems to minority students, as well as the benefits gained by all students through an inclusive curriculum.

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The curriculum was designed in order to best prepare students for graduate studies. Some faculty members argued that "their curriculum content is based on universal laws, and is not therefore subject to cultural or gender bias." This notion is disputed by several studies that indicate that an individual's "historical and social milieu" and gender influence science.
An increase in the retention and success rates of female students in the engineering department occurred after the commencement of this program. However, the authors note that there may not have been a causal relationship.
An example of inclusive curricula in civil engineering illustrates how instructors incorporated inclusive aspects in their course. Students were given lectures on "working overseas, team skills, negotiation skills and valuing diversity among colleagues and society." Peer-assisted learning (PAL) and small projects were introduced for students in mechanics and analysis courses to develop graduate qualities and inclusivity. Faculty members and voluntary tutors participated in the PAL sessions. Instructors selected design projects for their students to work on that were realistic and incorporated "technical branches of civil engineering" as well as "environmental, social, and economic implications."

Keyword(s):
Engineering
Women
Inclusively
Course content and curriculum
University climate

Ayre, M., Mills, J., & Slay, J. (2001). Equity and diversity in science, technology and engineering education. Retrieved September 28, 2004 from http://www.unisanet.unisa.edu.au/flc/staffsvcs/Equity/Equity&diversityinEngScTech.doc

Summary: This website documents racial/ethnic, gender, ability and socioeconomic status under-representation, along with current strategies for increasing diversity in engineering at the University of South Australia. It provides thought-provoking information on women's learning styles and motivation to enter engineering. After giving extensive data on diversity in Australian engineering education, the report ends with a summary of current intervention strategies. Most of the intervention strategies and recommendations are not targeted to address the societal concerns raised in the initial section. In addition, the authors do not extensively discuss the interests or learning styles of underrepresented groups other than women.

Recommendation(s): Be aware of the educational differences between male and female engineering students and design peer-assisted learning opportunities for students. Take steps to remedy male dominance in computer labs. Engage in recruitment and awareness activities for high school students, and establish award programs, preparatory programs and scholarships. You may also want to consider curriculum modification, collaborative/active learning, including socially relevant material in courses, and putting your course material in context.

Extended summary: This online document begins with a thorough overview of the literature on diversity in engineering education, ranging from "remedial" education for diverse students to education that actively challenges current engineering culture (antiracist education, etc.). A thorough discussion of research on women and men's motives to enter engineering reveals that women are more likely than men to enter engineering because of strong math and science ability and career considerations, whereas men are more likely to be interested in "tinkering" and to have been encouraged by their parents.

Because of the cultural norms that prevail in engineering, students who do not have mechanical experience or have difficulty visualizing three-dimensional objects were initially viewed as "deficient" and requiring remedial classes. A more progressive approach is to redefine the curriculum so that these students are considered differently educated rather than deficient and to include self-teaching components such as "peer assisted learning." Studies have shown that women prefer to learn science topics within a larger context, work in groups, and discuss personal experience. This collaborative and synthesis-oriented learning style is not privileged in traditional engineering education. A specific example of sexism in high school education is male dominance in computer labs which, according to the authors, is adversely affecting the Australian technical workforce. The authors state that attention to social issues in engineering education will improve the interest and retention of under-represented students.

Keyword(s):
Minorities
Women
Engineering
Learning styles
Motivation
University climate

Barlow, A. E. L., & Villarejo, M. (2004). Making a difference for minorities: Evaluation of an educational enrichment program. *Journal of Research in Science Teaching, 00*(00), 00.

Summary: This paper measures the effectiveness of an educational intervention program for minority students at the University of California-Davis. The program aims at reducing the attrition of minority students from the biological sciences. Program participants became more likely (compared to a control group) to persist in basic math and science courses and to graduate in biology. Supplemental workshops offering academic and personal advising, peer support, financial aid and supplemental instruction led to improved student performance and persistence.

Recommendation(s): Engage students in research projects during their undergraduate years. Inform students of supplemental classes or workshops available to them where they can gain a better understanding of course work and work in groups with other students.

Extended summary: Biology Undergraduate Scholars Program (BUSP), an educational enrichment/intervention program for minority students at the University of California-Davis (UCD), reduced the attrition rates of minority students. This program offered supplemental academic instruction in General Chemistry, Calculus, and Introductory Biology. Study groups facilitated by BUSP fostered strong peer networks. The students also received academic and personal advising, practical experience and financial support through work in research labs. Studies indicate a positive relationship between participating in a professor's research project and persistence in science majors. Faculty members provided "developmental experience" to the students - "starting with simple laboratory tasks" [and] advancing to more challenging activities as students demonstrate competence at each level."
The control group had the same gender ratio, fewer African American and Mexican American students, better academic preparation, higher high school GPAs, higher mean math SATs and higher mean verbal SATs than the students in BUSP. Also, the control group had only 50% of the number of Special Action students that were in BUSP. (A Special Action student is a student who would normally be considered below admissions criteria.) English was not the first language of most BUSP students; most students in the control group were English speakers.
The study measured persistence rates in General Chemistry, Calculus, and Introductory Biology. BUSP students had a higher GPA in General Chemistry, a higher persistence rate in Calculus and the same persistence rate in Introductory Biology relative to students in the control group.

Keyword(s):
Biology
Mathematics
Science
Advising
Career
Mentoring
Financial aid
Special programs
Retention
Minorities

Beoku-Betts, J. (2004). African women pursuing graduate studies in the sciences: Racism, gender bias, and third world marginality. *NWSA Journal, 16*(1), 116-135.

Summary: African women who pursued graduate studies in scientific disciplines at western universities between the 1960s and 1990s were interviewed to explore how gender, race and third world marginality affected their educational goals and outcomes.

Recommendation(s): Provide students, especially women and minority students, with positive mentoring. Inform international and minority students of ways to overcome social isolation. Inform students with families how to successfully balance family with graduate study. Identify and make efforts towards curbing overt and subtle discrimination towards women and minority students.

Extended summary: During their graduate study in western universities between 1960s and 1990s, African women scientists faced prejudice and racial discrimination. They felt excluded, received little support from peers and instructors, and encountered misperceptions of their language skills and negative stereotypes of Africa. They were regarded as "Africans" although they hailed from different parts of Africa. White professors doubted their ability to do work and required them to take remedial classes. However, they were able to cope with these negative perceptions because of their knowledge of their "national histories, their place in the global economy and their daily struggles as women in patriarchal societies."

Most African women scientists felt socially isolated outside the university, which led them to return home; those who remained in graduate school drew upon their self-confidence, their spiritual beliefs or other international students to overcome the social isolation.

Some of the scientists received positive mentoring from their advisors and/or professors, which helped them to overcome isolation and discrimination. Students who did not have helpful mentors relied on self-motivation, working with senior graduate students and faculty support from other departments to successfully complete their degree.

The relationships between these women scientists and their counterparts implied "Western hegemonic systems of domination and subordination" that exist between people of European descent and Third World people of color. The chilly environment faced by these African women scientists motivated them "to accomplish their goal and to resist the negative racial stereotyping regarding their African identity."

In Africa, men are not expected to share the domestic workload. Hence, the women required more time to complete their graduate degrees. The African women scientists "commented on the emotional costs, loss of opportunities, the burden of domestic responsibilities, neglect of spouse and children, and shortchanging of their own leisure and study time" associated with the demands of balancing family and graduate studies in a foreign country. These scientists were denied certain scholarships because they would have had to be separated from their spouses, a problem that is not often

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encountered by their male counterparts.

Keyword(s):
International students
Women
Minorities
Graduate school
Culture
Stereotypes
Retention
Expectations
Social support
Advising

BEST. (2004). *A bridge for all: Higher education design principles to broaden participation in science, technology, engineering and mathematics.* San Diego, CA: Building Engineering and Science Talent.

Summary: The nonprofit organization BEST (Building Engineering and Science Talent) conducted an extensive evaluation of intervention programs designed to increase the participation and success of women, minorities, and people with disabilities in the science and engineering workforce. They selected and profiled a series of exemplary programs, and published a list of "promising" programs as well. BEST also evaluated professional award programs for fairness. The report contains comprehensive general recommendations for people involved in all stages of engineering education, from policy making to teaching and administration.
Second, the U.S. must "draw on the strength of its demographics." Leaders must make a "stronger and more inclusive workforce" a priority. Funding rewards should be created for institutions that fulfill this objective. Educational and accreditation institutions must make structural changes that increase retention rates and ease students' transition to the workforce. Internship and professional development opportunities for students and professors from underrepresented groups should be expanded.
Third, communities must partner with colleges and universities to encourage local students to enter technical fields. This is especially important in states with a high minority population.
Fourth, policy must be aligned with practice and research.

Recommendation(s): The recommendations of the committee fall into four categories. First, institutional commitment must be solid. This commitment requires initiating publicly available self-evaluations of equity among faculty, students, administrators and staff; making evaluation and follow-up a condition for government funding; and, for corporate and foundation partners, emphasizing the need for a diverse workforce.

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Extended summary: There have been some changes in women's participation in SMET (science, math, engineering and technology) fields over the past decade, but much less progress has been made than one might expect. For Caucasian girls, this is due primarily to social stereotypes and differential classroom treatment rather than academic preparation. Cognitive differences, which are still being explored, may play a role.

In high school, college-bound girls and boys are both taking many science and math classes. However, girls' standardized test scores continue to be somewhat lower. Both girls' and boys' math scores on standardized tests have doubled in the past decade. A 35 point gender gap (favoring boys) remains on the SAT. In science, the scores are not rising and the gender gap is shifting but not disappearing. The ACT shows that both girls and boys are equally capable of science reasoning. Girls are well represented in AP Calculus, but are only ~15% of those taking the AP Computer Science exam. It is now common for most college-bound students, regardless of their gender or race, to have taken four or more years of high school science, with the only exception being Hispanic girls.

Most young women "opt out" of SMET majors when they select their professional goals. Those women who do choose SMET majors are more likely to stay in their major- and complete their degree within 5 years- than male students. The same story is true for graduate enrollment. Women are less likely to enroll in a graduate program to begin with; but, once they do enroll, they persist. As a result, the number of women receiving doctorates in S&E has risen from 28% to 35% from 1990 to 1999. For a variety of reasons which are not explored in this paper, minorities other than Asian Americans are more likely to switch majors or to drop out before completing their bachelor's or graduate degrees.

Once women are out in the technical workforce, they are more likely to a) change occupations, b) work part time due to family responsibilities, and c) work for universities rather than the private sector.

The authors believe that the omnipresence of stereotypes in a series of studies of parents, teachers, and the media make it impossible to say that gender differences in science are innate. A series of studies have documented that most people, including girls themselves, believe that girls have inferior math and science ability. In this setting, it is not surprising that some girls "stick to what they know." Many girls prefer to solve problems using arithmetic than to derive proofs. It is not clear which comes first: boys' culturally encouraged sports and repair activities, or a natural inclination towards physical problem solving. Studies have shown that boys' dominant behavior in science labs is correlated with a drop in girls' test scores. "Active learning" may not be effective when stereotypes inhibit girls' participation. Observers have also documented that teachers ignore girls in class, particularly white girls, although the girls continue making efforts to participate. Most girls become disappointed in math and science and effectively "write off" the subjects, stating that they are not interested in S&E, these fields are "not relevant," and they could not be successful in them.

More research is needed on girls' and boys' problem solving strategies. Some theories

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suggest that women have a more "relational" way of perceiving the world, are more interested in looking at the broader context of a problem, and are more interested in personal experience. At present, these theories have not been widely accepted.
The women's movement, educational reform, and the need for more engineers in the United States have contributed to the rise of many programs geared towards encouraging girls to study math, science, and engineering. Encouraging girls to develop more mechanical skills may be helpful. As the authors emphasize, we have a long way to go.

Keyword(s):
Special programs
Women
Minorities
Accessibility/disability
Science
Engineering
Teaching
Recruitment

Bianchini, J. A., Cavazos, L. M., & Helms, J. V. (2000). From professional lives to inclusive practice: Science teachers and scientists' views of gender and ethnicity in science education. *Journal of Research in Science Teaching, 37*(6), 511-547.

Summary: "To provide insight into issues of gender and ethnicity in science education," this paper probes the perspectives of secondary science teachers and university scientists of a range of backgrounds, using data from three separate studies. The three studies represent a continuum of evolution in the instructors' commitment to diversity. The interview process explored "the intersection of personal and professional identities; … the nature of science; beliefs related to [science] students' experiences;" the reasons for underrepresentation, and the role of teaching. The authors believe that the "inclusion" issue is complex and multifaceted, and should be approached with sensitivity.

Recommendation(s): Incorporate context and history into science teaching as a way of unveiling the multicultural roots of scientific topics. View students as individuals. Examine your own cultural history and share your personal experiences with students. Question the norms of scientific culture when you feel that such questioning would benefit your students.

Extended summary: Unlike other researchers, Bianchini, Cavazos and Helms believe that the identity of the teacher- and the teacher's degree of self-examination- are central to teachers' success at addressing gender and ethnicity in the classroom. (Their adherence to self-classification met with resistance from one subject in the study, who identified his or her ethnicity as "homo sapiens.") Feminist observers of science have addressed inequity in scientific culture, terminology, emphasis on objectivity, "climate," and other arenas. The authors draw extensively on the work of Nieto, who discusses the effects of low expectations on students of color.

Nieto says that failing to acknowledge the value of students' existing cultural knowledge leads teachers to "think of difference in negative terms." Nieto also emphasized individual cultural differences between students. The authors use this conceptual framework in their development of interview questions for the educators in the study. All three studies were interview-based. Helms's study involved educators who were not involved in any particular collective project. Bianchini's participants were scientists- both men and women- involved in a seminar series called Promoting Women and Science. Cavazos's interviewees were members of a group called Women Educators of Science and Technology that included high school instructors. First, the authors analyzed the interview content to determine the role that the teachers' gender and ethnicity had played in their own careers. In general, the responses were optimistic. Women described overcoming sexism. A few female science teachers described having been steered away from higher-prestige positions. Marriage and motherhood often conflicted with professors' obligations. The authors noted that the respondents may have been reluctant to give pessimistic feedback due to their professional and cultural pride. Some of the respondents viewed gender and race in science as being only a matter of inclusion rather than topic of study. Several respondents viewed science as objective and free of discrimination. Other respondents saw the structure of science as being created by social mores, and discussed this with their students.

A few instructors viewed "all students as the same" and tried to treat them as such, but most viewed students on the basis of their group membership. The categories that teachers separated students into were usually based on their perceived academic aptitude as well as their race and gender. Several instructors who had experienced restrictive identity labeling in the past preferred to see students as individuals who were all unique.

Most of the teachers had adopted innovations in their courses such as discussions of minority scientists, group work, discussing personal experiences, integrating crossdisciplinary material, and including portfolio assessments. Several teachers initiated female-friendly classroom practices such as increased wait time after questions, discussions of female scientists' work, personal attention and small group projects. One science teacher, "Elaine," adopted many creative strategies in order to try to include as many students as possible.

The authors close by pointing out that feminist scholarship should not be "dogmatically" imposed on scientists without listening to scientists' perspectives. Also, they note that viewing all members of a given underrepresented group as the same can make individuals who differ feel invisible.

Keyword(s):
Teaching

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Women
Minorities
Expectations
Feminism
Stereotypes

Biewert, C. (2002). *Making accomodations for students with disabilities: A guide for faculty and graduate student instructors*. Ann Arbor, MI: University of Michigan.

Summary: The author describes the needs of students with disabilities and their experiences on campus to enlighten faculty who may not be informed about these issues. The paper gives examples of facilitating and non-facilitating behavior on the part of instructors. The author discusses "principles of good practice" that are beneficial for students across the board and specifically helpful to students with disabilities.

Recommendation(s): Inform yourself about the disability policy of your university by contacting your local student services office. Place an announcement in your syllabus stating that students with disabilities should contact you for accommodations. Be open to discussing their needs and be flexible if they need more time to complete work. Do not feel uncomfortable if a student advocates forcefully for himself or herself, but understand that the student has developed this skill because of previous experiences. Speak to disabled students the same way that you would interact with any other student, and encourage classroom practices where students can meet and talk with those who are different from themselves.

Extended summary: Extended summary: The two main barriers to the learning and persistence of disabled students are lack of knowledge on the part of instructors, and lack of communication between students and instructors. The paper encourages instructors to take the lead in providing reasonable accommodation as their university policy requires and to recognize that these accommodations, whether involving time or material, are not "preferences."
Close to 10% of undergraduates nationwide report having a disability of some kind. Many of these disabilities are not visible or were only identified recently. Some students are used to advocating for themselves and were accommodated in high school; others are only just finding out about their disability. Unidentified learning disabilities may lead to ridicule on the part of instructors who do not understand why a student has difficulty writing or solving problems. It is the instructor's responsibility to identify students who may be struggling with these issues and, without attempting to diagnose them, refer them to writing or math assistance centers on campus.
Students may sometimes wait until later in the semester to bring up accommodation because they don't want to "inconvenience" their instructor. Unfortunately, this delay may inconvenience the instructor more than the accommodation would have at the

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beginning of the semester.
Besides being proactive about soliciting requests for accommodations in their syllabi, instructors should refrain from singling out disabled students or making them feel unwelcome. Their peer group may already be unsupportive. Instead, students with disabilities should be integrated into the classroom as a whole through cooperative group work, high expectations, active learning, communication, feedback, and attention to diversity issues and student "time on task." Clear communication, which assists students with learning disabilities, can enhance course material for other students as well.

Keyword(s):
Accessibility/disability
Inclusively
Teaching
Communication
Discrimination
Time
Faculty

Binkerd, C., & Moore, M. D. (2002). Women and minorities in computer science: where are they? No attention: No retention. *The Journal of Computing in Small Colleges, 17*(5).

Summary: The authors focus on short-term solutions to the problem of retention of women in computer science. They identify many specific problems which contribute to an unwelcome environment for women, such as lack of a social network, lower selfconfidence, condescension on the part of male TAs and faculty, lack of mechanical experience and competitive grading.

Recommendation(s): Make time to talk with your female students. Often, students need the support of a faculty member in order to feel motivated to continue in their programs. Give female students positive feedback on their professional competence. Create an atmosphere that is less competitive by encouraging socialization and not grading on a curve. And, of course, treat your students with respect.

Extended summary: This short paper is drawn from the personal and professional experience of two female computer science professors. The authors begin with a brief discussion of cultural obstacles that face women who are interested in working with computers, including lower self-confidence, lack of mechanical experience, absence of role models, and the aggressive culture of computer gaming. The authors have many suggestions for improving the computer science climate on campus. They begin and end by noting the crucial importance of the human element- the opportunity to connect

personally with a faculty member and/or a mentor. Although professors' time is at a premium, it is very important to talk with students about academic and funding opportunities. Social networking with other female computer scientists is another source of support. It is also important for campus administrators to ensure a physically safe climate for women. Gender-related comments in the classroom can discourage women from the field. Interruptions from peers, lack of eye contact, simplification of questions, or social avoidance by professors can be intimidating to students. Gender-specific examples that assume mechanical experience can be confusing, and comments that are derogatory to women are unprofessional and highly discouraging.
Grading policies which pit students against their peers can be problematic. Women tend to flourish in environments that encourage equality, participation, and group work.

Keyword(s):
Technology
Computer science
Women
University climate
Social support
Retention
Motivation
Identity and personality
Competition

Bozeman, S. T., & Hughes, R. J. (2004). Improving the graduate school experience for women in mathematics: The Edge Program. *Journal of Women and Minorities in Science and Engineering, 10*(3), 243-254.

Summary: This paper examines the effectiveness of the EDGE program initiated at the Spelman College and Bryn Mawr College. This program aims to help female mathematics students, especially those of color, make an easy transition from an undergraduate math program to a graduate math program. Female students are redirected to other programs if they find the programs they are assigned to "inappropriate or unsuitable." The program creates a network for its participants with peers, mentors and faculty. It aims to "diversify the mathematics program."

Recommendation(s): Providing negative feedback to students who are "not impressive to faculty members in their first semester or year of courses or who do not score well in their attempts at taking preliminary examinations" may discourage students, especially women and students from certain racial or cultural backgrounds "for whom the entry into graduate school requires a major adjustment." Help students to create a support group with their peers and mentors.

Extended summary: The EDGE (Enhancing Diversity in Graduate Education) program is targeted at reducing the high attrition rate of female students, especially those of color. The high attrition rate of female students from graduate mathematics programs has resulted in a lack of diversity at "advanced levels in the mathematics community." This program aims to retain female students who may drop out of graduate school if they do not receive social support.

This program prepares its participants to make an easier transition from undergraduate to graduate school. The program "helps students understand the nature of graduate school culture and anticipate the types of difficulties that generally arise." Faculty members mentor participants throughout their graduate programs. Also, participants are encouraged to understand, accept and learn from people of various ethnic, social, cultural and educational values and preferences. The program redirects students who drop out of the program to other programs that are better suited to their needs.

Students are trained in abstract algebra and analysis. These are basic courses required for graduate work in mathematics. These courses are tailored to help students "bridge the undergraduate and graduate content of these areas." Homework assignments are not graded, but constructive feedback is provided. Students are encouraged to work individually and in groups and to present their results to each other. All students receive a copy of the entire group's notes at the end of the courses. Guest speakers are brought in each week to explain research topics, the practical application of mathematics, the relation between mathematics and other disciplines, and possible career options for students with a mathematics degree. Students are also given the opportunity to participate in facilitated discussions relating to "differences of race, culture, geographical origins, and any other background differences or personal preferences." A platform is provided for the participants, graduate mentors and participants from the previous year to network among themselves for the academic advancement of participants. "Research support may be provided to participants "to attend professional meetings, purchase books or software, or for other research needs."

90% of the participants completed their masters' degrees and pursued doctoral degrees. The program gave its participants insight into the work and culture of graduate school, which helped build their self-confidence, thereby encouraging them to persist in the program. The core courses taught by the program were helpful to most of the students. Participants felt they had gained valuable knowledge through interactions with their peers and their graduate mentors. The facilitated discussions on diversity also encouraged the students to pursue graduate school.

However, the participants admitted that the program had not completely prepared them for graduate school. For instance, the participants were unprepared for "the loneliness [and] bad advisement," embarrassing situations with faculty, departmental politics, "incomprehensible courses," "teaching responsibilities, the amount of homework and the lack of tests," "time management needs, the lack of guidance and mentoring," and balancing school with the demands of personal life.

Keyword(s):
Graduate school

Mathematics
Networking
Advising
Time
Minorities
Women
Social support

Brown, B. L. (2001). Women and minorities in high-tech careers. Retrieved October 22, 2004 from http://www.eric.ed.gov/ERICWebPortal/Home.portal?_nfpb=true&_pageLabel=RecordDetails&_urlType=action&objectId=0900000b8013b533

Summary: This report briefly describes ways to attract women and minorities to computer-oriented careers. It discusses teaching methods, mentoring, career preparation, changing social attitudes, and connecting technology to students' interests Although the claims are not always backed by specific evidence, the sources of information are thoroughly cited.

Recommendation(s): Contribute to developing a welcoming environment for women and minorities in computing both within and outside the classroom. Make it clear to students that high-tech careers are socially relevant. Engage students in collaborative learning. Take steps to make sure that girls are allowed to participate in computer activities. Mentor female and minority students and discuss career options with them.

Extended summary: Currently, the United States is relying more and more on international graduates to fill technical positions in the workforce. Part of the reason for this disparity is that women and minorities are not entering computer science. Women's enrollment in computer science is currently decreasing while opportunities in the field - which are often well-paid positions - are increasing. Integrating community service, interdisciplinary applications, bias-free gaming, and everyday examples into computer science classes can encourage female and minority students to take an interest in computing. Collaborative learning, when structured properly, can break down classroom dominance patterns.
The "pipeline" to computing begins at a young age. The author encourages intervention at the middle school level. She notes that guidance counselors sometimes steer minority students away from technical careers.
Businesses such as Intel are taking part in encouraging women and minorities to enter the computing workforce. Introducing students to mentors and role models helps to break down the stereotypes surrounding computer science.

Keyword(s):

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Women
Computer science
Stereotypes
Identity and personality
K-12
Minorities
Career
Technology

Brown, S. W. (2002). Hispanic students majoring in science or engineering: What happened in their educational journeys? *Journal of Women and Minorities in Science and Engineering, 8*(2), 123-148.

Summary: The author conducted a series of in-depth interviews with Hispanic science and engineering students in order to determine what factors led to their success. Family support, caring teachers, honors tracking in school, college preparation, challenging andinteresting curricula, small class sizes, and small communities were key to the successof these students. The results raise questions about the reasons behind the failure of
other students who lacked these resources.

Recommendation(s): In order to ensure student comprehension of course material,interest in the course, and good study habits, involve students in cooperative learning. Encourage students to discuss concepts with each other. Train T.A.s in how to cultivate rapport and interaction in the classroom. Assess your innovations' effect on student performance, retention, and satisfaction.

Extended summary: Although much research indicates "what works" for students inscience and math, educators have been slow to implement these teaching strategies. There is much talk about encouraging students of color, but little progress is being made. The author considers many of the current inclusion efforts to be "window dressing" that does not change the fundamental system. The students were recruited for the study through minority student organizations at New Mexico State University. The author conducted a series of three interviews with each student and then tabulated the common themes. Many of the students interviewed were excited to have the opportunity to tell their stories to an interested audience.
All of the students mentioned supportive extended families that, although they might not have gone to college themselves, supported their children's success. Grandparents were especially influential. All students had grown up in families that held strong traditions and believed in education as an investment for the future.
Almost all of the students had been placed in an honors program. Their confidence and abilities were greatly enhanced by honors tracking. In honors programs, the teachers

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tend to be more motivated and more interested in the children. Honors programs have also been criticized for tracking on the basis of ethnicity. However, these young people made it into an exclusive circle of "college-preparatory" classes and good teachers. Although the high school teachers were often motivated, they taught using very traditional methods. About half of the students had hands-on science experience at some point during their education. Many of the students became very excited about science and math, primarily because of good teaching. The students appreciated discussing controversial issues in science classes, but rarely had the opportunity to do so.
Growing up in small communities and having smaller classes was also an asset to the students. Increased interaction with teachers helped students to achieve greater selfconfidence and to believe that they could succeed.

Keyword(s):
Latino
Academic achievement
Science
Engineering
K-12
Mentoring

Buck, G. A., Leslie-Pelecky, D. L., Lu, Y., Plano Clark, V. L., & Creswell, J. W. (2006). Self-definition of women experiencing a nontraditional graduate fellowship program. *Journal of Research in Science Teaching, 43*(8), 852-873.

Summary: The NSF-sponsored Graduate Teaching Fellows in K-12 Education (GK–12) Program gives STEM graduate students the opportunity to work closely with K-12 students and their teachers. Because of the program's emphasis on social values, the authors of this article felt it would be useful to study female graduate fellows' motivations for participation, thoughts about work/personal life balance, satisfaction with the program, and perspectives on their roles as scientists. The researchers conducted an in-depth, qualitative analysis of the self-definition of a small group of students. The participants expressed non-traditional ideas about their professional roles, emphasizing that they wanted to lead balanced lives and to inspire young people.

Recommendation(s): When seeking to make STEM graduate programs more female-friendly, consider work/life balance issues. Be open to students who are considering non-traditional career trajectories. Attempt to reduce the workload of graduate students in your discipline.

Extended summary: Because of the male-dominated history of STEM fields, their graduate programs tend to be structured in favor of students who have few time commitments outside of the academic world (such as raising families). In addition, some values espoused in STEM graduate education – competition and discovery – may be at odds with the more interpersonally connected values that female students often prefer.

The GK-12 Program, because it involves teaching science to young people, brings more "female-friendly" values, such as altruism, care and interdependence, into graduate students' lives.

The authors of this article conducted focus group interviews, journaling activities, and email correspondence with eight female graduate students participating in the GK-12 Program. Almost all of the students were European-American; five of them had children. Six of them planned to become university faculty. The authors analyzed the participants' responses using qualitative coding procedures.

The research questions centered on the students' motivation to enter the program, their fulfillment with the program, their identities as scientists, and their perspectives on work/personal life balance.

The graduate students were very enthusiastic about science teaching; many said they "loved" science, or had a "passion" for it. They also were interested in teaching, working with young people, and having a change from traditional assistantships. Their experiences during the program were positive, although they felt they were under pressure to be good role models. They also felt that the program reinforced their desire to be scientists and improved their confidence and communication skills.

The graduate students were aware of the stereotype of both male and female scientists as being loners and "geeks" who didn't communicate well, but said that they believed these myths were not true of themselves or of the scientists they knew personally. Instead, they said, science is currently opening up to allow people to balance their personal lives with their professions.

In the students' opinion, such balance is essential for success both during and after graduate school. They described graduate school as a rather frustrating balancing act with many time commitments. The multitasking and the emotional stress of graduate school were particularly difficult. However, the students continued to strive for balance, shifting priorities regularly to maintain both personal and professional success.

Keyword(s):
Science
Teaching
Women
Career
Graduate school
K-12

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Communication

Buncick, M. C., Betts, P. G., & Horgan, D. D. (2001). Using demonstrations as a contextual road map: Enhancing course continuity and promoting active engagement in introductory college physics. *International Journal of Science Education, 23*(12), 1237-1256.

Summary: This National Science Foundation - sponsored research sought to improve the classroom environment for women and minorities in an introductory physics class. Through interactive demonstrations and classroom discussion, the researchers attempted to raise students' confidence levels and improve their attitudes about science. The structure of the course was modestly changed by introducing a few interactive demonstrations. The lecture format was not significantly changed. The project was carefully evaluated by in-class observation of student interaction. The results were compared to observations in conventionally taught introductory physics courses. Researchers reported that the new class format stimulated engagement and encouraged inclusivity. Students' critical thinking skills improved, but their selfconfidence did not.

Recommendation(s): Use interactive demonstrations and classroom discussion to raise students' confidence levels and improve attitudes about science. This can be done making only modest changes to course content and technique.

Extended summary: Building upon the work of Tobias and Hake, researchers tried to create connectivity, engagement and inclusivity in an introductory physics class. Connectivity means linking the material to students' concrete experiences. Inclusivity means involving all students irrespective of gender, ethnicity or socioeconomic background. The authors designed a series of "road map" demonstrations which linked the materials to students' concrete experiences. They believe that active engagement is necessary for "warming the climate" and encouraging inclusivity, and that connectivity of the material is important. They took an "infusion" approach, where modest interventions were introduced into a basic lecture format. The advantage of infusion over comprehensive reform lies in:
(1) its portability from course to course and discipline to discipline,
(2) its emphasis on 'techniques' rather than fundamental restructuring of course content,
(3) the fact that technique or activity can be introduced independently - allowing faculty transition from what they have been doing to include selected innovations with which they may be most comfortable, and
(4) the fact that faculty can adopt this approach even in the absence of departmental curriculum reform.
The paper presents a series of standard demonstrations as examples of activities that can be used to introduce concepts and tie introductory sections together. While these

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are physics examples, they could be adapted to any STEM introductory course. The demonstrations are on the following topics: 1) Velocity, acceleration and twodimensional motion, 2) Applications of Newton's Laws, 3) Work and Energy, 4) Center of Mass and Moment of Inertia, 5) Rotation, and 6) Linear and Angular Momentum.
The authors researched the extent to which demonstrations and modest changes in teaching techniques would foster engagement and inclusivity. Through qualitative observation and surveys, they compared the model course with "traditional" classes. A more extensive and diverse group of students participated in the model class as compared with only a few white male "stars" participating in the conventional class. Although student critical thinking did increase, student self-confidence did not increase significantly.

Keyword(s):
Physics
Undergraduate
Active learning
Women
Minorities
Inclusively

Burack, C., & Franks, S. E. (2004). Telling stories about engineering: Group dynamics and resistance to diversity. *NWSA Journal, 16*(1), 79.

Summary: This article provides a psychodynamic analysis of engineering culture, with an emphasis on the importance of the language of masculinity and intellectual superiority as a hallmark of the profession. The article suggests alternative ways of speaking that can still convey engineers' occupational pride and values without excluding women.

Recommendation(s): Consider making the following changes in the way you talk about engineering:
1. Describe engineering as a profession that contributes to society.
2. Use the terms "communication" and "technical" instead of "soft" and "hard" to describe the skill sets required of engineers.
3. Describe engineers as "hard workers" and "problem solvers" rather than as an intellectual elite.

Also, since majority students may unintentionally dominate common spaces, allow students from underrepresented groups to form private organizations.

Extended summary: In recent years, growth in the numbers of women and underrepresented minority students in engineering is stagnating. The authors suggest that the profession is resistant to inclusion, and explore the group psychodynamics that

underlie this resistance. The authors state that "it is very difficult for an in-group to draw its boundaries, reinforce them unconsciously through language, images, and stereotypes, and then be able to transcend them through rational evaluation."
The authors observe that the use of the terms "hard" and "soft" skills have the effect of casting technical communication as a feminine endeavor. This makes male engineers resistant to learning these abilities, even though they are essential in the workplace.
Engineering students have reported in workshops that they are aware that the image of the "ideal" engineer is of a male. Speaking of engineers as "he" makes female students feel excluded in the classroom.
Portraying engineering students as intellectually superior to those in other fields makes the field considerably less inclusive because it challenges the self-esteem of students who know they do not fit the stereotypical mold.
The authors propose that the best response to the question, "Why special programs for women?" is to say that "women and underrepresented minority men do not need special help to be good engineers, but they do benefit from assistance in dealing with engineering culture."

Keyword(s):
Engineering
Women
Minorities
Sexism
Stereotypes
Culture
Communication
Special programs
Classroom climate
Competition

Busch-Vishniac, I. J., & Jarosz, J. P. (2004). Can diversity in the undergraduate engineering population be enhanced through curricular change? *Journal of Women and Minorities in Science and Engineering, 10*(3), 255-282.

Summary: The authors present a review of the literature related to curriculum changes in undergraduate engineering to increase retention of underrepresented students. The authors recommend a revolutionary change in the "unattractive, unresponsive, and culturally biased curriculum" of engineering. There is evidence that integration of theory with applications "make[s] engineering attractive" to women. Also, emphasizing the contributions made by women and underrepresented minorities to science makes female and minority students "feel as if they are an integral part of the engineering profession." Collaborative learning methods are most effective for retaining female and minority students, provided that the presence of these students is "not diluted by

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dispersal into separate teams." Instructors and students should be trained to better understand the dynamics of teamwork. Gatekeeper courses strongly discourage women and minority students from entering engineering programs. (This claim partially disagrees with the research of Tobias (1990).) Introduction of "creative [or interdisciplinary] engineering degree programs" might attract more students to engineering. The authors believe that "web-based and other distance instruction approaches" may have potential in attracting underrepresented students to engineering (see Alha (2003)).

Recommendation(s): Use collaborative teaching methods to effectively reach all students in the classroom. When assigning teams, "distributing a minority within a majority can lead to the disappearance of the minority." Hence, care should be taken to avoid isolation of students within groups. It is useful to assign each member of the group different roles throughout the course ("so that an aggressive team member does not always assume the lead role") and to create all-female teams or teams with female majorities. Inform students of contributions made by women and minorities inengineering. Encourage students to attend workshops for introductory courses. Also, offer freshman orientation sessions wherein students can learn skills to adapt to the college environment. Attempt to reduce the impact of gatekeeper courses. Connect technical material with social issues and bridge physics and math with engineering applications. Attempt to institute interdisciplinary majors and reduce barriers to entering engineering.

Extended summary: This article targets the lack of diversity in undergraduate engineering. It reviews literature and data on curriculum reform programs initiated at various engineering colleges. The authors report increasing attrition rates of female and minority students in engineering. Students from underrepresented groups and women continue to cite "chilly environments" as their reason for dropping out of engineering. The authors are concerned that courses in the engineering curriculum such as core science and math courses have little "cross-linking" with other courses such as physics or statistics- let alone the humanities and social sciences. This can be disadvantageous to women and minorities because they are "encouraged to pursue engineering careers" though they are "less likely to be exposed to engineering as a profession." The paper shows several instances wherein courses were integrated and more underrepresented students were retained. Several courses were integrated into one course (math was integrated with science, humanities and fine arts, for example) or integrated into a cluster of concurrent courses (engineering design, physics, calculus, and English classes during the freshman year). Also, social values were combined with technical material. Examples included courses in "technology, society, and values; environmental issues and societal values."

The authors suggest that considerations relevant to women and minorities should be integrated into the engineering curriculum. Women and minority students perceive "concrete evidence of relevance to their subcultures" as especially important. Female students usually do not have any hands-on-experience with engineering, unlike boys,

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who "get into computers at an early age with tinkering and video games." Hence, women can benefit from hands-on-experience with engineering during their freshmen year in college. Designing traditional science courses with a feminist approach helps to increase the retention and participation rates of female and minority students. Acknowledging the contributions made by female and minority engineers makes underrepresented students more comfortable. Integrating the relevance of science to the culture and views of science of minority students is also effective in increasing the retention of minority students.

The authors believe that there are too many courses required in engineering. Students, burdened with heavy course loads, have little room for experimentation. Also, "higher than normal credit hours" are required to graduate on time in an engineering program.

Engineering programs often assume students have certain levels of knowledge and ability when they enter college. However, not all students take advanced math and science courses in high school. Therefore, a barrier is created that prevents the entry of many female and/or minority students. If students take the prerequisite classes before they enter the engineering program, this lengthens their stay in college, which can be expensive. The authors recommend reducing the prerequisites required to enter engineering programs.

Engineering departments usually have an extremely competitive and discouraging environment. The authors recommend instituting collaborative learning, reducing the impact of gatekeeper courses, creating alternative paths to engineering-related careers, and advising freshmen on college pressures.

The authors advocate a "well-rounded" or Renaissance model of engineering education which is highly interdisciplinary. They suggest offering minors in engineering, master's degrees for non-engineers and interdisciplinary majors in order to reduce the rigidity of engineering programs.

The authors believe that "engineering colleges must assume responsibility for promoting technological literacy throughout the university."

Technology can be used to make engineering more accessible to women, minority students and disabled students. Providing on-line lectures frees up lecture time for discussions that can be used as team problem-solving sessions. Online courses can also be effective when a topic does not require much interaction. However, students may not benefit from such teaching methods if there is a digital divide among students. Also, this form of teaching can lead to student frustration due to the lack of technical support and immediate instructor feedback. In addition, physical separation of students may make collaborative learning difficult and may frustrate students who seek communication and social support.

Keyword(s):

Engineering
Gatekeeper courses
Women
Feminism
Minorities

Collaborative learning
Course content and curriculum

Cabrera, A. F., Colbeck, C. L., & Terenzini, P. T. (2001). Developing performance indicators for assessing classroom teaching practices and student learning: The case of engineering. *Research in Higher Education, 42*(3), 327-352.

Summary: The study investigated the relationship between classroom practices and undergraduate engineering students' self-reported gains in professional competence. The sample for this study included 1,258 engineering students from seven engineering colleges. Effective teaching practices included feedback and encouragement, clear and organized lectures, and collaborative learning. These practices help students understand engineering as a profession and develop cooperative work and problemsolving skills. Altogether, those teaching practices contributed more to a student's gains in professional competence than did such factors as his/her gender, ethnicity/race and academic ability (as measured by SAT scores). The authors recommend focusing on the connection between teaching practices and gains in professional competence as the source of student success. Firm causal connections cannot be established; the research design followed was not experimental and rested on students' self-reported information. However, the study used multiple regression analysis to account for the effect of factors other than classroom practices. The paper does not discuss 'inclusive' teaching practices for the retention of underrepresented students; however it shows that the negative impact of a 'chilly classroom' environment for women and underrepresented students can be overcome when the instructor follows effective teaching practices.

Recommendation(s): Maximize the use of collaborative learning for all students. Instruction methods should instill in students professional competencies such as problem solving skills, communication skills, leadership skills and working with diverse groups. Complex design processes in engineering should be taught not through conventional lecture and discussion methods, but through instruction from an experienced coach who frequently interacts with students and encourages them towards critical thinking through demonstrations and "articulating design specifications."

Extended summary: This article is a report on the evaluation of performance indicators for educational gains of undergraduate engineering students. It is based on an ongoing curricular reform launched by seven universities which are members of the National Science Foundation (NSF)-funded Engineering Coalition of Schools for Excellence in Education and Leadership (ECSEL). The primary focus was the development of performance indicators to capture the relationship between classroom practices and educational gains.
The authors developed performance indicators based on the assessment literature and

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the "Teaching for Competence" model. The assessment literature states that an ideal performance indicator should be one that helps evaluate the connection between inputs and outcomes in a particular education process. Accordingly, the authors argue that the "Teaching for Competence" Model meets this condition since it takes into account students' pre-college characteristics and their classroom experiences. Pre-college characteristics of a student include his/her intellectual ability, educational aspirations, his/her parents' educational level, gender and race. Studies show that female and minority students generally prefer collaborative learning practices (p.331-332). The factors pertaining to classroom experience include formal and informal curriculum, interactions with faculty within the classroom, student learning styles, and gender and racial climate, as well as teaching practices.

Collaborative teaching practices are, according to previous research, advantageous for enhancing students' intellectual development vis-à-vis problem-solving, application of knowledge, "long-term retention of knowledge," "achievement," sensitivity to other students, "positive attitudes towards subject area, student leadership behavior, student openness to diversity, and persistence." Collaborative learning practices instill in engineering students skills that are beneficial in the workplace.

The study implies that student learning benefits from instructors who give specific and detailed feedback to students, encourage students towards critical thinking and academic advancement, articulately present course material, relate assignments to the content of the course and provide information for problem-solving and design projects. Students, especially female and minority students, profit from collaborative learning practices. The authors suggest that instructors who commit themselves to "excellence in teaching" by using collaborative instructional methods should be rewarded through promotions or salary raises. This will encourage them to focus on effective teaching. Holding institutions responsible for developing students' professional skills can also help improve teaching quality. Faculty should be trained in classroom and group management as well as working with a diversity of learning styles to create a positive learning environment wherein female and minority students do not feel intimidated. Female students often feel that the engineering environment is hostile and extremely competitive, which lowers their self-confidence and leads them to change their majors.

Keyword(s):
Collaborative learning
Undergraduate
Minorities
Women
Academic achievement
ACT/SAT
Aptitude
Self-perception
University climate

Cabrera, A. F., Crissman, J. L., Bernal, E. M., Nora, A. P. T., & Pascarella, E. T. (2002). Collaborative learning: Its impact on college students' development and diversity. *Journal of College Student Development, 43*(2), 20-34.

Summary: There are two theories about the effectiveness of collaborative learning: 1)collaborative learning benefits all students, 2) collaborative learning benefits primarily women and minority students for cultural reasons. This study confirms that collaborative learning benefits all students and encourages them to be more open to diversity. The article also discusses factors that correlate student comfort with diversity. The authors strongly recommend using collaborative learning in the classroom.

Recommendation(s): Introduce collaborative learning to enhance student communication skills, openness to diversity and academic success.

Extended summary: Collaborative learning involves small group work in which students solve problems while the faculty member acts as a facilitator. Studies report that students become more confident and less likely to drop out of college when they engage in collaborative learning. Vogt (1997) maintains that collaborative learning promotes tolerance because it is egalitarian, solution oriented, and noncompetitive. This teaching method can be extended outside the classroom. Many well-known educational organizations believe that it is wise to link students' in-class learning with extracurricular activities.

Since earlier studies suggested a correlation between academic success, class participation and tolerance, the authors measured these seven independent variables:

1) Preference for Collaborative Learning,
2) Socioeconomic Status,
3) CAAP Scores,
4) High School GPA,
5) Racial Composition of High School, and
6) Average Hours of Study per Week.

The results measured were changes in:

1) Personal Development,
2) Understanding Science and Technology,
3) Appreciation for Fine Arts,
4) Analytical Skills, and
5) Openness to Diversity.

The first four dependent variables are connected to students' likelihood to remain in college.

The researchers surveyed 2050 randomly chosen college sophomores at 23 institutions, including "private, public, research, liberal arts, and historically Black colleges and universities." They found that students of all groups grew personally and intellectually due to engaging in collaborative learning. Minorities were slightly more interested in collaborative learning than Caucasian students were, but students of all

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backgrounds benefited from the experience. There were no significant gender differences.
Student open-mindedness was also enhanced by working in groups. This effect was most pronounced for White females and Hispanic students, but less so for White males. As the authors state, "Cooperative learning practices create the process and setting where learning is maximized and preconceptions are confronted through positive, productive interactions between students of different backgrounds."

Keyword(s):
Collaborative learning
Academic achievement
Communication
Women
Minorities
Learning styles

Cabrera, A. F., & La Nasa, S. M. (2002). Classroom teaching practices: Ten lessons learned. Retrieved November 16, 2004 from http://www.soemadison.wisc.edu/edadmin/people/faculty/cabrera/Classroom%20Teaching.PDF

Summary: The authors distill 40 years of teaching and learning research into a brief overview of ten key lessons regarding effective classroom teaching practices. The authors first define "effective teaching" by adopting a definition consistent with that of the major higher education accrediting programs: "Effective teaching is one that produces demonstrable results in terms of the cognitive and affective development of the college students." They then review what has been learned about the nature of college teaching and provide some advice regarding teaching assessment. They conclude by describing how knowledge of effective teaching is affecting American colleges and universities.

Recommendation(s): Clearly specify the specific knowledge, skills and values the students are supposed to master.
To create an effective learning environment, emphasize equity and fairness in the relationships among students and between students and faculty.
Active learning methods (discussion, collaborative learning) are emerging as the most effective and promising pedagogy. Instructors should utilize active learning in every context in which they are able to apply such techniques.
Seek to learn to be an effective instructor, and encourage departments to reward innovative and effective teaching.

Extended summary: The heart of this manuscript is the authors' list of "ten lessons

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learned:"
1. Good teaching can promote student learning and development. Instruction can allow students' potential to flourish.
2. Learning is a complex social phenomenon. Classroom climate, student needs, goals and preferences, teaching strategies and curriculum all influence student personal development.
3. Students have different ways of knowing. Students' preferred mode of learning may vary by discipline, major, gender, ethnicity or any combination of these. Instructors should be aware that students' ways of knowing are affected by a variety of factors ranging from their learning preferences, their interests (e.g. vocational vs. academic), their gender and their culture of origin.
4. College teaching is multidimensional. Teaching is complex. It embodies a wide variety of practices and methods.
5. There is no best way to teach. Teaching methods' effectiveness varies as a function of the result under consideration. Effective teaching can only take place if professors clearly specify the specific knowledge and skills the students are supposed to master. Clearly specifying the objectives allows instructors to choose teaching techniques that are most likely to achieve the specific outcome(s) desired.
6. Classroom climate matters. Positive relationships among students and between students and faculty are as important for student learning and development as is teaching. (Prejudice and discrimination on the part of faculty and peers affects students' college adjustment, their choice of major, and their persistence.) Professors can create an inclusive learning environment by emphasizing equity and fairness among students and between students and faculty.
7. Students are excellent raters of observable classroom activities. Student rating of instructors tends to be reliable whenever observable (low-inference) teaching behaviors are the focus of evaluation. Raters are more likely to disagree on global measures (e.g. flexibility, caring for students), while they agree on observable teaching behaviors (e.g. instructor explains class assignments clearly).
8. Students may be as reliable in assessing their cognitive development resulting from classroom experiences as are standardized tests. However, it is important to use effective measurement questions.
9. Few full-time faculty use innovative teaching methods. Two-thirds or more of college professors rely on lecture as their primary teaching practice. Few full-time faculty, if any, use active learning methods (5%) while one out of six full-time faculty rely on class discussions or seminars.
10. Effective teaching can take place when faculty are trained in teaching and rewarded for it. Most college professors are not trained to teach, nor rewarded when they are effective. Accreditation and performance funding is creating the impetus to value and reward teaching.
The authors believe that changes will come because "attention to outcomes and demonstrable results is playing an increasingly important role in public policy."

Keyword(s):

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Collaborative learning
Teaching
Faculty
Undergraduate
University climate

Cabrera, A. F., & Nora, A. (1994). College students' perceptions of prejudice and discrimination and their feelings of alienation: A construct validation approach. *Review of Education/Pedagogy/Cultural Studies, 16*(3-4), 387-409.

Summary: This article describes a statistical method of measuring students' experiences of prejudice and discrimination and their feelings of alienation from the university community. The correlations between factors were measured and the results were used to infer the relative satisfaction of students as a function of their ethnicity (white, African-American, Asian-American, or Hispanic). The students' responses indicate that 1) in-class discrimination is strongly related to alienation, 2) African Americans are most likely to experience alienation related to discrimination, 3) white students are also very likely to feel alienated, but their feelings are based on other factors which were not measured in the study.

Recommendation(s): The authors recommend faculty awareness of classroom behavior in order to prevent in-class discrimination, which may alienate students from their university community. Discriminatory behavior which may go unnoticed by white instructors or students is highly visible to minority students and may affect their college persistence and ability to form community with their white classmates.

Extended summary: The study focuses on discovering relationships between students' alienation and their perceptions of prejudice and discrimination. The research took place at a large, doctoral-granting university in the Midwest. The participants were 879 freshmen, of whom the population was 10.7% African American, 21.6% Asian American, 17.2 percent Hispanic and 50.5% white. (This was close to a representative sample.)
Discrimination and prejudice were measured using three variables: 1) Racial and Ethnic Climate on Campus, 2) Faculty and Staff Prejudice, and 3) In-Class Discriminatory Experiences. Alienation was measured by questions as to whether the students were enjoying their college experience and whether they felt that they "belonged" at the university. (There was no differentiation between perceived animosity towards the respondent's ethnic group and animosity towards other ethnic groups.) There was much more variation among ethnic groups in their perception of prejudice and discrimination than in their alienation. In general, African Americans perceived the most prejudice and discrimination, followed by Asian and Hispanic Americans and then by whites. All minorities felt isolated in class, but African Americans also had many experiences of

discrimination and perceived prejudice outside of class.
White and African American students had equally high experiences of alienation. The reason for this is not known. However, the African American students were more likely to feel alienated due to racial issues, while white students felt alienated for other reasons.
It was difficult for white students to differentiate between different types of racism that they observed, whereas minority students were more aware of the nuances of human behavior. This may be due to the fact that minority students are likely to attend predominantly white institutions.

Keyword(s):
Minorities
Discrimination
University climate
Undergraduate

Campbell, A., & Skoog, G. (2004). Preparing undergraduate women for science careers. *Journal of College Science Teaching, 33*(5), 24-26.

Summary: This paper reviews the effectiveness of an undergraduate research and mentoring program at the Texas Tech University/Howard Hughes Medical Institute in encouraging women to pursue science careers. "Increased skills, self-confidence and motivation" were observed among female students who were involved in undergraduate research. These female students were more likely to pursue science careers.

Recommendation(s): Create research opportunities for students, especially underrepresented students. Provide mentoring to students through encouragement, support and lab experience. Provide students with opportunities to do "interesting research." All of these experiences contribute to professional confidence.

Extended summary: The Undergraduate Biological Sciences Education program at the Texas Tech University/Howard Hughes Medical Institute (TTU/HHMI) was created in attempt to increase the participation of "women and minorities in the sciences by involving undergraduate students in research laboratories and experiences." Researchers measured the effectiveness of this program using questionnaires and interview transcripts. The program increased student retention.
Positive career-related interactions with the project director, their mentors and other students helped the students to prepare for graduate school. Undergraduate research experience increased female students' self-confidence through "success in labs" and positive feedback from research mentors. It provided them with research expertise, opportunities to present papers at conferences, and a "realistic view of science." These students were not discouraged by the time demands posed by graduate study.

They felt that their undergraduate research experience prepared them for these challenges. The students made lab work their first priority, while family responsibility "took a back seat."

Keyword(s):
Mentoring
Women
Science
Undergraduate
Self-perception
Career

Capobianco, B. M. (2007). Science teachers' attempts at integrating feminist pedagogy through collaborative action research. *Journal of Research in Science Teaching, 44*(1), 1-32.

Summary: Capobianco presents the results of an action research intervention that brought feminist science teaching into high school settings. Participating teachers identified the obstacles they faced in communicating with their students, and devised strategies to motivate and engage the students. The strategies were customized by each teacher to meet the unique needs of their classroom. The three teachers whose interviews appear in this paper took diverging approaches to reaching their students. One instructor made the classroom more egalitarian and brought up personal issues related to science, such as student concerns about drugs and HIV. A second instructor made her chemistry class more hands-on and more socially relevant in an attempt to interest her female students. A third instructor took steps to "draw out" the quiet students in her course.

Recommendation(s): Consider your own science experiences, including what drew you to the field, and find ways of sharing these types of experiences with your students. Also, examine your educational principles and practices. Evaluate these practices to determine whether they serve your students effectively. Consider your students' backgrounds, and be willing to try new methods of teaching which may engage them in science and interest them in the subject. Implement and evaluate interventions designed to bring student voices into the classroom and to make science visibly relevant to students. Be willing to depart from the traditional lecture format, if needed.

Extended summary: The study was qualitative and based on the fundamental concepts of participatory action research. The author held a series of dinner get-togethers with a group of female and male high school science teachers who were interested in feminism and action research, recorded the conversations that took place, and also interviewed, observed and consulted with the teachers. The teachers developed ideas about ways to use feminist and transformative teaching methods to connect more effectively with their students. Then, the teachers implemented the changes they conceived and gathered data on student responses to their innovations.

In this paper, the author only presents data from three of the instructors. The instructors varied in their use of feminist pedagogy. One instructor introduced her students to hands-on, environmentally relevant lab experiences; however, her students remained unmotivated. Another opened up her classroom for discussions of science issues relevant to students' concerns, such as HIV prevention, and received very positive feedback from her students. A third simply encouraged the quiet students in her class to speak.

Keyword(s):
Biology
Chemistry
Science
Latino
Minorities
African American
K-12
Communication
Teaching
Class discussion
Course content and curriculum
Laboratory
Active learning

Cavallo, A. M. L., Potter, W. H., & Rozman, M. (2004). Gender differences in learning constructs, shifts in learning constructs, and their relationship to course achievement in a structured inquiry, yearlong college physics course for life science majors. *School Science and Mathematics, 104*(6), 288-300.

Summary: The authors examined gender differences in many learning variables at the beginning and end of a one-year "structured inquiry" physics course for life science majors. These variables included student learning approaches, grades, motivational goals, self-confidence in the subject area, beliefs about science, reasoning abilities, and physics comprehension.
Results indicated that male students had higher self-confidence, expected higher grades, and understood physics better than the female students throughout the course. Female students with higher self-confidence and higher reasoning abilities were more likely to achieve high grades than were their peers.

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Recommendation(s): Strengthen female students' background knowledge of physics, and help them to improve their self-confidence and reasoning ability before they enter introductory college physics.

Extended summary: Past research shows that women are more likely to achieve in science and to be interested in the field in high-inquiry classrooms. (An inquiry-based classroom is one in which students participate in the learning process more than is usual.)

The physics class in this study was primarily based on discussion and laboratory exercises. Students participated actively. Only one lecture took place each week, and it was not central to the content delivery. Many quizzes were given, followed by a cumulative final exam. The course content was organized around conceptual models rather than physical topics.

Surveying 290 mostly White and Asian life sciences majors studying physics at a large Western university, the authors evaluated the following:

1. Student Learning Approaches. Using the Learning Approach Questionnaire, the authors determined whether students were practicing rote learning or meaningful learning. Meaningful learning requires students to integrate prior knowledge with new concepts through meaningful activities.
2. Motivational Goals. Using the Achievement Motivation Questionnaire, the authors assessed whether the students' motivational goals were performance-oriented or learning-oriented (e.g., whether they were motivated by grades or by interest in the subject).
3. Self-efficacy. The authors measured student self-confidence in their own abilities in physics.
4. Beliefs About Science. The Science Knowledge Questionnaire measured whether students believed science was a static set of facts, or a dynamic process changing with new research.
5. Scientific Reasoning. The Reasoning Ability Test measured student logical abilities on a scale from concrete to abstract.
6. Physics Concept Understanding. This was evaluated using the Force Concept Inventory.

Results showed that students became more interested in learning physics during the course. Students' concept understanding also improved.

There were gender-specific patterns that appeared to be affecting student success, comprehension, and learning habits. Female students were at a disadvantage in three areas: expectation of high grades, self-confidence, and prior physics knowledge. However, some female students who were self-confident and had good abstract reasoning skills were able to succeed despite their relative lack of background information.

Female students' lack of background information may explain why many of them were less able to engage in meaningful learning towards the end of the course than their male peers, whose meaningful learning increased.

Male students tended to be more successful when they were more self-confident, less

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interested in learning goals (an interesting result), and engaged in less rote learning. In general, rote learning did not produce very positive results for these students. Students engaged in meaningful learning also tended to be more interested in the subject and to have higher self-confidence, while those practicing rote learning tended to be more motivated by grades.

Keyword(s):
Physics
Collaborative learning
Laboratory
Inclusively
Academic preparation
Motivation
Competition
Undergraduate
Women

Cejda, B. D., & Rhodes, J. H. (2004). Through the pipeline: The role of faculty in promoting associate degree completion among Hispanic students. *Community College Journal of Research and Practice, 28*(3), 249-262.

Summary: Using an interview method, the authors identified factors that successful instructors at a Hispanic-serving community college used to assist their students in making decisions that would promote their academic persistence and professional development. Factors that the instructors identified as important were: pointing out the potential for higher income with a completed degree, encouraging students to take remedial courses as needed, helping students understand which of their credits would transfer to other institutions, recognizing that many students did not want to leave their families, mentoring and advising students, and encouraging students who had leadership ability. Not all students aspire to a bachelors' degree.

Recommendation(s): See abstract.

Extended summary: See abstract.

Keyword(s):
Latino
Community colleges
Mentoring
Teaching
Retention
Academic preparation

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Chuang, H. C. (2003). Teaching evolution: Attitudes & strategies of educators in Utah. *American Biology Teacher, 65*(9), 669-674.

Summary: The author surveyed biology professors in Utah to determine their responses to challenges from students regarding evolution. 76% of the professors had been challenged, although most reported that it happened infrequently. When responding to challenges, most of them relied on a combination of scientific explanations for evolution and explaining the difference between science and religion. Over 80% of the professors considered evolution to be an important topic in biology.

Recommendation(s): This article does not recommend specific responses to challenges regarding evolution, but does advocate improving science literacy and mentioning religion in the classroom. Completely avoiding all discussion of religion may cause students to become alienated or confused.

Extended summary: College student misconceptions about evolution include the belief that evolution is “only a theory” and the belief that, according to this theory, human beings are descended from monkeys. The public may also be unaware of evidence of evolution such as selective breeding and antibiotic resistance.

The author, an Assistant Professor of Biology at Southern Utah University, surveyed professors in biology fields at Utah universities to determine their experiences and views related to teaching evolution. The professors averaged close to 15 years teaching at the university level (approximate median). 81% of them were male. Only 63% reported that an evolution course was required for all undergraduates in their program, but 90% believed that a course should be required. 76% had been challenged by students about evolution, but most reported the frequency of challenges as being very low to low. (The educators who did not advocate a course requirement were more likely to have been challenged frequently.) Less-experienced professors believed that teaching evolution was more important than senior professors did.

In response to these challenges, professors were most likely to choose a combination of two strategies- explaining evolution scientifically, and emphasizing that science is separate from religion. The NSTA recommends that faculty neither advocate in favor of religion nor oppose it.

The author closes by expressing concern that purely scientific or “detached” responses to questions about evolution may leave students feeling that religious inquiry is not valued.

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Keyword(s):
Biology
Science
Undergraduate
Faculty
Religion
Culture
Teaching

Clewell, B. C. (2002). Taking stock: Where we've been, where we are, where we're going. *Journal of Women and Minorities in Science and Engineering, 8*, 225-284.

Summary: Although girls are taking high school math and science courses at rates similar to boys, they are opting out of physical science, math, computer science, and engineering majors in college. The authors evaluate factors that affect women's success in science and engineering. They conclude that the main cause of Caucasian girls' lack of interest and persistence in these fields is ongoing and pervasive social stereotyping by the media, teachers, parents, and classmates. African American and Hispanic girls tend to be less affected by these stereotypes, but are more likely to have inadequate high school preparation. (Treisman (1992) questions this statement.) A secondary factor is that girls may learn better when math and science problems are placed in a larger context of relationships.

Recommendation(s): Be aware of discrimination and stereotyping in classroom behavior, expectations of students, textbooks and other course media.
Encourage female students who express an interest in science, math, and engineering to develop hands-on skills.
Phrase science problems so that they are in a social context.
Provide challenging math and science courses to African American, Native American and Hispanic students at the high school level.

Extended summary: There have been some changes in women's participation in SMET (science, math, engineering and technology) fields over the past decade, but much less progress has been made than one might expect. For Caucasian girls, this is due primarily to social stereotypes and differential classroom treatment rather than academic preparation. Cognitive differences, which are still being explored, may play a role.
In high school, college-bound girls and boys are both taking many science and math classes. However, girls' standardized test scores continue to be somewhat lower. Both girls' and boys' math scores on standardized tests have doubled in the past decade. A 35 point gender gap (favoring boys) remains on the SAT. In science, the scores are not rising and the gender gap is shifting but not disappearing. The ACT shows that both

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girls and boys are equally capable of science reasoning. Girls are well represented in AP Calculus, but constitute only 15% of those taking the AP Computer Science exam. It is now common for most college-bound students, regardless of their gender or race, to have taken four or more years of high school science, with the only exception being Hispanic girls.

Most young women "opt out" of SMET majors when they select their professional goals. Those women who do choose SMET majors are more likely than male students to stay in their major and complete their degree within 5 years. The same story is true for graduate enrollment. Women are less likely to enroll in a graduate program to begin with; but, once they do enroll, they persist. As a result, the number of women receiving doctorates in science and engineering has risen from 28% to 35% from 1990 to 1999. For a variety of reasons which are not explored in this paper, minorities other than Asian Americans are more likely to switch majors or to drop out before completing their bachelor's or graduate degrees.

Once women join the technical labor market, they are more likely to a) change occupations, b) work part time due to family responsibilities, and c) work for universities rather than the private sector.

The omnipresence of stereotypes in a series of studies of parents, teachers, and the media make it impossible to say that gender differences in science are innate. Studies have documented that most people, including girls themselves, believe that girls have inferior math and science ability. In this setting, it is not surprising that some girls "stick to what they know". Many girls prefer to solve problems using arithmetic than to derive proofs. It is not clear which comes first: boys' culturally encouraged sports and repair activities, or a natural inclination towards physical problem solving. Studies have shown that boys' dominant behavior in science labs is correlated with a drop in girls' test scores. "Active learning" may not be effective when stereotypes inhibit girls' participation. Observers have also documented that teachers ignore girls in class, particularly white girls, although the girls continue making efforts to participate. Most girls become disappointed in math and science and effectively "write off" the subjects, stating that they are not interested in S&E, these fields are "not relevant", and they could not be successful in them.

More research is needed on girls' and boys' problem solving strategies. Some theories suggest that women have a more "relational" way of perceiving the world, are more interested in looking at the broader context of a problem, and are more interested in personal experience. At present, these theories have not been widely accepted.

The women's movement, educational reform, and the need for more engineers in the United States have contributed to the rise of many programs geared towards encouraging girls to study math, science, and engineering. Encouraging girls to develop more mechanical skills may be helpful.

Keyword(s):

Retention

Stereotypes

Self-perception

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Women
Science
Computer science
Engineering
Minorities
Academic preparation

Colbeck, C. L., Cabrera, A. F., & Terenzini, P. T. (2001). Learning professional confidence: linking teaching practices, students' self-perceptions, and gender. *Review of Higher Education, 42*(3), 324-352.

Summary: This study investigated relationships among teaching practices, classroom climate, and engineering students' self-perceptions (expected grades, self-confidence of pursuing a related occupation, intention to persist, and expected grades).
Analysis of a 1998 teaching practices questionnaire collected from 1,258 engineering students revealed that faculty efforts in the classroom have important and significant influences on students' gains in their confidence to become an engineer, their expected grades, motivation, responsibility, and their intent to persist above and beyond students' highest degree expected, socioeconomic background or their SAT math and verbal scores. Effective teaching practices enhancing learning and persistence by women and minorities in STEM fields uncovered by this study include: Collaborative learning, quality feedback, interaction with students, clear and organized expectations, and fair and equal treatment of all students.

Recommendation(s): Both male and female undergraduate students' gains in self-perceptions can be fostered in the classroom by frequent interaction with, and feedback from, the instructor, by proving opportunities to work collaboratively with peers, and by clear instructions and structure from the instructor.
To build positive student self-perceptions, faculty should:
I. use collaborative and active learning practices,
II. provide quality feedback,
III. interact with students,
IV. bring clarity and organization to the lecture and class assignments,
V. make expectations clear to the students when assigning projects or ill-defined problems,
VI. incorporate examples or activities that convey a clear idea of the kind of work engineering graduates face, and
VII. treat all students equally and fairly.

Extended summary: More than one-third of the students who leave science and engineering cite poor teaching as their primary reason for changing majors (Seymour & Hewitt, 1997). For college students, continuous, specific, and immediate feedback and

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teacher clarity have been associated with achievement (Feldman, 1976) and with motivation to continue in academic programs (Murray, 1991). Students' self-perceptions of their ability to learn are also important in understanding whether they actually learn and persist in STEM majors. In general, the higher a student's self-perceptions (also called self-efficacy), the higher the likelihood that the student will exert effort and will to accomplish academic tasks. Some research indicates that student self-perceptions are better predictors of academic performance than objective measures of ability (Hackett et al., 1992; Pajares & Miller, 1994).
This study focused specifically on self-perceptions as related to engineering. It investigated what teaching practices and characteristics of the classroom climate contribute to female and male undergraduates' positive perceptions of themselves, which may reliably be linked to changes in students' academic and career self-perceptions.
The study looked at changes in three academic self-perceptions: i) intent to persist, ii) perceived responsibility for learning, and iii) outcome expectations. Students' intent to persist in college has been found to be a strong predictor of actual college completion (Cabrera et al., 1992).
This study found teaching practices exerting greater effects on gains in self-perceptions than students' perceptions of classroom climate or their background characteristics (e.g. socioeconomic status, SAT scores, highest degree expected). Instructor Interaction and Feedback, and Collaborative Learning, were significantly and positively associated with gains in all five self-perceptions. The more instructors interacted with students, provided detailed and frequent feedback, and provided opportunities to work together, the more students believed they would complete their degrees, gained a sense of responsibility for their own learning, believed they would get a high grade in the class, and gained in confidence and motivation to become engineers. Lecture clarity and organization was also significantly and positively associated with gains in three self-perceptions. The more clearly instructors explained their assignments and expectations, the more students believed they would complete their engineering degree and the more students gained in confidence and motivation to become engineers.
Faculty impact on the classroom climate was related to changes in two self-perceptions. The more students perceived that their instructors treated male and female students the same, the more students' sense of responsibility for their own learning increased and the higher was their motivation to become engineers. Peer impact on the classroom climate, however, was not associated with changes in students' self-perceptions.

Keyword(s):
Expectations
Self-perception
Classroom climate
Engineering
Teaching
Collaborative learning

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Cottrell, S., & Jones, E. A. (2003). Researching the scholarship of teaching and learning: An analysis of current curriculum practices. *Innovative Higher Education, 27*(3), 169-181.

Summary: Teaching can be a valuable and viable form of scholarship. The scholarship of teaching and learning consists of an investigative analysis into the maximization of student learning. This study was a preliminary, exploratory, qualitative research study meant to initiate inquiry into how instructors are exploring the impact of course design upon student learning and development. Research was conducted at higher education institutions where scholarship of teaching and learning initiatives had already been implemented by discipline-diverse instructors. Five broad research questions were investigated:
1. What influenced instructors to implement the scholarship of teaching and learning?
2. What were their learning outcome expectations?
3. What learning approaches were implemented in their course designs?
4. What were the assessment methods applicable to their revisions and teaching practices?
5. How were assessment results used for course improvement?

Recommendation(s): Institute organizational support for teaching as research practices. Discuss teaching as research with your colleagues who are committed to improving student performance and development. Engage in active learning in your courses and assess the results.

Extended summary: Instructors are most influenced to undertake the scholarship of teaching and learning as a result of internal influences, their personal commitment to helping students reach their full potential being uppermost, combined with frustrations with student learning effectiveness. Organizational influences are also significant factors, with support from administration (such as providing instructor development initiatives including resources to help instructors design courses) being significant.
This study also explored defining learning outcomes. A range of cognitive learning outcomes was stressed by the study's instructors, the most significant being comprehension, knowledge and application and analysis. Affective learning outcomes (such as developing attitudes and values) were also significantly cited. Instructors at all studied institutions implemented overwhelmingly applied active learning approaches. Of the eleven active learning approaches mentioned, those most often cited included discussions, presentations, problem-based learning and cooperative learning.
Instructors used a wide range of assessment methods. Direct methods included such tools as papers, exams, participation and presentations among others. However, multiple indirect methods were also used, with all instructors utilizing teaching evaluations, and half of instructors also utilizing written reflections.
All instructors participating in the study also used assessment results to make deliberate changes in their courses to maximize student learning and development. This utilization

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is at the core of the scholarship of teaching and learning.

Keyword(s):
Teaching
Active learning
Assessment
Faculty

Cross, S. E., & Vick, N. V. (2001). The interdependent self-construal and social support: The case of persistence in engineering. *Personality and Social Psychology Bulletin, 27*(7), 820-832.

Summary: Receiving social support from peers and faculty positively impacted underrepresented students' intent to remain in the major and their academic performance as well as their self-esteem through the first two years of their undergraduate engineering studies. The study investigated which students placed a high value in developing close connections with other individuals. The study took place at a large southwestern university and involved 282 students (200 men and 82 women). This article does not address inclusive teaching practices. However, the study's results strongly support the use of collaborative learning inside and outside the classroom to foster the academic development and persistence of underrepresented students pursuing engineering majors.

Recommendation(s): The creation of a social network among students with faculty and peers inside and outside the classroom can aid in the retention of underrepresented engineering students. Faculty members as well as advisors can help guide students to plan for the future and provide support systems to reassure students of their competence and academic skills. This support mechanism can help reduce the attrition rates among students of underrepresented groups, who often find the undergraduate engineering environment extremely competitive and discouraging.

Extended summary: The results of the study emphasize the importance of social support through the first two years of undergraduate engineering for the retention of women and other underrepresented students in engineering. This article examines the effect of social support for interdependent self-construal individuals. An interdependent self-construal individual is one who "define(s) the self in terms of close relationships" (p.820). The authors hypothesize that students with a high interdependent self-construal benefit from the existence of social support which provides a positive influence to student self-esteem thus helping the student excel in the competitive field of engineering. Women as well as Hispanics, African Americans, and Asians are generally highly interdependent self-construal. Interdependent self-construal students prefer "collaborative academic situations" and require a system in which they can receive ample social support from their peers as well as faculty members. The authors state that undergraduate engineering programs are often highly competitive and unsupportive. Also, the grading system serves to remove the "weaker students." These factors tend to lower the student's confidence in his/her academic skills. The undergraduate engineering environment, wherein very little social support is offered to highly interdependent self-construal students, can lead to high attrition rates among those students. The study shows that highly interdependent self-construal students who receive social support score better academically than those who receive very little social support. This social support also enhances an underrepresented student's self-esteem which, in turn, leads to increased confidence in his or her own academic skills. These students are also less likely to harbor thoughts of changing majors. The authors state that this study has important implications in that it can be used to design support programs in engineering departments. The support programs currently in existence often are not based on theoretical or empirical research.

Keyword(s):
Undergraduate
Social support
Retention
Self-perception
Mentoring
Collaborative learning
Advising
Group work

Crump, B. J. (2004). The new arrival minority: Perceptions of their first-year tertiary programming learning environment. *Journal of Women and Minorities in Science and Engineering, 10*(1).

Summary: The article explores the experiences of immigrant and international students--"the new arrival minority"- through semi-structured interviews with tertiary students studying 1st-year programming in New Zealand. The author organized the open-ended answers based on categories of language and culture, collaborative work, being a minority, racism, treatment by teachers, enrollment policy, course content, and differences between countries. The results were used to determine which factors affected the experiences of the new arrivals most. The answers provide some teaching and environmental recommendations to improve students' experiences.

Recommendation(s): The author offers new perspectives on the experience of international and immigrant students, and suggests many areas for improvement. Instructors should try to be accessible, fair, and friendly to all their students. Providing real-world, practical experience and homework in the classroom also helps students.

Step-by-step instructions may be too easy for college students and do not provide deeper level understanding of concepts. Instructors should be selective when assigning collaborative work, so that students do not discourage one another through competition. During the freshman year, students' confidence is especially vulnerable. Ask how they are doing in class. Ask "new arrivals" about issues of language and culture to see if there are any ways to help smooth their transitions into a new environment. Recognize that older, mature students may have an easier time adjusting and dealing with the stresses of living and learning in a foreign environment than their younger counterparts. Burns (2001) recommends a longer familiarization period, mentoring by students of similar ethnicity, pairing students with faculty, and additional technical and colloquial language classes.

Extended summary: International and immigrant students, or "new arrivals," are a growing cohort at universities who face unique language and cultural challenges. To explore how these students' experiences vary from others' and to improve these experiences, the author administered the CUCEI (an existing survey instrument which assesses students' perceptions of social climate) to 125 students, observed students in various settings, and conducted interviews with 28 1st-year tertiary programming students at three different universities in Wellington, New Zealand. The author analyzed the interview responses in terms of the following categories: language and culture; collaborative work; being a minority; racism; treatment by teachers; enrollment policy; course content; and differences between countries. The author provides multiple examples of open-ended responses from the interviews to expound on her findings. Language and cultural differences were the most significant problems faced by the new arrivals, especially the first few months. Many students observed that programming was easier than other courses which require greater written fluency. Learning in a foreign language also appeared to force students to become more "independent learners." Two younger students (19 and 20 years old) experienced loneliness, and had problems dealing with the strange culture and difficult language; however, they were over a decade younger than the average new arrival interviewed (32 years old). Age affected the new arrivals' experiences; student maturity and experience led to an easier adjustment. Some students said that this explained their not being affected by racism or other interpersonal problems.

Language differences were a barrier to collaborative work in classes, because native students were reluctant to work with the new arrivals. Some students found it difficult to communicate with students of the same ethnicity who spoke different dialects during group work. Despite commonly held beliefs about the benefits of group work, due to varying levels of competency, too much collaborative work can create an unequal learning environment. One student was frustrated by group work because his group relied too heavily on his assistance. Students criticized the course content because it focused too heavily on simple, step-by-step approaches and did not provide a deeper understanding of concepts. However, the students greatly praised practical work because it gave them real-world experience. Students also recommended more practice and repetition, and appreciated instructors' clear explanations of concepts and

expectations for time frames.
Surprisingly, issues of racism and being a minority were not problematic. Most students reported that it "doesn't matter" or didn't "affect me that much." In fact, one older student reported being surprised at how well younger students accepted him. Again, age may have been influential in the students' experiences. Also, the urban location of the universities provided a multicultural population which was perhaps more accepting of diversity. Students gave the greatest praise to personal contact with teachers; they specifically appreciated instructors who treated all students equally, were open to questions, and responded thoroughly. The author notes recommendations from Burns (2001) to ease new arrivals' problems, especially with culture and language. These recommendations are a longer familiarization period, mentoring by students of similar ethnicity, pairing students with faculty members, and additional technical and colloquial language classes.

Keyword(s):
International students
Minorities
Culture
Discrimination
Reentry students
Computer science
University climate

Cuny, J., & Aspray, W. (2000). *Recruitment and retention of women graduate students in computer science and engineering.* Paper presented at the Status of Women in Computing, Washington, DC.

Summary: This NSF-funded project presents 20 recommendations aimed at recruiting and retaining women in Computer Science and Engineering (CSE) graduate programs. Recommendations include providing diversity training to faculty, staff and incoming students geared towards changing stereotypes about women in sciences. While some recommendations are gender-specific, most are not. The authors believe that the adoption of their recommendations would improve the educational environment for all students. While little hard data are provided to support the recommended strategies, recommended practices are based on experts with a track record of successful engagement of women in Computer Science and Engineering. Inclusive teaching practices are not discussed.

Recommendation(s): Below are listed the 20 recommendations from the body of the report. While only some recommendations are elaborated below, the full body of the report includes more extensive explanation. Refer to the full text article for expanded details.

I. Recruiting women to graduate CSE Programs
A. Increasing the number of women enrolling in a given department
1: Broadening the recruitment pool beyond students with undergraduate CSE majors. Women tend to become interested in CS as an "acquired taste" that emerges over time. As a result, they may come to computing at a later stage in their education. Departments should go beyond the traditional applicant pool to recruit and admit strong students without undergraduate degrees in CSE.
2: Broadening the criteria used in admissions and being flexible in their application. "Broadening the criteria" does not mean "lowering the standards." Traditional criteria used for graduate school admissions are not always the best predictors of success. Do not focus solely on technical skills. Include such factors as intellectual accomplishment in other disciplines, leadership, motivation, communication skills, breadth of ability and experience, and social commitment. These factors contribute to innovation and a broader application of technology, and they are valued by employers.
3. Encouraging reentry students.
4: Providing bridging opportunities for entering graduate students.
A bridging program would provide assessment or self-assessment exams for all entering students, along with suggested mechanisms for filling gaps in their educational background. Possible remedies might include attendance at upper-level undergraduate courses (credit or non-credit), introductory summer courses for new graduate students, reading lists, and mentoring by senior graduate students or faculty.
5: Explicitly including diversity considerations in your admissions process.
6: Being proactive in making recruiting contacts.
7: Reviewing all departmental publications for both text and images containing overt or subtle messages that might discourage women from applying. Materials should be inclusive, depicting both men and women in a variety of activities. They should portray women as the integral members of the department.
B. Increasing the number of women in CSE graduate programs nationally
8: Informing your undergraduates about the opportunities and rewards of a research career, giving them timely information about appropriate preparation for such a career.
9: Providing undergraduate women with exposure to computing research.
10: Giving individual encouragement to your women undergraduates. Women who major in the sciences often report that they have been influenced by the personal encouragement of high-school teachers, and thus they expect more individual attention from faculty members.
11: Actively countering negative stereotypes and misperceptions of computer science and engineering. Ensure that department literature and departmental visitors include women whose lives and careers do not reinforce the standard clichés (such as, for example: All computer scientists are nerds. Computer scientists work 24-7-365, etc.). The myth that "women are not as good at computer science" is prevalent and particularly destructive.
12: Providing women role models for your undergraduates.
II. Retaining women through graduation
(These recommendations are divided between those that improve student relations (and

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thus support within the department) and those that foster a more inclusive research environment).

A. Improving student-student and student-faculty relations

13: Being diligent at mentoring women graduate students.

The relationship between the advisor and the graduate student is often the most influential relationship in the student's career. All faculty members need to take this duty seriously. Research indicates that mentoring is important to persistence and success in graduate school.

14: Helping to create a peer community for your women students.

15: Broadening the institutional culture of the department to accept a range of personal choices in balancing work and life. The default culture in an institution is often defined by its majority constituents. To broaden access to your department, broaden that culture.

B. Fostering a Research Life

16: Providing women role models.

17: Integrating students into the research culture of the department as early as possible. Early involvement in research has a strong positive correlation to success and persistence in graduate school. Decisions about funding for first- and second-year students often have implications for research involvement: students who hold research assistantships are, not surprisingly, among the first students to become involved in departmental research activities. Students holding fellowships or teaching assistantships may be marginalized in the research life of the department.

18: Helping women graduate students to become involved in the professional community as well as the departmental community.

19: Standardizing the methods your department uses for delivering information, so that students do not have to be part of an informal social network to receive it.

20: Changing the departmental infrastructure to better promote the equal participation of women. Assure that all students have a safe physical environment in which to work. Be proactive in avoiding sexual harassment by faculty, staff, or students. Offer diversity training to faculty, staff, and incoming students. Form a diversity committee at the department level or participate in one at the university level.

Establish clear and widely known procedures for seeking informal advice and/or filing formal grievances related to gender-based issues.

Develop structural mechanisms that ensure that all students have good advising.

Perform a self-assessment of your department's weaknesses in recruiting and retaining women, and prioritize needed improvements.

Publicize your successes at recruiting and retaining women.

Extended Keyword(s):

Women

Computer science

Engineering

Reentry students

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Mentoring
Graduate school
Stereotypes
University climate

Dar-Nimrod, I., & Heine, S. J. (2006). Exposure to scientific theories affects women's math performance. *Science, 314*(5798), 435.

Summary: When women are exposed to scientific theories that attribute women's underachievement in math to genetic causes, women perform less well than they do when they are presented with scientific theories that attribute underperformance to experiential causes.

Recommendation(s): Reduce the effects of stereotype threat on women's math performance by presenting women with experiential accounts of the origins of the stereotype.

Extended summary: The authors of this article investigated how women's math performance is affected by whether they are considering genetic or experiential explanations for women's underachievement in math.

Stereotype threat is a phenomenon in which a stereotype of a person leads them to show stereotype-consistent behavior. Past research has shown that people respond differently to genetic and experiential accounts of behaviors. When undesirable behavior is shown to have experiential causes rather than genetic ones, it is seen as having less impact and being more controllable. In some cases, stereotypes about one's groups are perceived as inescapable because they are perceived to have a genetic basis.

The authors of this article proposed that people might react differently if the origins were perceived as experiential, and devised a study to test the effect of women's beliefs about gender differences in math on math performance. In the study women took a test consisting of two math sections that were separated by a reading comprehension section. The reading comprehension contained the manipulation in the study. The women were divided in four different conditions that all read different essays: one essay argued that math-related sex differences had genetic causes (G), one that it had experiential causes (E); one argued that there was no difference (ND) and one that addressed sex differences but did not specifically target math (S).

The findings showed that the women who were in condition E and ND did not differ from each other, but outperformed women in G and S. These findings demonstrate that stereotype threat can be reduced, or even eliminated, when women are presented with

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experiential accounts of the origins of stereotypes.

Keyword(s):
Women
Sexism
Mathematics
Stereotypes
Feminism
Aptitude
Expectations
Self-perception

Davies, A. R., Klawe, M., Ng, M., Syhus, C., & Sullivan, H. (2004). Gender issues in computer science education. Retrieved June 1, 2006 from http://www.wcer.wisc.edu/nise/News_Activities/Forums/Klawepaper.htm

Summary: This website contains a wealth of information on the challenges and successes of efforts to attract girls to the computer science profession. It includes survey data on girls' and boys' perceptions of computer science and their professional goals, information on the ways girls are socialized away from computers and discouraged from programming, and a critique of the absence of "female-oriented" computer games. The site also describes educational efforts towards developing computer programs that encourage gender equity.

Recommendation(s): Encourage the development of computer games that speak to girls' interests by including more narrative and less violence. Take steps to demystify programming for women and introduce them to the computer science field. These initiatives should be developed for girls as well as adults.

Extended summary: Computer science, like engineering has been a traditionally male preserve. This phenomenon is deeply ingrained in our society. Beginning at age four, girls begin to show less interest in computers. Boys tend to dominate computer resources at school and at home, and to talk in "expert" lingo that intimidates women. Images of computer-savvy women are few and not always complimentary. Computer literacy is considered to affect girls' popularity negatively, unlike boys'. Girls, unlike boys, view computer scientists as socially unskilled.
There is a strong correlation between gaming and interest in computer science. Computer games are overwhelmingly geared towards the young male audience, despite the fact that young women represent an immense potential market for the gaming industry. The culture of gaming presents women as sex objects and emphasizes violence at levels that girls are often uncomfortable with. Studies show that girls are more likely to take interest in games that are social and relational and involving

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narrative, whereas boys are more interested in games that involve competition. Integrating computers with girls' lives, creating girls-only computer times in class, introducing girls to programming in non-intimidating ways and designing software that appeals to both boys and girls are all ways to encourage women to see themselves as computer scientists. Some pilot efforts have been made in this direction and have met with success. Groups such as the E-GEMS group at the University of British Columbia have successfully designed software that appeals to women as well as to men. The SWIFT (Supporting Women In Information Technology) program, also based in British Columbia, developed an object-oriented programming learning tool called Virtual Family, which has been well-received. Inviting computer professionals to visit K-12 classes and holding IT workshops for girls can also encourage girls to enter computer science. SWIFT has developed an accelerated program called ARC to allow people who have bachelors' degrees but limited computer experience to be able to enter the field. This program incorporates an interdisciplinary approach and internship opportunities. In general, the program has been very successful, and boasts an enrollment of 60% women. Employers report satisfaction with the students' talents and motivation. Student grades have been higher than average. The article gives extensive specifics on the success of the program.

Keyword(s):
Women
Computer science
Stereotypes
K-12
Reentry students
Career
Special programs

Davis, B. G. (1993). Diversity and complexity in the classroom: Considerations of race, ethnicity and gender. Retrieved June 1, 2006 from http://teaching.berkeley.edu/bgd/diversity.html

Summary: Instructors who wish to be aware of race, ethnicity and gender issues in the classroom will find this article, from Tools for Teaching, a good place to start. The author presents a series of points for consideration during all phases of instruction, from advising to classroom conversation, course content, and exams.

Recommendation(s):
Extended summary: Although legally, universities can no longer exclude people on the basis of their race or gender, female students and students of color often report feeling unwelcome, ignored in class, or otherwise treated with disrespect. In many of these situations, the professor does not notice what is going on -- or is not sure what to do

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about it. This article is a guide for the well-intentioned instructor who wants to learn more about teaching an increasingly diverse college population.
Stereotypes are common in our society and persist in the assumptions that we may make about students. Do we call on female students less often in math and science classes? Do we ask less challenging questions to non-native English speakers? Do we assume that certain students are "there because of affirmative action"? Do we assume that a student represents and can speak for his or her entire ethnic or cultural group? Do we assume that none of our students are first-generation college students or that all of them are heterosexual?
Assumptions and misunderstandings can influence the way that we treat students academically as well as interpersonally. Language differences may lead to miscommunications or errors in grading. Low expectations can be as damaging to students as insensitive language, although more subtly. These reduced aspirations for students can manifest as "easy" grading, condescension, or surprise when a student performs well.
There are many ways to make courses more inclusive. Besides encouraging dialogue on diversity, class participation, and a diversity of opinion, the curriculum can be made more representative of society in general. In this way, diversity can be integrated thoroughly into the course material. Connecting students with each other and with faculty strengthens their support systems. Also, assignments can take into account the varying cultural background and interests of students and can encourage them to explore others' perspectives.

Keyword(s):
Class discussion
Women
Minorities
University climate
Communication
Classroom climate
Advising
Assessment
Course content and curriculum

Davis, B. G. (1993). Reentry students. In B. G. Davis (Ed.), *Tools for Teaching* (pp. 52-54). San Francisco: Jossey-Bass.

Summary: This section discusses ways in which instructors can effectively teach reentry students and engage them in classroom activities.

Recommendation(s):
Extended summary: Reentry students, unlike other undergraduate/younger students,

are less involved in social and extracurricular activities on campus, more motivated to learn and more practical. They possess problem-solving skills, have clearer educational goals and treat professors as their peers. The following suggestions are designed to assist instructors to "meet the challenges and opportunities of working with reentry students:"

1. Help students fit in with campus life though advising and mentoring.
2. Reentry students may not have attended college earlier or they might have done poorly in college. Hence, they might not have enough self-confidence about their academic skills. Instructors should help these students to feel "comfortable" in their classrooms.
3. Avoid bias and unfairness towards students of certain age groups.
4. "Seek advice from your campus' reentry program."
5. Encourage students "to get to know one another." This will help reentry students feel comfortable with other students in the class. Also, it allows for collaborative learning.
6. Reentry students may have "family responsibilities, job commitments, social and community obligations, and commuting," which should be considered when assigning "field trips and weekend or evening activities."
7. Younger students may perceive older students as extremely "motivated, knowledgeable, and collegial with the professor." Also, older students may act authoritatively or as a parent figure towards younger students.
8. Most reentry students prefer interactive learning.
9. Collaborative learning is most effective for teaching a class with reentry students. Real life scenarios faced by reentry students can help younger students gain a practical view of material presented in class.
10. Reentry students are usually self-motivated and are used to working independently. Hence, "independent study opportunities" will effectively engage these students.
11. Consider presenting applications before theory while teaching reentry students.

Keyword(s):
Collaborative learning
Reentry students
Advising
Mentoring
Active learning

Davis, B. G. (1993). Teaching academically diverse students. In B. G. Davis (Ed.), *Tools for Teaching* (pp. 55-59). San Francisco: Jossey-Bass.

Summary: This section discusses strategies to engage students "with a range of academic abilities, interests, skills, and goals" in the classroom.

Recommendation(s): Certain students in class may lose interest in the material

presented in class if it is not intellectually challenging. There may be other students in class who may find the course material overwhelming. Below are strategies to engage both these groups of students:
1. Let students know what they are expected to know to succeed in the course.
2. A pretest on the first day of class on material that students are expected to know will help determine if students have the requisite knowledge to succeed in the course. If the class is writing-intensive, ask students to submit a sample of their writing. For students who do not have the requisite knowledge, advise them on courses they should take or "assign supplementary work early in the semester."
3. Divide reading list into background reading ("to review or acquire skills or knowledge to succeed in class"), basic reading and in-depth reading (to gain further knowledge and understanding of course material).
4. A test during the second or third week of class helps to identify students who have difficulty with course material. Class attendance may also indicate if a student is feeling lost or overwhelmed by course material.
5. "Plan a variety of assignments appropriate to various kinds of learning."
6. "Students tend to learn more when a course is conducted just above the level at which they are functioning."
7. Ask students questions that "require them to demonstrate them to demonstrate their understanding." Ask students for "definitions, associations, and applications of the ideas." "Ask a student to explain something you have presented in class, and gauge the response in terms of detail and accuracy. Go over material a second time, as needed."
8. "Give frequent, short in-class assignments."
9. At the end of class, ask students to write the most significant thing they learned, present any questions they have regarding the material presented in class, list "key concepts or main ideas" about the topic discussed in class, and/or write down "definitions and applications for difficult concepts." Ask students to summarize the reading material assigned. "Ask follow-up questions of all students". This helps to determine if students understand course material that was presented in class.
10. "Collect students' lecture notes at random" to encourage them to take good lecture notes. Also, this helps to evaluate students' understanding of the material that is being presented in class.

Extended summary:
Keyword(s):
Learning styles
Academic preparation
Motivation
Assessment
Evaluation
Communication

Dietz, J. S., Anderson, B., & Katzenmeyer, C. (2002). Women and the crossroads of

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science: Thoughts on policy, research, and evaluation. *Journal of Women and Minorities in Science and Engineering, 8*(3-4), 395-408.

Summary: In this essay, the authors examine policy, research, and evaluation of women and science. The authors discuss past and current research, theory, and programs. They assert that gender equity studies research brings together of science and society, and advocate for a base of cumulative knowledge for policy and practice.

Recommendation(s): None, but recommends that researchers studying women in science and engineering pursue the four approaches outlined in the extended summary.

Extended summary: The authors, all NSF program officers, believe that "traditional evaluation strategies aimed at a single intervention [concerning women in science] fail to capture important information and can lead to faulty conclusions." They believe that Women in Science issues are cross-disciplinary, and so are the solutions. They enumerate six problems seen with many research proposals, and go on to list different strategies which have more potential for uncovering important patterns.
The authors state that it is time for evaluation and research efforts to influence policy and thinking concerning women and science.
The authors list four distinct areas which they feel need more attention and go on to outline research approaches warranting development:
1) Systemic Reform Theory - targeting social and educational systems to transform the systems of preparation and support so that all participants are well-served;
2) Organization Theoretical Approach - Creating models in which changed culture and climate will eliminate barriers and changing institutional practice;
3) Career - targeting the STEM community to develop a persuasive model of scientific capacity that takes into account both career development and the advancement of knowledge; and
4) Self-Efficacy Approach - targeting girls and women across the spectrum and their support networks in order to encourage female students to pursue science, and studying the influence of belief systems on the representation and the culture of science.

Keyword(s):
Women
Science
Engineering
Career

Duff, A. H., Rogers, D. P., & Harris, M. B. (2006). International engineering students - avoiding plagiarism through understanding the Western academic context of scholarship. *European Journal of Engineering Education, 31*(6), 673-681.

Summary: Plagiarism among international students is not always deliberate and is often linked to inexperience with Western expectations of scholarship. By employing interventions to make students familiar with Western scholarly traditions, the amount of plagiarism among international students in an engineering master's degree program in an Australian university was significantly reduced.

Recommendation(s): This article states that plagiarism can be reduced significantly through prevention methods. By making Western requirements explicit and teaching students how citations can be used to strengthen their work and ideas, student performance can be improved and inadvertent plagiarism avoided.

Extended summary: In 2003, 16 students in a class of 35 international students in an engineering master’s degree program had plagiarized. Noticing that the plagiarism was not necessarily a result of deliberate dishonesty but, especially in the case of international students, was the consequence of cross-cultural misunderstanding, interventions were made to reduce the amount of plagiarism among the international student population.

Unintentional plagiarism is often linked to ignorance or lack of skill. As students’ perceptions of academic integrity are highly influenced by historical and cultural assumptions, it follows that international students may be unfamiliar with Western ways of attributing knowledge. The authors of this article believe that plagiarism can be reduced by making Western requirements of scholarship explicit.

In the class with a high amount of plagiarism, a workshop was provided for the students to attend in which they were acquainted with referencing systems and the mechanics of referencing. After the workshop, only three students plagiarized. The next time the course was taught, workshops were embedded in parallel with the course content from the start. A total of six interventions were devised to make the students familiar with Western scholarly traditions and to avoid plagiarism. First, students were given a presentation that introduced referencing and made the cultural origins of referencing and plagiarism clear. The second intervention was an online workshop about plagiarism in their discipline. The third intervention consisted of four workshops that were run by library staff and learning advisors who introduced the students to library databases and using sources. Fourth, the students were asked to work on a literature review exercise that integrated summaries, paraphrases and other elements of academic writing. The fifth intervention was a weekly, hour-long Writer’s Circle in which the students shared their work and did peer assessments. Finally, students who still had trouble grasping the academic concepts of referencing were encouraged to meet with a learning adviser.

The collaboration of learning advisers and engineering teaching staff to reduce plagiarism was highly successful. After using the intervention program for a three-year

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period, there was a clear, sustained decline in the use of plagiarism. The incidence of plagiarism in the course was reduced from 50% to 5%.

Keyword(s):
Engineering
International students
Academic preparation
Culture
Graduate school
Expectations
Assessment

Eisen, A., & Laderman, G. (2005). Bridging the two cultures. *Journal of College Science Teaching, 35*(1), 21-30.

Summary: The authors of this article initiated a year-long program to integrate the teaching of science and the humanities. The project included a faculty seminar and an undergraduate course, both of which were constructed to build bridges across disciplines, reshape research, and teach critical thinking in the context of science. The goals were to teach nonscientists science in a richer context by integrating it with the humanities and to teach scientists the context of science to emphasize its real-world applications.

Recommendation(s): Science and humanities teaching and thinking can and should be complementary to each other. This can be achieved through developing interdisciplinary courses at the university level that teach science in a more applied context. Faculty should cooperate across departments to combine scientific knowledge with applications. In this way, science majors can learn the broader context of their discipline and non-science majors can have a richer experience when learning science.

Extended summary: The article shows how an integrated educational approach was used to bridge the cultures of science and religion to enhance science education. The initiators of the project believed that the creation of a scientifically literate, critically thinking public is discouraged by the current university educational system. While science professors know little about the larger context of their work, humanities scholars, in turn, are rarely exposed to scientific perspectives on their discipline.

University educators have previously approached this problem from three angles: broadening the context in major science courses, adding rigor to non-major courses, and developing science studies programs to analyze science sociologically. The authors of the article developed a new course linked to extracurricular activities that integrated all three strategies. They settled on a multilevel approach which brought together diverse students, scholars and community members to rethink the way people view science, learn, and teach.

To plan the program, the authors held discussions with faculty from the medical, theology, and public health schools and from the psychology, biology, physics, history, religion and philosophy departments. Since a great deal of expertise in science and religion is related to health and healing, the faculty decided to focus on this area, and developed two public symposia. Next, the faculty built a formal, year-long program, including a faculty seminar, to test and develop ideas for the following undergraduate seminar and public forum.

Finally, the faculty developed an undergraduate seminar called Mind, Medicine and Healing for upperclassmen. The seminar was cross-listed in biology, history and physics. The course's aim was to change the way students viewed science and thought, learned, and taught. The course challenged the western notion of learning by encouraging participants to share how their own views affected their ideas of science. The course ended with a public symposium in which the students presented their work to faculty and to the public. The program inspired the creation of a new undergraduate minor in Science, Culture and Society.

Keyword(s):
Biology
Physics
Science
Culture
Undergraduate
Religion
Interdisciplinary

Felder, R. M. (1993). Reaching the second tier - Learning and teaching styles in college science education. *Journal of College Science Teaching, 23*(5), 286-290.

Summary: Most science courses are taught in a way which appeals primarily to only students with particular learning styles. Many students who fail or drop out of STEM disciplines do so because their learning styles are not being emphasized. Course material should be presented in multiple ways to accommodate all students.

Recommendation(s): STEM instructors need to utilize a variety of teaching strategies to reach all of their students. Teachers should focus on using hands-on experiences, discussion, and visual imagery in addition to traditional lecture. Teachers should also help to motivate theories by first investigating the phenomena which led to their concept and then apply these theories and concepts to the broader framework of the discipline.

Extended summary: The “second tier” of students relating to STEM are those students who have the initial intention and ability to earn a degree in science but fail to do so. Felder suggests that a primary reason many of these students do not achieve science degrees is because they often have significantly different learning styles than emphasized by most science courses. Students with a learning style compatible to that of the instructor and course tend to do better and be more motivated than those who don’t. Since many science courses are taught with a similar style, many students are left out. Felder describes five dichotomous dimensions of students’ learning styles that should be addressed:

Sensing/intuitive perception. Sensing learners learn best through hands-on experience, facts, and procedures. Intuitive learns learn through abstract ideas, theories and formulas. Most science classes focus exclusively on intuitive style learning.

Visual/verbal input. Visual learners prefer images to text and speech, and verbal learners prefer text and speech to images. Traditional lectures and text book reading favor verbal learners. Teachers should try to incorporate visual images whenever possible.

Inductive/deductive. Inductive learners tend to see specific cases and generalize to theories. Deductive learners take theories and can then apply them to situations. Traditional science classes present theories first and then explore application, favoring deductive learners. Teachers could encourage both types by beginning topic discussions by presenting interesting phenomenon and asking students to think through explanations. Theories and further examples can then be presented.

Active/reflective processing. Active learners learn through doing, through problem-solving and discussion, while reflective learners benefit more from internalization of lectures and demonstrations. Utilizing both discussion and lecture will help to reach both types of students.

Sequential/global understanding. Sequential learners gain understanding through a series of small chunks, being quick to gain enough understanding to solve computational homework problems while taking longer to grasp “the big picture.” Global learners may appear slow at solving computation problems since they first must gain an understanding of the broader context. This broader context should be discussed before computational proficiency is expected.

Keyword(s):
Learning styles
Teaching
Active learning
Inclusively
Aptitude

Felder, R. M. (1996). Teaching to all types: Examples from engineering education. *Matters of Style, ASEE Prism, 6*(4), 18-23.

Summary: This helpful and concise article describes how to implement learning style models in the engineering classroom to provide a more thorough learning experience for all students and to improve student retention in the field. The models used are the Myers-Briggs Type Indicator, the Felder-Silverman Model, the Kolb Learning Style Model, and the Herrmann Brain Dominance Instrument. The article gives specific examples relevant to engineering.

Recommendation(s): “To reach all types of learners, a professor should explain the relevance of each new topic… present the basic information and methods associated with the topic… provide applications for practice in the methods… and encourage exploration of applications.” Instructors should also include teamwork, communications, creative problem solving, systems thinking, synthesis, and design.

1. “Teach theoretical material by first presenting phenomena and problems that relate to the theory.”
2. “Balance conceptual information with concrete information.”
3. “Make extensive use of sketches, plots, schematics, vector diagrams, computer graphics and physical demonstrations in addition to oral and written explanations and derivations in lectures and readings.”
4. “To illustrate an abstract concept or problem-solving algorithm, use at least one numerical example to supplement the usual algebraic example.”
5. “Use physical analogies and demonstrations to illustrate the magnitudes of calculated quantities.”
6. “Occasionally give some experimental observations before presenting the general principle, and have the students (preferably working in groups) see how far they can get towards inferring the [principle].”
7. “Provide class time for students to think about the material being presented and for active student participation.”
8. “Encourage or mandate cooperation on homework.”
9. “Demonstrate the logical flow of individual course topics, but also point out connections between the current material and other relevant material in the same course, in other courses in the same discipline, in other disciplines, and in everyday experience.”

Extended summary: The author writes that “functioning effectively in any professional capacity requires working well in all learning style modes.” Instruction that goes against students’ preferred modes can discourage them from science fields. Instruction that consistently matches students’ existing preferences can make students less mentally flexible and, ultimately, less professionally capable.

According to the Myers-Briggs model, “engineering professors usually orient their courses toward introverts (by [not emphasizing] active class involvement and cooperative learning), intuitors (by focusing on engineering science rather than on design and operations), thinkers (by stressing abstract analysis and neglecting

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interpersonal considerations), and judgers (by [not] exploring ideas [or] solving problems creatively).” Electrical Engineering Professor Charles Yokomoto of Indiana University-Purdue University at Indianapolis “uses the [Myers-Briggs Type Indicator] as a diagnostic tool” to develop problem-solving strategies to help students who are having academic difficulties.

According to the Kolb Learning Style Model, engineering education traditionally uses an abstract, reflective style that involves lecturing. Many students prefer explanation of relevance, applications, and opportunities for practice. Julie Sharp, Associate Professor of Technical Communications and Chemical Engineering at Vanderbilt University, teaches her students to communicate to, and work with, all four learning types through assignments and group projects. The College of Engineering and Technology at Brigham Young University has also begun to train faculty to use the Kolb paradigm. Faculty have enthusiastically accepted the techniques and are applying them in their courses. Since engineering instruction focuses on left-brained, logical, analytical, quantitative, critical thinking (Quadrant A in the Herrmann Brain Dominance Instrument) and the associated detailed methods and procedures (Quadrant B), it neglects to emphasize the right side of the brain- teamwork, communications, creativity, systems thinking, synthesis and design. Edward Lumsdaine and Jennifer Voitle of the University of Toledo studied the HBDI types of engineering students and faculty members. They found a high rate of attrition among right-brain thinkers and attempted to remedy the situation through curriculum reform. The Felder-Silverman learning style model, developed by the author, is quite complex.

The author concludes that engineering instruction is “biased towards intuitive, verbal, deductive, reflective and sequential learners. However, relatively few students fall into all of these categories.” The author is developing an Index of Learning Styles (ILS) software that is being used by professors at the University of Western Ontario, the University of Michigan, and the U.S. Military Academy to make changes to their instructional methods. The author made changes to his chemical engineering courses that included presenting applications before theory, using examples and site visits to illustrate concepts, including open-ended questions and creative exercises in homework assignments, and incorporating active and cooperative learning.

Keyword(s):
Learning styles
Assessment
Active learning
Course content and curriculum

Felder, R. M., Felder, G. N., Maundy, M., Hamrin Jr., C. E., & Dietz, F. J. (1995). A longitudinal study of engineering student performance and retention. IV. Instructional methods and student responses to them. *Journal of Engineering Education, 84*(4), 361-367.

Summary: Over a five course series of chemical engineering courses, Felder utilized a number of active and cooperative learning techniques to engage students with conceptual and practical knowledge of course material.

Recommendation(s): Valid teaching techniques such as cooperative learning should be used to teach in STEM disciplines. In particular, the source of knowledge should transition away from the instructor and toward the student. Varying types of questions should be used on assignments and tests. Both concrete and abstract information should be emphasized.

Extended summary: A variety of well documented active learning techniques can be beneficial to teaching in STEM. Felder's goal was to show that increased achievement would occur by repeatedly exposing students to such techniques. Over a five semester series of chemical engineering courses, Felder taught with an emphasis on illustrating concepts through examples and utilizing cooperative (team-based learning). Felder spent most of the 75 minute class periods establishing context for problems and explaining how to approach solutions. He used realistic examples of engineering processes whenever possible, including visits to plants and laboratory experiments. Throughout class he would often have students break into groups of two to four students to work on recalling prior material, responding to questions, or some other form of problem-solving. Techniques such as these actually led to more material being covered in class than traditional lecture provided. Felder used handouts extensively and did not explicitly cover every point from the book.

Felder's emphasis on cooperative learning was primarily focused around creating homework teams. Based on scores from previous courses, Felder broke the class up into heterogeneous ability groups. These groups were required to work together on weekly homework problems, with each student taking turns with different roles("coordinator," "recorder," and "checker.") Changing roles as well as continual encouragement from the instructor helped to ensure that all group members participated. Although some students were at first hostile to the idea of forced group work, by the end of the first semester, the vast majority of students found it very beneficial.

Both homework and tests were broken into 80% traditional quantitative problems and 20% conceptual problems (such as "describe this concept "in terms a high school senior could understand"). This breakdown encouraged students to both learn the concepts and learn how to apply them. Speed as a factor for test performance was minimized, with extended blocks of time for test taking as well as tests designed to be completed in less than a regular class period.

Keyword(s):

Active learning

Collaborative learning

Engineering

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Teaching
Learning styles
Group work

Ferreira, M. M. (2002). The research lab: A chilly place for graduate women. *Journal of Women and Minorities in Science and Engineering, 8*(1), 85-98.

Summary: This article is a case study based on two interviews with female chemistry graduate students. One student faced hostility from male senior graduate students when she was beginning her program, but was able to change the culture in the lab when she became a senior student herself. The second student liked her advisor personally when she met him, but discovered that he would not evaluate her fairly after she entered the program. She was unable to complete her Ph.D.

Recommendation(s): Attempt to influence departmental culture and welcome women. Be aware of interpersonal dynamics that may occur in the laboratory. If one of your students is being hard on his female peers, tell him to change his behavior.
Include your female students in social and professional networks.
Evaluate all your students fairly, regardless of their background.

Extended summary: 60% of women surveyed in science departments have experienced harassment due to their gender. The statistics for the chemistry department evaluated in this study showed that women and men were on par in terms of their grades, but women dropped out at a higher rate than men (44.9% v.s. 31.2%). Women also reported spending slightly fewer hours in the laboratory. The author's suspicions that women were being unfairly treated in the department were confirmed by two detailed interviews with Caucasian, American-born women in the program. Their histories were quite different from one another, but both were significantly affected by sexism during their graduate program.
"Sally's" parents encouraged her to learn about science from a young age. She was not particularly interested in school and was advised to enter a local college. Sally became very interested in chemistry during college and decided to specialize in environmental issues. She entered graduate school and was immediately faced with a forbidding lab environment over which her advisor exercised little influence. She felt intimidated and was ridiculed by the male students. When she became a senior student, she changed the lab environment to make it less competitive. She also networked with other women in science and used her social support systems to make it through the program. She earned her Ph.D. and was hired by a corporation.
"Anne" was always academically confident. She double majored in chemistry and math in college because of her enthusiasm for the subjects. She entered graduate school because of difficulties with the job market, and chose an advisor who she thought would be congenial. However, she found that he was not rigorous with his male students, but

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scrutinized and often publicly criticized her work. She tried patiently to make it through exams, for which she studied thoroughly; but, no matter what she did, he was not satisfied. She finally left the program without complaining publicly.

Keyword(s):
Discrimination
Graduate school
Advising
Women
Laboratory
Expectations
Culture
Sexism

Ferreira, M. M. (2003). Gender issues related to graduate student attrition in two science departments. *International Journal of Science Education, 25*(8), 969-989 (921).

Summary: The author examines the factors pertaining to the high attrition rates of women in the fields of biology and chemistry at a large research university in the Midwest. Data were collected from departmental records. Surveys from 170 students and interviews with 32 students, in addition to interviews with 12 faculty members, were used to identify factors pertaining to the attrition of graduate students in the two departments. The results of the study indicate a larger attrition rate in the biology department relative to the chemistry department. Both departments had larger attrition rates for women than for men. Also, various factors relating to the attrition rates are reported in this paper. Those include: a chilly climate for women, overemphasis on competition rather than on collaboration, advisors favoring men rather than women, and lack of female faculty who could serve as role models. This paper provides an interesting perspective on the environment that prevails in these two departments that often prove adverse for women graduates. The study was limited to two departments within the same university. Only six students were interviewed to find out why students leave the department. Hence, caution should be taken when generalizing the results obtained from this study.

Recommendation(s): Make laboratory and departmental environments more collaborative and conducive to the academic advancement of female graduate students. Hire more female faculty members. Allow for faculty to balance family and career responsibilities through departmental changes, and make graduate students aware of these allowances. Combine research with pedagogy. Encourage biology departments to collaborate with industry to expose students to potential careers open to them.

Extended summary: The sample used in this study included graduate students and

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faculty members from the biology and chemistry departments at a large Midwestern university. The biology department had 177 graduate students, 43% of which were women. Nine of the 48 faculty members in the biology department were women. The chemistry department had 186 graduate students, 30% of which were women. There were no female faculty members in the chemistry department. Additionally, six graduate students (1 male, 5 women) who had left the program without completing their degree were interviewed to find out what led to their drop-out decision.

Female chemistry graduate students perceived the working environment in the lab and the department as "chilly," governed by "masculine patterns of behavior" and hence, discouraging for their academic advancement. Female students were excluded from informal interactions with their peers and professors in the chemistry department. Faculty members were unfriendly, unhelpful and often rude to female students. Moreover, the social environment in the chemistry department was characterized by the "survival of the fittest" concept; aggressiveness and cut-throat competition was expected from students. Female students indicated that they would have preferred a collaborative environment. Advisors discussed research related issues with male students, while they mostly discussed social issues with female students. They often ignored female students' opinions. Female students mentioned that they did not receive much mentoring from their advisors. They felt helpless and isolated due to the absence of female faculty members who could have been role models for them.

The working environment in the biology department was more collaborative and hence more conducive to the academic advancement of female graduate students. Male and female advisors were extremely helpful, supportive, and treated male and female students equally and fairly. In spite of the favorable environment in the biology department, the attrition rate is higher in this department than it is in the chemistry department. This could be because of role conflict and research versus teaching. Role conflict pertains to balancing of familial responsibilities with academic responsibilities. Female students believed that a career in research did not allow them to have families. The female faculty members in the department did not have children. The biology department had made departmental changes to help faculty balance familial responsibilities with career demands, but graduate students were unaware of them. Also, teaching is often the best option for individuals facing role conflict. But teaching is not highly valued relative to research, and students are trained to be researchers rather than teachers.

Students in the chemistry department were unaware of role conflict due to the absence of female faculty members and the seniority of male faculty members. Also, most female students in the chemistry department were young and unmarried. Students could enter industry if they faced role conflict during their research career. The biology department, on the other hand, did not have any affiliations with industry and hence, this option was closed to biology students.

Keyword(s):
Retention
Women

Biology
Chemistry
Advising
Competition
Sexism
Graduate school

Fletcher, S. L., Newell, D. C., Anderson-Rowland, M. R., & Newton, L., D. (2001). *The women in applied science and engineering summer bridge program: Easing the transition for first-time female engineering students*. Paper presented at the Frontiers in Education Conference,

Summary: This short paper reports on a successful and simple intervention program for women in the College of Engineering and Applied Sciences (CEAS) at Arizona State University (ASU). After attending an introductory week in which they learned basic computer programming, reviewed science topics, networked, and were introduced to university resources, female engineering student retention went up from 60% to 87% in the first year and from 36% to 67% in the second year of students. Although the students who attended the program may have been more motivated than their peers who did not attend, the results appear promising, and the feedback on the open-ended responses was quite positive.

Recommendation(s): When introducing female students to engineering, make the academic expectations clear, and provide them with resources to contact if they need support later.

Extended summary:"The Women in Applied Science and Engineering (WISE) summer bridge program is designed to prepare incoming female students" in their transition from high school to the University. "Students attending the program become familiar with the campus, have a head start on their freshman engineering classes, and have a chance to meet other female students."
Statistically, graduation rates of women in engineering, architecture and engineering technologies are only 42%, as compared to men, who have a 62% graduation rate. Many young women feel that they are "forced" out of the field by a combination of competition and poor teaching, which erodes their confidence.
"Attrition studies report that women enter [the field] with little information." This program set out to remedy female students' perceived lack of information and address stereotypes about math and science achievement. For female students to persist through the challenges of first-year coursework, they must be prepared to encounter obstacles and have academic and social connections to help them maintain their motivation. The program offered chemistry, physics and mathematics reviews, training in Excel and HTML, information on student services and financial aid, social events, and advising.

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A small fraction of the student participants (17% of 84) completed surveys. They indicated a high degree of satisfaction with the bridge program. The math and science course reviews and exposure to campus services earned the highest ratings. The respondents all reported that meeting other female students aided their morale. The students took advantage of the academic advising, mentoring, seminars, and computer labs provided to them by the WISE program.

The students all indicated that they decided to major in engineering after being introduced to the subject by a family member. Science and math talent and job prospects also played a role. Subsequently, the student participants often worked during college; the average amount was 15 hours per week. Many students worked off-campus. Over 50% reported that they did not participate in extracurricular organizations.

Despite the multiple demands on their time, the bridge program participants graduated at significantly higher rates than their peers who did not attend the program. (See above.)

Keyword(s):
Women
Retention
Engineering
Science
Advising
Competition
Social support
Academic preparation
Special programs

Freymuth, G. W. (2004). Diversity in the science classroom. Retrieved October 6, 2004 from http://students.ed.uiuc.edu/freymuth/490i/diversityessay.htm

Summary: The author of this piece outlines the ways in which he creates an inclusive science classroom.

Recommendation(s): Geoffrey W. Freymuth, the author of this article, describes encountering diverse students during his first day of class. He discusses the changes he could incorporate in his lesson plans in order to include all the students in his class, without being biased towards the "typical student." He wants to make science accessible and interesting to the students in his class. The author reflects on his reading of Science Instruction in the Middle and Secondary Schools by Chiappetta and his own learning experiences to gain insight on inclusive teaching practices.

The author provides various examples of inclusive teaching practices that he uses. He decides to modify experiments to accommodate a student who is confined to a

wheelchair. He also includes a section on biomechanics and rehabilitation to engage the student's interest. He incorporates the historical significance of African American scientists to address students of color. He decides to use visual aids for the student who can barely speak English and for the student with hearing impairment, so that they can get a better understanding of the concepts presented in class. He asks gifted students to do research on a topic that would be discussed in class. He also includes hands-on experiences and labs to engage students with learning disabilities.
Freymuth believes that the creation of interest in science begins within the classroom. By relating science to the lives of students, he believes he can encourage students in pursue science as a career as well as help them make better decisions concerning "their lives and the lives of others."
Freymuth does not mention that including multicultural or socially relevant examples, using visual aids and including hands-on experiences can benefit the rest of the class as well as students from underrepresented groups. Challenging the gifted student can also lead to improved learning for her classmates.

Extended summary:
Keyword(s):
Minorities
Women
Aptitude
Inclusively
K-12
Science

Frieze, C., & Blum, L. (2002). Building an effective computer science student organization: the Carnegie Mellon women@SCS action plan. *ACM SIGCSE Bulletin, 34*(2), 74-78.

Summary: Frieze and Blum describe the workings of a student organization for women within the computer science department at Carnegie Mellon. The student-run Women@SCS Advisory Council encourages the persistence of women in computer science through a series of social and professional development events.

Recommendation(s): Student organizations such as the Women@SCS Advisory Council can help to support the inclusion of underrepresented groups and their continuance in STEM disciplines. The key to these organizations' success is strong commitment from faculty and administration.

Extended summary: The number of women students in the Carnegie Mellon's computer science department grew rapidly from 1995 and 1999 as a result of high school interventions, the de-emphasis of the importance of prior programming

experience, and advantage being given to students with records of community service. In 2000, The Women@SCS Advisory Council was created to ensure these new female students would feel "at home" in the program and would be willing to stay. Frieze and Blum asserted that the creation of such organizations is dependent upon faculty and institutional support (including funding), a hired program coordinator, having set meetings and elected council leaders, a functional and promoting website, and an emphasis on service.
Graduate and undergraduate students who were members of the Women@SCS Advisory Council engaged in both professional and social activities, with graduate students less involved in the social aspects. Some of the events included freshman orientation, pairing young students with more senior "big sisters," offering small undergraduate research grants, and offering learning sessions for different computer systems such as Unix. The Council also put on a number of events to give back to the department and community. For two consecutive years, a group of graduate students led a workshop with middle school girls "Is There A Robot In Your Future?" In this and other ways, the Council is helping to bolster involvement of current women in science at Carnegie Mellon as well as future generations.

Keyword(s):
Computer science
Special programs
Women
Social support
Mentoring

Ganz, A., Howe, S., Rivera, V., & Chu, Y. (2003). *Breaking the silicon ceiling: Women in engineering freshmen seminar*. Paper presented at the ASEE/IEEE Frontiers in Education Conference, Boulder, CO.

Summary: Ganz et al. conducted a pilot study for freshmen women in engineering in the form of a weekly seminar. Ganz found that first year women engineering students enjoyed the chance for community building, experiences with practitioners and faculty, as well as the use of technology in the form of a PDA. Although the seminar did not mitigate all of the fears about the program for the women involved, it was a good beginning toward persistence of women in engineering.

Recommendation(s): Since many women who begin engineering programs do not finish them, efforts need to be made to disrupt the fears many women have in engineering programs. Chances for community building and technology use are important first steps.

Extended summary: The goals of the seminar were to build a needed community for

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women in engineering, to provide women with and empower them to use technology, and to increase professional confidence through interaction with students, faculty, available services, and practitioners in the field.
The seminar included workshops for women, minority engineering students and transfers. These workshops focused on career skills such as resume writing and time management. Sections for women only were available and focused on technology. Each participant was given an article to read and then present to the class. Every woman in the program was loaned a PDA and completed a number of specific assignments with it. Technology was also emphasized by student presentations about specific technology issues and the class use of an interactive website.
The use of technology was positive and one of the most liked features of the program. Although at the end of the program, many women still reported fears about their future, they still felt as if "they weren't alone" as female engineering students.

Keyword(s):
Minorities
Women
Technology
Engineering
Social support
Career
Self-perception
Undergraduate

Gerardi, S. (2005). Self-concept of ability as a predictor of academic success among urban technical college students. *The Social Science Journal, 42*(2), 295-300.

Summary: Surveying urban college students, the author found that self-concept of ability was a more powerful predictor of GPA than high school preparation, high school achievement, and standardized exam performance in reading and mathematics.

Recommendation(s): Hold high expectations for your students and build their self-esteem.

Extended summary: Previous research suggests that minority students who are successful in college tend to think of themselves as academically capable. Students tend to perform as their teachers expect. The author asked the question, "Is self-concept of ability an important and significant predictor of positive academic outcomes among minority and low-socioeconomic college students?"
To answer this, the author surveyed a large percentage of the incoming freshman class at a City University of New York (CUNY) technical college (307 people). This college graduates many of the nation's minority and low-SES background engineers and health

professionals. The study followed this cohort from Fall 1994 through June 1998.
The study participants had typically not done well in high school and had poor reading, writing and mathematics scores on standardized tests.
The surveys measured educational background, scores on CUNY's standardized placement examinations in reading, mathematics and writing, student performance in college, and student self-concept of ability as measured by the Brookover Self-concept of Ability Scale.
Self-concept of ability was a strong predictor of college GPA, outweighing the effects of college preparatory courses taken, high school GPA, and student test performance in reading and mathematics.

Keyword(s):
Academic achievement
Minorities
Expectations
Stereotypes
Teaching
Undergraduate

Gilbert, J., & Calvert, S. (2003). Challenging accepted wisdom: Looking at the gender and science education question through a different lens. *International Journal of Science Education, 25*(7), 861-878.

Summary: This study is a qualitative psychological exploration of the motivations behind a group of women scientists' success. The authors found that "girl-centered" course material and the presence of female role models were not formative for these women. Rather, they found that having close relationships with male family members, liking the lack of emotionality of science disciplines, and being drawn to a sense of "power" that science conveys were all instrumental in women's decisions to enter the sciences. This article is interesting because it explores the effects of the masculine culture of science on women and, in addition, does not describe women as being uniformly "feminine" in their aspirations or personality traits. In addition, it describes a phenomenon that many female scientists feel- a sense of "disconnection" from their field and a lack of personal relatedness to their work.

Recommendation(s): Encourage assertive women in your classes to pursue the sciences. Assist women in connecting their science careers with their personal lives and interests. Give women in the sciences opportunities for leadership, professional advancement and social interaction.

Extended summary: The authors critique past literature and efforts towards inclusion of women in science. They state that, although women are studying science internationally in increasing numbers, they are not participating in the workforce in increasing levels. Past literature, they write, "assumes that the problem of gender and science arises in the widespread understanding of science as being a largely 'masculine' pursuit." Based on early studies identifying the "scientific personality" as being "politically conservative and authoritarian, inward-focused [and] low in social interests and skills," educators have turned to application of science to real-world problems in the hopes of interesting women in the field. However, these programs have had mixed results.

The authors believe that women are not necessarily "feminine" and men are not necessarily "masculine." Some feminist scholars have written that women cannot succeed in science while perceiving themselves as feminine. Many programs for women in the sciences, the authors say, have taken an essentialist approach to gender, unintentionally reinforcing girls' sense of science as disconnected from the feminine.

The study consisted of a series of psychologically oriented interviews with a sample of successful women scientists, conducted in a three-stage process. The interviews were interpreted on both a surface and an unconscious level, using a "reading between the lines" technique based on the work of philosopher and psychoanalyst Luce Irigaray. The authors explored the "relationship between the internal constructions [of their subjects] as women, and their ability to fully participate in science."

The scientists who participated in the interviews saw "science as powerful knowledge." Some even described it as a means of "certainty" or "escape" during difficult times. Many saw science as "analytical," "individualistic," and even anti-feminine. They tended to keep their personal and professional lives separate. This, in addition to the social isolation, led to a sense of disconnection among many of the respondents. They expressed a desire for connection within science and a desire for power and control. They were action-oriented and expressed scientific curiosity. Many of the women described being more similar to their fathers than their mothers, and seeing their mothers' lives (as homemakers) as being "limited." (Most of the women's fathers worked in technical professions.)

In conclusion, the paper questions whether science is considered masculine because it is power-oriented, or vice versa. This report is of interest because it portrays clearly "what it takes" for some women to succeed in the sciences and the compromises that they make.

Keyword(s):

Culture
Women
Science
Identity and personality
Self-perception

Gilbert, L. A., Bravo, M. J., & Kearney, L. K. (2004). Partnering with teachers to educate girls in the new computer age. *Journal of Women and Minorities in Science and*

Engineering, 10(2), 179-203.

Summary: Gilbert, Bravo, and Kearney used an intervention in a middle school designed to alter negative perceptions of girls and technology. Through skits and group projects, children were educated about what stereotypes exist about girls and computers and then engaged in positive technology experiences without gender bias.

Recommendation(s): Misconceptions and gender stereotypes that both girls and boys hold regarding women and technology need to be confronted and changed. University programs that educate teachers and students about what stereotypes exist should be done, targeting children as early as possible.

Extended summary: "Girls and women currently have a very limited voice and place in the tech-savvy world." To this end, Gilbert, Bravo and Kearney conducted experimental studies in consecutive years at a middle school around an intervention designed to reduce the barriers between girls and computers.
The intervention was focused at both teachers and students. Students participated in two role plays (interactive skits) and two collaborative group activities The skits allowed students to take on the role of a project leader or a girl joining a group of all boys (and vice-versa). Activity 1 let students debate true-false questions about gender stereotypes. Activity 2 let female students lead a design team focused on creating the layout for a homepage. The teacher intervention involved their observation of trial skits prior to the class experience and participation in two 2-hour seminars on gender issues and education.
Gilbert, Bravo, and Kearney found somewhat significant results suggesting that the intervention encouraged future computer use for girls and more balanced views of gendered computer expertise. The authors concluded that girls' lack of computer use was more the result of them not seeing themselves as computer users as opposed to any lack of computer skills.

Keyword(s):
K-12
Women
Technology
Computer science

Gokhale, A. A., & Stier, K. (2004). Closing the gender gap in technical disciplines: An investigative study. *Journal of Women and Minorities in Science and Engineering, 10*(2), 149-160.

Summary: This article describes a survey of female undergraduates and alumnae at the Illinois State University Department of Technology. The survey questions were designed to identify ways to make a required introductory course- and the rest of the program- more "female-friendly." The course "introduced technology majors to mechanical systems, electronics, and fluid power principles through lectures and laboratory work." The students were enthusiastic about design, engineering, and hands-on work, but were at a disadvantage because of their lack of mechanical experience. The department has made outreach efforts as a result of the survey.

Recommendation(s): Offer girls and women opportunities for hands-on participation in the sciences. Don't assume that the women in your classes are already familiar with basic concepts (such as the real size of a "2 x 4"). Use examples that are relevant to women's everyday lives as well as the standard examples (pistons, rockets, etc.). Demonstrate concepts using real machines whenever possible.

Extended summary: In an attempt to discover what departmental changes would benefit female undergraduates, the authors administered evaluation surveys to female technology majors participating in a required introductory course. The authors also surveyed alumnae of the program. However, most of the alumnae had not taken the introductory course, so their responses were of limited value.
The women in the survey sample were mostly of typical college age (under 23), with little to no experience in engineering work environments. They expressed enthusiasm for technical topics, hands-on exercises, design and active learning. However, their mechanical experience was limited.
The students reported that the course examples assumed that they had the basic knowledge that comes from regular machine use and repair. The women had to work harder to understand the examples because of their unfamiliarity with the material. They noted that it was easier to understand electronics than hydraulics.
Although the instructors treated the female students with respect and were inclusive, several students mentioned that it was challenging to "prove themselves" to their male peers. However, their peers became more accepting as the course progressed.
As a result of the responses from the survey, the department has assembled a female advisory board and is offering workshops to introduce girls to engineering.

Keyword(s):
Women
Gatekeeper courses
Undergraduate
Engineering
Technology
Active learning

Grace, A. P., Gouthro, P. A., & Mojab, S. (2003). "Thinking the practice": Academic adult educators' reflections on mediating a summer institute as a multicultural learning

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journey for graduate students. *Studies in Continuing Education, 25*(1), 51-74.

Summary: The authors discuss the “transgressive and transformative learning journey” that they created during a summer workshop for graduate students called “Culture and Diversity in Education for Adults.” The participants examined how, as teachers, their cultural and societal backgrounds affected their “conceptions of pedagogy and multiculturalism.” The authors describe how their “learning journey with institute participants took [them] into the uneasy intersections of the personal, professional and political.”

The article is valuable due to its honest discussion of the difficulties of talking about diversity and its description of how the instructors negotiated the issue. Therefore, this article may be of interest to educators who are considering initiating conversations about diversity in their courses.

Recommendation(s): “[Discussion of diversity is]… difficult work, with few clear-cut answers.” However, such discussion can aid in students’ personal and professional development. In this workshop, the “students left with a much deeper understanding and a greater respect for the complexities of dealing with issues of culture.”

Extended summary: During the summer of 2000, the three authors of this article held a 10-day institute for educators at a Canadian university. During the institute, the educators discussed “degrees of inclusion/exclusion of different cultures,” “intercultural… understanding,” token recognition of diversity, “legal, legislative and cultural supports for visible minorities… and other cultural groups,” “race relations,” immigration, national sentiment, and gender issues in a multicultural context, among other topics.

The workshop was focused on educational reform. The authors consider respect for learners to be part of the foundation of effective teaching. The group discussed the value of “an ethics of [social] responsibility.” The instructors used a theoretical framework that drew on feminist, post-colonial, and LGBT perspectives. They also discussed the experiences of indigenous First Nations educators in Canada and their attempts to introduce their cultural values and world view into the curriculum.

The course was highly interactive. Students gave presentations, played games in which they took on various cultural roles, engaged in dialogic lectures, and took part in “circular response” during the class.

The instructors discussed the interpersonal dynamics which took place during the workshop. They described their own discomfort in sharing their personal backgrounds with the class and their concern about being “defined” by their perceived identity by the students. They also discussed their efforts to empower themselves in a marginalizing society.

Keyword(s):
Women

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Minorities
Teaching
Discrimination
Feminism
Culture

Greene, S. V., Wheeler, H. R., & Riley, W. D. (2004). Performance in college chemistry: A statistical comparison using gender and Jungian personality type. *Journal of Women and Minorities in Science and Engineering, 10*(3), 217-228.

Summary: The authors evaluated student performance in introductory chemistry based on their gender and Jungian personality type in order to understand how to assist students in reaching their full potential. Female students whose types were ESFP (extroverted, sensory, feeling, perceiving) and ENFP (extroverted, intuitive, feeling, perceiving) performed less well than other women in the class. Male students whose types were ISTP (introverted, sensory, thinking, perceiving) and ESTP (extroverted, sensory, thinking, perceiving) tended to perform less well than other men did. ESTJ (extroverted, sensory, thinking, judging) females tended to withdraw from the course, even though their grades were good. The most successful type across both genders was INTJ (introverted, intuitive, thinking, judging).

Recommendation(s):
Extended summary: Jung described personality structure by classifying people into sixteen categories based on combinations of four attributes:
1. Extroversion (action) versus Introversion (reflection),
2. Intuition (abstract thinking) versus Sensory perception (concrete/factual thinking),
3. Thinking (facts-based decision making) versus Feeling (values-based decision making), and
4. Judging (preferring decisions) versus Perceiving (preferring open-ended options).

For more information on the personality types, please refer to Keirsey's taxonomy (1998).
This study examined the performance of 999 students in freshman chemistry. These students had a wide variety of majors, ranging from Engineering to English. The students' grades and withdrawal rates were pooled based on gender and personality type.
The authors note that students with the combination of "Sensing and Feeling" usually opt out of chemistry. They base this conclusion on a comparison between the profiles of the chemistry students and that of the general population. This result was statistically significant across genders.
There were interesting correlations between personality type and academic performance. Women who were "Intuitive, Thinking and Judging"- logical, organized and determined- were more likely to study chemistry than other women were and were

also likely to perform well. For both genders, people with a logical (T) orientation were more likely to study chemistry than people with a values (F) orientation. Men who were "Sensing, Thinking and Perceiving" and highly detail- oriented did poorly in chemistry. Students with a flexible (P) decision making style did more poorly than students who were decisive (J).
Because of the statistical distribution of women among the sub-types, women face a disadvantage in chemistry. The article takes no position as to whether cultural change is needed or whether the "Introverted, Intuitive, Thinking, Perceiving" nature of chemistry is simply part of the academic landscape.
Since women tend to make values-based decisions (F) more often than men, women may be uninterested in studying fields that they perceive to be less value-oriented. However, women who are logically oriented and determined can be quite successful in freshman chemistry.

Keyword(s):
Women
Chemistry
Identity and personality
Learning styles

Grumbine, R., & Brigham Alden, P. (2006). Teaching science to students with learning disabilities. *The Science Teacher, 73*(3), 26-31.

Summary: Because of increasingly inclusive practices, students with learning disabilities (LD) are becoming a larger percentage of the science classroom. Many science teachers, however, lack experience teaching LD students and are unaware of how to best meet their learning needs. This article outlines basic educational principles and practical examples that teachers can use to improve the learning environment and motivation of these students.

Recommendation(s): Principle 1:
- Provide instruction that reaches the full spectrum of diverse learners
- Provide various means of assessment that capitalize on students' learning strengths or preferences

Principle 2:
- Teach and model reading and study strategies
- Teach effective ways to organize, revise, and review notes
- Teach the structure of lab report writing by providing models and templates
- If the recall of vocabulary is important, then teach and model review techniques
- Teach students to use some form of course planner or calendar that shows assignment due dates in a clear, graphical format
- Consider giving students the option of leaving their course materials in the

classroom to minimize loss of handouts and notes
Principle 3:
- Post and review daily agendas for all class activities and assignments
- Establish and rationalize a routine for how class operates
- Distribute all important assignment handouts in the same format and structure
Principle 4:
- Make a direct connection, orally and in writing, between each class task and its associated learning objective
- Provide scoring rubrics that describe the qualities of excellent work for the various components of each assignment
- Provide (or assign) some form of study guide for students to review before any quiz or exam
Principle 5:
- Instead of relying on large unit tests or exams, build in more frequent forms of assessment
- Use grade-keeping software and make updated grade reports accessible to students
- Provide direct personalized feedback to students
Principle 6:
- At the beginning of a course, have a conversation about the value of understanding one's learning profile and/or let students take a learning style survey
- Explicitly share with students your observations about their learning strengths and challenges

Extended summary: Between 5% and 10% of all K-12 children are identified as having a learning disability, and 36% to 56% of these students leave high school without a diploma. Because of inclusive practices and new identification procedures, the number of LD students in science classes is now increasing, but many science teachers have little experience in identifying and meeting the needs of these students. The authors of this article created a set of six principles to help science teachers serve LD students more effectively. The principles are based on a review of science teaching and special education literature, as well as on the authors' personal experiences at a school designed for LD students.

LD students benefit when instructors accommodate teaching to a variety of learning styles by representing content in diverse ways and using multiple means of assessment. Explicit instruction in strategies for planning, prioritizing and time management, which can be overwhelming for LD students, can also be helpful. Furthermore, explicitly organized instruction and assessment can help students plan, prioritize, and set goals. Instruction and assessment should be based on clearly stated objectives which are easily available and frequently mentioned. Students are more motivated when teachers provide consistent feedback and self-assessment information. This information is especially important for LD students because they have a tendency to falsely estimate their academic abilities.

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Keyword(s):
Accessibility/disability
Science
Academic achievement
Assessment
Communication
Learning styles
Self-perception
K-12

Hanson, S. L. (2004). African American women in science: Experiences from high school through the post-secondary years and beyond. *NWSA Journal, 16*(1), 96-115.

Summary: This study examines the intersection of gender and race by following the history of a cohort of young Black and White women from the National Educational Longitudinal Survey. Young African-American women are more likely to persist in science than their White female peers. It appears that science experiences at a young age facilitated their interest in science careers. The author writes that standardized test results tend to be biased towards the middle class and may not be effective predictors of success in science. The author believes that cultural factors may strengthen African-American women's determination and aid their pursuit of non-traditional careers.

Recommendation(s): Engage young African-American women in science experiences. Address inequities in standardized testing, as well as racism in educational settings. Share the contributions of African-American scientists with your students.

Extended summary: African-American women face both advantages and disadvantages in United States culture. Due to the legacy of slavery, Black women expect to have careers as well as having children. They also seek educational and professional achievement rather than marriage as a means of upward mobility. African-American culture encourages assertiveness and self-confidence among women. These traits are helpful to women in non-traditional occupations. Assertiveness, high self-esteem and determination are all part of the culture of science.
Through examining the science access, achievement and attitudes of a cohort of young women, the author discovered interesting trends. In general, young African-American women reported greater interest in science, and were more likely to major in the field. Although White women scored higher on standardized tests, African-American women were more likely to maintain their interest in science beyond college and persist in science-related careers. However, there is an overall attrition of women that occurs during college.

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Keyword(s):
Women
Minorities
African-American
Retention
University climate
ACT/SAT
Academic preparation
Self-perception
Motivation
Academic achievement
K-12
Undergraduate

Harris, B. J., Rhoads, T. R., Walden, S. E., & Murphy, T. J. (2004). Gender equity in industrial engineering: A pilot study. *NWSA Journal, 16*(1), 186-193.

Summary: This paper reports the findings of a pilot study on the increasing number of female graduates from an Industrial Engineering Department.

Recommendation(s): Provide students opportunities for hands-on experiences through research projects, internships, co-ops etc.
Help students, especially female undergraduates, with career planning.
Recognize any form of sexism or discrimination among students so that students can have an inclusive learning environment.

Extended summary: This study, conducted at the University of Oklahoma (OU), noted an increase in the number of female faculty members in the Industrial Engineering (IE) Department. IE classes had more female students than any other core engineering classes on campus. These classes had an active, hands-on learning environment which incorporated study groups. Also, faculty members encouraged students to participate in research activities on campus. Faculty members interacted with students during and after office hours. Female students indicated that they liked the practical application, the management potential and the people-oriented aspect of industrial engineering.
The 11 female students who participated in this study received guidance from their mothers (rather than their fathers) on their undergraduate education. They had comparatively less exposure to computers than their male peers.
Students did not feel discriminated against by faculty members and the IE department on the basis of their gender. However, female students did sense some prejudice on the part of their male peers. One female student indicated that, in spite of earning a high GPA, she felt that she had to constantly prove herself. Male students stated that female students were attracted to IE because it is a "softer" science.

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Keyword(s):
Women
Engineering
Sexism
Discrimination
Career
Advising
Mentoring
Undergraduate

Hassoun, S., & Bana, S. (2001). *Practices for recruiting and retaining graduate women students in computer science and engineering.* Paper presented at the International Conference on Microelectronic Systems Education, Los Alamitos, CA.

Summary: This manuscript lists 43 practices followed in 1997 by Computer Science and Engineering Departments (CSE) to recruit and retain female graduate students. Those practices are organized in terms of 7 rubrics, including: 1) positive departmental environment, 2) role models, 3) support groups, 4) academic and professional support, 5) attracting and retaining freshmen, 6) addressing family responsibilities, and 7) special programs. The authors did not follow sound qualitative methods in gathering this information. No studies are cited to support the validity of the practices listed.

Recommendation(s): Be aware of differences in learning styles and provide a clear description of career paths for women.

Extended summary: The manuscript presents the results of a series of interviews conducted among members of several Departments of Science and Engineering in attendance at the 1997 Grace Hopper Women in Computing Conference. The purpose of the study was to identify those practices deemed successful for attracting and retaining female graduate students. The central issue of the conference was the "shrinking pipeline" phenomenon - the attrition which occurs as women progress toward advanced degrees. Not only do women earn proportionally substantially fewer B.S. degrees in Computer Science than men, but they earn proportionally even fewer master's degrees and still fewer doctoral degrees. This leads to a substantial underrepresentation of women in the field, causing both a shortage of qualified professionals overall and the exclusion of women from participating in designing systems and products.
Successful practices are those that address the needs of female graduate students in a holistic manner. Recommended practices target academic, financial and social needs. The listed activities also emphasize the need for faculty to be aware of learning styles, the need to discuss career paths, and the need to connect female graduate students

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with role models in high-level administrative and faculty positions.

Keyword(s):
Computer science
Women
Social support
Mentoring
Recruitment
Retention
Special programs
Reentry students

Hathaway, R. S., Sharp, S., & Davis, C. (2001). Programmatic efforts affect retention of women in science and engineering. *Journal of Women and Minorities in Science and Engineering, 7*(2), 107-124.

Summary: This article describes the results of a program at a large Midwestern university that is designed to help women stay in science and engineering through a two-year shared housing program. The program was more effective for science majors, who tended to leave STEM more easily, than for engineering majors, who already had a high rate of retention. It was also more effective for White and Asian students than for underrepresented students of color.

Recommendation(s): Be aware of differences in learning styles and provide a clear description of career paths for women.

Extended summary: The manuscript presents the results of a series of interviews conducted among members of several Departments of Science and Engineering in attendance at the 1997 Grace Hopper Women in Computing Conference. The purpose of the study was to identify those practices deemed successful for attracting and retaining female graduate students. The central issue of the conference was the "shrinking pipeline" phenomenon - the attrition which occurs as women progress toward advanced degrees. Not only do women earn proportionally substantially fewer B.S. degrees in Computer Science than men, but they earn proportionally even fewer master's degrees and still fewer doctoral degrees. This leads to a substantial underrepresentation of women in the field, causing both a shortage of qualified professionals overall and the exclusion of women from participating in designing systems and products.
Successful practices are those that address the needs of female graduate students in a holistic manner. Recommended practices target academic, financial and social needs. The listed activities also emphasize the need for faculty to be aware of learning styles, the need to discuss career paths, and the need to connect female graduate students

with role models in high-level administrative and faculty positions.

Keyword(s):
Retention
Women
Minorities
Special programs
Undergraduate
Social support

Henwood, F. (1998). Engineering difference: Discourses on gender, sexuality and work in a college of technology. *Gender and Education, 10*(1), 35-49.

Summary: This paper is an incisive analysis of gender stereotyping among male and female engineers and college administrative staff. The author believes that people's unwillingness to question gender roles lies at the root of the problems- as well as the advantages- that women engineers experience.

Recommendation(s): Examine your preconceptions about gender and be willing to question them.

Extended summary: The author proposes an alternative explanation for the difficulties faced by women in science and engineering, based on discourse theory. She studied the conversations that take place about women in engineering among faculty, students, and administrative staff at a technical college in the UK. Her research led her to conclude that both men and women in engineering and administration actively resist challenging the norms of society. They believe that men are naturally aggressive and technically oriented, while women are more socially adept and should preserve their femininity.

While most women supported equal rights and opposed job discrimination, they also were reluctant to affiliate themselves with the feminist movement, which they considered overly radical. Both men and women saw female engineers as exceptional or unusual. This made it difficult for male professors to accept mediocre performance from their female students. However, male students were hostile to their female peers when they excelled. In general, men in technical fields were protective and paternal towards women engineers unless they felt threatened by them, in which case they became unfriendly and demeaning.

The author specifically states that both women and men are afraid of women who are overly assertive or unfeminine. Women in technical fields go to greater lengths to prove their femininity, and men expect that women- even female engineers- will remain somewhat deferential to them. These actions and assumptions are rooted in people's discomfort with the violation of traditional gender roles.

Keyword(s):
Engineering
Women
Sexism
Stereotypes
Science
Careers

Herzig, A. H. (2004). Becoming mathematicians: Women and students of color choosing and leaving doctoral mathematics. *Review of Educational Research, 74*(2), 171-214.

Summary: This article is a review of the literature on graduate retention of women and students of color in doctoral programs, focusing on mathematics. The author presents arguments for equity, details a series of social factors that are essential for graduate student success, and describes how these factors can present challenges to students from underrepresented groups. She proposes a cross-country race, rather than a leaky pipeline, as a model for graduate education.

Recommendation(s): Remove obstacles for female and underrepresented minority graduate students by:

1) connecting mathematics to socially relevant physical applications,
2) providing opportunities for entry-level graduate students to become involved in research,
3) mentoring female students and treating them as junior professionals,
4) accommodating the needs of students with family and other obligations,
5) providing students with professional development opportunities, and
6) encouraging your advisees.

Extended summary: The mathematics community is concerned that doctoral students are not being prepared effectively for faculty positions. The areas of deficiency include "professional development for teaching, uses of technology, exposition, developing and pursuing a research program, participation in… communities," and development of an awareness of one's professional role in the larger world. The author argues that the same conditions that work against the effective preparation of all graduate students contribute to the attrition of women and minorities. She recommends a curriculum shift to better prepare entry-level graduate students for faculty careers.

The author describes the first few years of graduate school as a winnowing process in which graduate students are being screened for "talent" and evaluated on the basis of their ability to retain information, rather than their critical thinking skills. During these first few years, students must rely on one another for academic support. Students who find

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themselves outside the cultural norm of their field may depart during this trial period; this reduces the diversity of thought in the profession. Also, students have complained about poor teaching during this period.

The filtering-out process that takes place during the first years of doctoral programs may, in fact, remove students on the basis of diversity rather than aptitude. Cultural gender bias sometimes leads mathematics faculty to perceive women's interest in interdependent work as lack of assertiveness. Unsupportive advisors may have a disproportionate effect on students from underrepresented groups. Female graduate students are less likely to be mentored and treated as equals by faculty. Social isolation also takes a toll on students.

Although research has not revealed that having children has a negative effect on science careers for women, extensive anecdotal evidence indicates otherwise. Many women faculty choose to work at small teaching colleges because of academic pressures.

Research assistantships can be tremendously helpful in integrating students into mathematics departments. Social integration with peers and faculty gives students the tools they need to succeed in their program, including an understanding of the culture and discourse of the field. In addition, intellectual integration of mathematics with real-world applications could aid in student retention.

The author describes graduate school as a competitive race in which students do not start out with equal equipment. She recommends that graduate schools, rather than reducing their student body through competition, encourage the application of mathematics to other professions.

Keyword(s):
Mathematics
Minorities
Women
Retention
Gatekeeper courses
Recruitment
Academic achievement
Academic preparation
Graduate school

Heyman, G. D., Martyna, B., & Bhatia, S. (2002). Gender and achievement-related beliefs among engineering students. *Journal of Women and Minorities in Science and Engineering, 8*(1), 41-52.

Summary: This study compared the beliefs about the gender and achievement of female and male engineering and non-engineering students. Among engineering majors, women are more likely than men to identify engineering aptitude as a fixed ability, which is associated with a tendency to give up on classes or difficult projects. Female engineering majors believe that they are treated as "lesser" than their male counterparts, while men believe that women receive "special" treatment. Women tend to study engineering for more extrinsic factors (e.g. finances, social prestige) than men do, and say that they are really not interested in the technical aspects of engineering.

Recommendation(s): Emphasize to all students that "intelligence" is not a fixed quality, but one that develops over time. Encourage female students not to give up if they don't immediately get an "A" or instantly understand the solution to a problem. Problemsolving skills are important in the job market. Create discussion groups for female students in which they can share solutions to interpersonal problems. Teach with an emphasis on mastery rather than competition (e.g. grading on a curve). Explain to female students how to deal with technical intimidation and other problems that they may face. Teach male engineering students to understand women's perspectives. Encourage girls to take an interest in the way things work.

Extended summary: Beliefs about intelligence, aptitude, the culture of engineering classrooms, and success influence students in their choice of a major. To evaluate the relationship between these beliefs, gender, and choice of major, the authors surveyed 238 undergraduates at the University of California, San Diego, 142 of whom were enrolled in engineering. The predominant ethnicities were White (~50% in all fields) and Asian (38% in engineering, ~23% in other fields).

Both male and female engineering students were equally likely to believe that intelligence was innate (~50%). However, female engineering students were much more likely than males to believe that engineering aptitude was a fixed quality (72% vs. 46%). Of the female engineering students who reported dropping a course when they faced difficulty, 100% believed that engineering aptitude was innate. In contrast, male students dropped courses without regard to whether they thought engineering talent was innate.

Female engineering students were ~25% more likely than males to believe that women were treated differently in the classroom. In all other majors- social science, other sciences, and humanities- very few students reported gender bias. Comments from the students in engineering revealed a profound disconnect between women's and men's perspectives. Men reported that they thought women were treated with higher consideration and more attention, while women perceived lower expectations and even "intimidation." Many male engineering students appeared to resent this "special" treatment, but some agreed with the women's perspectives.

Men in general were more likely to place a high value on societal and financial success than women. However, men in engineering were more likely to be intrinsically interested in their coursework than women in engineering were. The reverse was true for students

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in non-engineering fields, where women reported more satisfaction. This may be related to the way engineering material is presented in the classroom.

Keyword(s):
Women
Retention
Aptitude
Self-perception
Academic achievement
Discrimination

Hughes, W. J. (2000). Perceived gender interaction and course confidence among undergraduate science, mathematics, and technology majors. *Journal of Women and Minorities in Science and Engineering, 6*(2), 155-167.

Summary: The study examined the connection between students' gender and their perceptions that Science, Mathematics and Technology (SMT) majors are better suited for males. The authors used self-reported data obtained from upper-level SMT courses taught at Georgia Southern University. The sample consisted of 352 individuals, 45.8% of whom were women. Women reported lower course confidence, less recognition by and respect from instructors, and less respect from their male peers. They also reported that the SMT curriculum is better suited for males, whereas male students did not.
The study builds upon an extensive review of the literature. It is a good source of information on how the social environment within the classroom can be modified to increase the persistence of female students in SMT majors. However, the descriptive nature of the study makes it impossible to infer causal connections.

Recommendation(s): Instill course confidence among students by effectively communicating respect to all students, creating a gender-inclusive curriculum, recognizing students' academic skills, and encouraging them towards academic achievement. It is also important to avoid favoring certain students over others in the classroom.

Extended summary: Previous studies indicate that female SMT students have lower course confidence than do male students. The factors contributing to this trend are 1) the interpersonal dynamics that female students experience with male faculty and peers, and 2) the gender-exclusive nature of the curriculum. Specific contributing factors include: 1) gender-biased instructors, 2) sexual harassment, 3) discrimination, 4) exclusion from study and work groups, 5) resentment towards high-achieving female students, and 6) perceived lesser importance of the academic and career goals of female students. Such studies suggest correction of this scenario by creating a genderinclusive curriculum, increasing the number of female faculty within STEM fields,

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using female guest speakers and "support[ing] female peer and professional mentoring initiatives."
The results of this study indicate the following:
1. Female SMT students reported lower course confidence relative to male students. Course confidence levels among female students were not significantly affected by the gender of the instructor.
2. Fewer female students than males reported that their instructors knew them by name and respected them, that their instructors had a gender-inclusive curriculum, and that their male peers respected them.
3. Instructors stated that they favored neither male nor female students.
4. Female SMT majors with male instructors reported the least favorable classroom experience, while male SMT majors with male instructors reported the most favorable classroom experience.
5. Perceived respect from instructors was positively related to course confidence among both male and female students.
6. Perceived personal recognition from female instructors was positively related to course confidence among female students.
7. Course confidence was positively related to academic achievement among male students with male instructors.
The female students' perception of unfavorable gender interaction in the classroom is significant. This perception can impact female students' academic behavior, academic achievement and self-concept. Since perceived respect from instructors affects course confidence for both men and women, it is recommended that instructors convey respect for all students. Female instructors should also attempt to personally recognize their female students.
Further research is required to examine what specific behaviors are perceived by female and male STEM students as respectful. Further exploratory research is necessary, since the gender interaction model tested in this study could not effectively predict course confidence among female students with male instructors. The authors suggest that a longitudinal study of students enrolled in STEM fields would help to identify the correlation between gender interaction within the classroom, persistence in STEM fields, course confidence, and academic achievement.

Keyword(s):
Women
Self-perception
Aptitude
Stereotypes
Discrimination
Sexism
Social support
Undergraduate

Irvine, J. J. (1985). Teacher communication patterns as related to the race and sex of the student. *Journal of Educational Research, 78*(6).

Summary: "This article summarizes previous research [on] teacher communication patterns related to student race and student [gender] and presents the findings of a study which examined the differences in teachers' verbal feedback statements to black and white and to male and female students. Observational data were obtained from 67 classrooms in 10 schools in 4 school systems."
"The researcher found that black students received more negative behavioral feedback and more positive-negative feedback than did white students. Females received significantly less total communication, less praise, less negative behavior feedback, less neutral procedure feedback, and less nonacademic feedback. The white female received significantly less total communication than the other three race/[gender] groups. [and] less neutral behavioral feedback and less academic feedback than did white males."

Recommendation(s): Make an effort to communicate with white female students, who may do their work quietly and ask fewer questions. Give white females non-academic feedback and encourage them to be assertive. Do not allow white male students who demand attention to dominate the classroom.
Adapt your teaching style to include the needs of kinesthetic and relational learners. If you are a white teacher working with black students, learn to understand the culture, and examine your perceptions of what a "successful student" looks like.
Note: This study took place in a K-12 environment; behavioral norms change by the time students are in college.

Extended summary: This article reviews the existing literature on teacher communication as related to the race and gender of their students. The author believes that the literature lacks "internal coherence" and uses "idiosyncratic methodologies" to study both race and gender. However, the literature frequently suggested the existence of race- and gender-based discrepancies in teacher behavior.
The existing literature addressing race, in general, reported that black pupils received more negative academic and behavioral feedback. One experimental study showed that teachers gave gifted white students the most praise while they gave gifted black students the most criticism. The overall patterns that emerged from the previous work were that "teachers, particularly white teachers, had more negative. beliefs about black children than about white children regarding. potential for success in college, initial impression, deviant behavior, [and] ability."
The studies of gender bias observed that teachers both criticize boys and interact with them more than they do with girls. Teachers believe girls to be better-behaved than boys. The author cites the "Pygmalion effect", in which students begin to perform according to their teachers' expectations.
The author performed a large-scale study of race and gender effects on

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teachercommunication. The majority of the teachers were white (61/67), and almost all of them were female. The classes were small (approximately 21 students), and included metropolitan and rural classrooms. The trained observers who participated in the study were racially diverse, and their agreement coefficient ranged from 0.80 to 1.0. Although there were many black students in the total sample, the author does not address the degree of integration of the individual classrooms.

“Females received significantly less total communication, less praise, less negative behavior feedback, less neutral procedure feedback, and less non-academic feedback. [This] data. illustrates the salience of boys in the classroom. The prominent and conspicuous status of males in the classroom is reflective of their sex role socialization. Brophy and Good (1974) speculate that high-achieving males assert themselves by dominating class discussions.[while] low-achieving males misbehave and challenge the teacher.”

White females received significantly less total communication. “This finding suggests that white females are more unobtrusive in the classroom than black females, and possibly have been subjected to. more traditional [gender] role socialization. Because white females are more likely to be on-task and manageable, they receive. indifference, even neglect.” which may be related to subsequent low self-esteem in the classroom and in adult life.

Black students received more behavioral feedback, as well as mixed positive-negative feedback, which may confuse them or lead them to feel that the teacher is not being honest. The author observes that, according to Adams and Lavoie (1974), “a child who a teacher perceives as not conforming to behavioral expectations is viewed as having less potential and lower ability.” She believes that cultural differences inhibit communication between white teachers and black students, “who have been described by researchers (Hale, 1982; Shade, 1982) as being more. expressive, active, spontaneous, creative, and. relational” than white students. She notes that white teachers consider white students more “mature”, compared to black students, than black teachers do.

Keyword(s):

K-12
Stereotypes
Minorities
Women
Communication
Teaching

Jacobs, D. (2004). An alternative approach to general chemistry: Addressing the needs of at-risk students with cooperative learning strategies. Retrieved September 30, 2004 from http://kml2.carnegiefoundation.org/gallery/djacobs/index2.htm

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Summary: This website describes the "implementation of the alternative course" designed by Professor Dennis Jacobs (of the Department of Chemistry at the University of Notre Dame). It demonstrates methods used by Professor Jacobs to investigate the impact of the alternative course on at-risk students. Videos document the cooperative learning process. Interviews of student focus groups indicate where the students think that their best learning takes place. The website also contains surveys of student perceptions, attitudes and study habits. Results of a longitudinal study of students in traditional general chemistry course and those in the "redesigned" general chemistry course are included.

Recommendation(s): Use cooperative learning to foster student knowledge and engagement. Encourage students to discuss concepts with each other. Train TAs to create positive and collaborative interpersonal dynamics.

Extended summary: Professor Jacobs lists the pitfalls of a large lecture format, which highlights the benefits of the alternative course design over the traditional course design. Small focus groups were formed with a random sample of students enrolled in general chemistry to understand how students learn in the traditional chemistry classroom. The web site documents students' poor study habits in the traditional chemistry class. Students did not feel encouraged to keep up with readings for lecture or ask questions, feel responsible for what happens in class or feel compelled to develop their problem solving skills. Other limitations of the large lecture format include that students take notes without thinking deeply about the course material. Sometimes, the instructor cannot assess students' understanding of the material, but continues to teach regardless of how much the students might have understood. Professor Jacobs presents the alternative general chemistry course and compares its effectiveness to a traditional general chemistry course vis-à-vis student understanding, student persistence in chemistry, and grades. He used "concept tests" in his 250-student classroom in which students paired off to discuss conceptual questions. The website has links to examples of chemistry concept tests used by the University of Wisconsin-Madison and Carnegie Mellon University.
The website contains video clips of students of cooperative learning which demonstrate how students' understanding of course material increases through small group interaction. The videos show the crucial role of the TA in "establishing an environment where cooperative learning is effective and enjoyable." They demonstrate TA-student and student-student interactions that are beneficial to learning.
"At-Risk" students are those students who have a greater probability of "dropping out of the general chemistry course and are not going on to advanced chemistry courses."

Keyword(s):
Chemistry
Active learning
Class discussion
Motivation

Gatekeeper courses
Undergraduate
Retention
Laboratory
Academic achievement
Collaborative learning
Group work

Johnson, A. (2007). Graduating underrepresented African American, Latino, and American Indian students in science. *Journal of Women and Minorities in Science and Engineering, 13*(1), 1-21.

Summary: Johnson took an in-depth look at the University of Colorado's Minority Arts and Sciences Program. She compared the retention and GPA statistics of ethnic minorities who participate in the program with those of both minority and white students who are not involved in MASP. She explored the reason students leave the sciences rather than staying through graduation, in an effort to help figure out how to prevent the loss of qualified minority students from science.

Recommendation(s): It is important to create an environment that encourages the retention of minority students in the science fields. The program's main goal should be to shelter students from nonacademic obstacles: stereotype threat, lack of knowledge about college and the culture of science, lack of personal support, racial prejudice, and isolation due to the absence of minorities in the university population.

Extended summary: The author focused on three ethnic minority groups throughout her study - African Americans, Latinos, and American Indians. By looking into the University of Colorado's MASP program - briefly comparing it to the University of Maryland, Baltimore County's comparable Meyerhoff Program - Johnson found some contributing factors that partially account for why minority students tend to leave science for other disciplines. Statistics show that increased GPA and financial aid are not directly related to retention rates. These three minority groups have repeatedly stated that personal support from family and university faculty motivated them to stay in the science programs. The students noted Academic Support, Scholarship, Staff Support, and Peer Support as the reasons they have stayed in the MASP program. With MASP, this kind of support is encouraged, and the students are more likely to graduate in science as a result.

Keyword(s):
Science
African American
Latino

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Minorities
Retention
Undergraduate

Kahveci, A., Southerland, S. A., & Gilmer, P. J. (2006). Retaining undergraduate women in science, mathematics, and engineering. *Journal of College Science Teaching, 36*(3), 34-38.

Summary: This study examines the effectiveness of a program intended to retain women in science, math and engineering majors. The retention and attitudes towards science education of first-year female undergraduates who were participating in a support and mentoring program were compared to those of students who were not enrolled in a program. After one year, significantly more students from the program than students who were not participating in the program remained in the SM&E fields.

Recommendation(s): Supportive environments, close student-faculty relationships, and opportunities for research experiences are fundamental to student success and retention. If universities want to reduce the loss of potential talent, programs focusing on student interactions with faculty and other students in their discipline need to be established to retain more women in SM&E fields.

Extended summary: Women are still underrepresented at the college level in SM&E majors. This study compares the retention of undergraduate women participating in an SM&E support and mentoring program called PWISEM (The Program for Women in Science, Engineering and Mathematics) with the retention of other closely matched undergraduates who were not in the program.

The program required the women to live together in a residence hall the first year and included a one-credit course entitled “Women in Science Colloquium,” in which scientists from the university described their research.

In the study, the PWISEM students were compared to the HGC (Honors General Chemistry) students over the course of one academic year. The HGC students were chosen due to their similarities to the PWISEM students in high school GPA, SAT, and intention to pursue SM&E majors. A pretest-posttest design was employed which tested the students before and after their first year in college. The students answered questionnaires on 23 items including their interest in the field, determination to pursue a SM&E major, view of science and scientists, and intended major.

According to the results there were no significant differences in interest, confidence, or determination to pursue an SM&E major between the groups. There was also no significant difference in GPA. Views of scientists were similar; however, PWISEM students were more likely to disagree with stereotypes about scientists. The biggest differences were seen in terms of the students' major choice. In the beginning of the academic year, the majority of students from all groups intended to pursue SM&E careers. At the end however, a significant part of the HGC students had decided on non-SM&E careers, while all PWISEM students remained in the SM&E fields. When compared with non-program students, program students were more likely to choose an SM&E major.

Keyword(s):
Science
Mathematics
Engineering
Women
Feminism
Retention
Networking
Undergraduate
Motivation
Social support

Kane, M. A., Beals, C., Valeau, E. J., & Johnson, M. J. (2004). Fostering success among traditionally underrepresented student groups: Hartnell College's approach to implementation of the Math, Engineering, and Science Achievement (MESA) program. *Community College Journal of Research & Practice, 28*(1), 17-26.

Summary: This article describes the successful Math, Engineering and Science Achivement (MESA) program which is currently taking place at Hartnell College in California. Students in this program have averaged one letter grade higher in performance than students who have not participated. The program has increased math and science enrollment at this Hispanic Serving Institution significantly. MESA provides many services to students which include academic support, career counseling, priority registration, academic counseling, assistance in transferring to a university, leadership opportunities, field trips, and early intervention when problems occur. The administrators of the program have leveraged external funding to improve student services.

Recommendation(s): Initiate comprehensive supportive programs for first-generation college students to enable them to transition effectively to college life. Create opportunities for them to connect with career advice, financial support, and role models in math, science and engineering.

Extended summary: Hartnell College serves a region of California largely populated by

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Latinos, 90% of whom have not attended college. There are many migrant workers, and unemployment is high, especially in recent years. 82% of Hartnell students are the first in their families to attend college. Most of the student body holds either full-time or part-time jobs in addition to attending college. 67% of the students are minority and 55% are female.
At this institution, Latino students are underrepresented in higher-level science, math and engineering classes. The college has identified finances and the need to hold outside employment as the main barriers to success for Latino students in these fields. Working in addition to attending school increases the likelihood that students will drop out of challenging academic programs.
Given the increasing demand for graduates with technical expertise, Hartnell administrators seek to prepare their students for science-based careers through the MESA program. The program includes: "outreach and recruitment, orientation activities, a MESA student center, student cohort clustering, academic excellence workshops, academic planning, counseling support, professional development opportunities, university campus tours, and hands-on experience." MESA staff also perform outreach at local high schools.
MESA has led to an increase in enrollment in many math and science courses. The number of students majoring in math has increased 54% and the number of students majoring in engineering technology has increased by 82% since 2000. Participants have averaged a full grade increase as compared to non-participating students.
The program has sought external funding through the U.S. Department of Education, Hewlett-Packard, NASA, the NOAA, and a locally funded government bond.

Keyword(s):
Undergraduate
Mathematics
Engineering
Science
Minorities
Latino
Academic achievement

Keilson, S. (1997). *Infusing a multicultural approach to education in the engineering and science curriculum.* Paper presented at the ASEE Conference: National Conference on Outcomes Assessment for Engineering Education, Washington, D.C.

Summary: This motivational paper describes changes that the author has implemented to make an introductory engineering course more open to women and multicultural students. Her research in this area is aligned with that of other scholars in the field. She introduced discussion of ethics, the social impacts of technology, government funding priorities, learning styles, and female and minority contributions to computing. She also used exercises designed to undermine stereotypes. No course evaluation data is included in the article.

Recommendation(s):1) Initiate discussion of historical and current cultural, economic, ethical and legal issues in engineering.
2) Provide engineering students with diverse role models.
3) Encourage students to understand their own learning styles (Kolb, HBDI or MBTI) and their professional significance.

Extended summary: The article begins with strong arguments for creating an inclusive culture in engineering and the physical sciences, comparing the lack of progress in these disciplines to the relative success of women and minorities in "law, medicine and government." The author believes that, as engineering companies internationalize their work force and encourage collaborative work, students must learn to communicate with others who are different from themselves. She also states that departments will be able to attract more funding and choose from a wider pool of talented students if women and minorities are included in the field.
The author advocates "mak[ing] explicit the connections between scientific culture and other human cultural enterprises and relationships." If professors humanize and demystify the scientific process, students will feel more comfortable thinking critically about science and will therefore become more creative scientists and citizens. "Neutral teaching," she says, can actually make courses less accessible. When a teacher sees himself or herself "as [a] coach rather than as a filter of the fit and unfit," the author states, science courses will become less intimidating.
The author recommends applying these principles by taking the following steps:
1. "Teach[ing] the history of the field."
2. Presenting students with role models to expand their concept of engineering.
3. Discussing ethical, political, and social issues in the context of technology.
4. Including students who have non-traditional learning styles.

Keyword(s):
Culture
Course content and curriculum
Minorities
Classroom climate
Engineering
Women
Recruitment
Retention
Inclusively

Kelly, R. R., & Mousley, K. (2001). Solving word problems: More than reading issues for deaf students. *American Annals of the Deaf, 146*(3), 251-262.

Summary: This study explored the common claim that deaf students' difficulties with word problems in math are a function of their reading level. The authors conclude that, while some common mathematical language is difficult for deaf students, the problem is not primarily an issue of reading level but is instead an issue of persistence, focus, handling complex information, and making connections between problems, all of which can be modeled in math courses.

Recommendation(s): Deaf students face unique learning challenges because they sometimes do not acquire the habits of problem solving that are necessary for success in math (and other math-based subjects). These habits of thinking include optimism about one's ability to succeed, connection of information from various types of problems, awareness of the relevance of course material to future goals, and knowledge of how to approach complex problems and analyze them. With deaf students, it is especially important to effectively explain mathematical terms such as "if/then", "greater than/less than", "not", "should, could, since/because", and vague or lengthy descriptions. It is important for instructors at every level to encourage students to develop strong problem-solving skills, a positive attitude, and persistence.

Extended summary: Learning how to solve word problems is a building block of developing complex problem-solving skills, according to Briars and Larkin (1984), and is strongly emphasized in math teaching.

Word problems typically pose difficulty for both deaf and hearing students. However, deaf students appear to face specific challenges in interpreting the language commonly used in word problems (see above), as well as to have difficulty reflecting on problems, transferring knowledge learned during one problem to the next problem, and persisting to find solutions.

Teachers sometimes connect deaf students' difficulties with word problems to reading issues. Although deaf students do sometimes have difficulties with reading, this study shows that the connection between reading and word problem solving is more complex than it appears.

The author compared the mathematical performance of 3 groups of deaf college freshmen and sophomores (n=11) to that of a control group of hearing students (n=11). (The experimental group's reading scores were not equivalent to those of the control group because the reading tests were different for deaf and for hearing students.) None of the students were math majors or had learning disabilities. The students completed three problem sets of increasing complexity using multiplication, addition, and subtraction. Each set had a graphical/numerical section and a word problem section that paralleled it. (The problems were similar, but not identical.) The authors analyzed the solutions that the students presented and also noted student comments. All of the

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problems were at a reading level that the deaf students could understand and contained no difficult language (see Recommendations).

The results revealed that, although the deaf students were as likely as hearing students to draw accurate diagrams for the word problems, they were much more likely to make computation errors or leave the problem blank. Qualitative feedback from the deaf students indicated a strong aversion to doing word problems, as well as doubt about the relevance of these problems to their future work. While the hearing students appeared to notice the similarity between the graphical/numeric problems and the word problems, the deaf students were less likely to make that connection. This may also have been related to the fact that they were discouraged about solving word problems.

Keyword(s):
Accessibility/disability
Mathematics
Expectations
Academic achievement

King, D., & Domin, D. S. (2007). The representation of people of color in undergraduate general chemistry textbooks. *Journal of Chemical Education, 84*(2), 342-345.

Summary: In this study, King and Domin documented four types of bias in general chemistry textbooks. These types of bias relate to the underrepresentation or misrepresentation of people of color. The most commonly noted bias was "invisibility" - there are fewer people of color shown in chemistry texts than there are in the general population (over 35%). All three of the other types of bias were also present: "cosmetic" bias, "fragmentation/isolation," and "stereotyping."

Recommendation(s): The recommendations below are intended for science textbook authors.
1. "Show people of color doing science."
2. "Place more photographs of people of color in earlier chapters as opposed to later chapters."
3. "Place the photographs in chapters that are more likely to be covered."
4. "Show people of differing ethnicities in the same photograph as equals."
5. "Avoid photographs that perpetuate stereotypes of specific ethnic groups."

Extended summary: In addition to helping students understand scientific phenomena, illustrations in science textbooks also can affect students' attitudes toward science and their perspectives on who can become a scientist.

In this study, the authors evaluated instructional bias in the representation of ethnic

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minorities in general chemistry textbooks. Their analysis omitted photos of the authors, and categorized the remaining images of people in the texts as "historical, person of color, not a person of color, or ambiguous." The images of people of color were then categorized to determine whether any of the following four types of bias were present:

1. "Invisibility" occurred if people of color were underrepresented in the book (as compared to recent U.S. census figures). Invisibility was also noted if the people of color were portrayed in a non-science-relevant context.

2. "Stereotyping" was considered an issue if an illustration reinforced a generalization about a minority group (i.e., Asians studying).

3. "Fragmentation/isolation" occurred if the people of color were only represented together with other people of their same ethnicity, or if the image was part of a boxed section.

4. "Cosmetic bias" was present if an image including a person of color was placed prominently in the text, but the text otherwise contained few representations of ethnic minorities.

The authors found that all the textbooks in their study met the first criterion for invisibility - simple numerical underrepresentation. The only book which contained a somewhat higher number of images of people of color, Chemistry in Context, was intended for non-majors. Fragmentation/isolation occurred in six of the eleven texts. Stereotyping appeared in four texts. Finally, cosmetic bias was found in two textbooks.

The authors provide recommendations for textbook authors at the end of the paper.

Keyword(s):
Chemistry
Minorities
Latino
African American
Discrimination
Stereotypes
Course content and curriculum

Kvam, P. H. (2000). The effect of active learning methods on student retention in engineering statistics. *The American Statistician, 54*(2).

Summary: Kvam taught an introductory engineering statistics course in alternative ways in consecutive semesters, using active and cooperative learning methods and

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using traditional lecture. He discusses the pros and cons of using the active learning technique.

Recommendation(s): If teachers are willing to make the effort, active learning can be a useful technique to teach students who otherwise might not have learned very much. It also allows a teacher to get to know students better and perhaps propel their interest in a subject so that they will pursue advanced coursework and graduate school.

Extended summary: Kvam found that the active learning class required more work from the professor than traditional lecture, especially the first time it was taught. The students appeared to enjoy the active learning class more but also reported lower teacher ratings. The "lower half" of the active learning class benefited the most while the highest achieving students sometimes did not appreciate group work because "they had to carry most of the load." The active learning class learned from failure, trying an experiment and seeing that it wouldn't work, as opposed to simply being told what to do. In general, given the small sample, Kvam did not find any statistically significant differences between his two courses. He suggests that a larger sample would likely find long term retention of information benefits from active learning methods for average students and lower-performers.

Keyword(s):
Engineering
Mathematics
Teaching
Collaborative learning
Academic achievement
Active learning

Lewis, B. F. (2003). A critique of literature on the underrepresentation of African Americans in science: Directions for future research. *Journal of Women and Minorities in Science and Engineering, 9*(3&4).

Summary: After an extensive review of the literature, the author concluded that there are virtually no empirical studies focused on understating why African Americans remain disproportionately underrepresented in STEM fields. This lack of knowledge is a major limitation in formulating policy decisions aimed at reducing this underrepresentation. Five limitations in the literature are noted: 1) lack of quantitative observation, 2) poorly defined analysis of career decisions, 3) lack of variety in research approaches, 4) a tendency to equate career attainment with career choice, and 5) the lack of explanation for these ethnic-based disparities. Well grounded in the literature, the main contribution of this paper is to set up the criteria future research should meet when examining the under-representation of minorities in STEM fields.

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Recommendation(s): The author acknowledges that it is a cliché to suggest that "More research is needed," but he argues that of greater importance is the need for aprotracted research agenda aimed at gaining a greater depth of understanding of the intricacies of underrepresentation.

Extended summary: The author argues that policy initiatives and intervention efforts have yielded very little progress in improving African-American underrepresentation in sciences and technology. He finds that most research tends to rely on folk insight rather than on sound empirical evidence. Seeking to fill this void, the author conducted a comprehensive review of the literature. The selection criteria included: 1) empirically-based studies, 2) publication in a refereed journal, 3) African American topic, 4) a focus on science and science related careers, and 5) recent publication (1990 or later). Only 5 out of 157 articles identified met the selection criteria. The literature identifies several six main factors contributing to underrepresentation of African American in science. These include: 1) students' lower levels of confidence in their abilities in science; 2) fewer math and science courses taken; 3) lowered students' self-image as scientists; 4) poor academic preparation; 5) lack of role-models; and 6) perception of limited career opportunities. Lewis extensively discusses his conclusions by noting the following five features of the extant literature. The most striking of them is the lack of sound empirical research on the topic. Most of the material is made up manuscripts reporting intervention programs, stating positions, or providing descriptive statistics. The second striking feature is the preponderance of research on poorly defined factors found to correlate with student's career decisions (e.g. choice of major, having positive attitudes about oneself as a scientist). The third striking factor is the implicitassumption that underrepresentation in STEM is due to deficiencies in the life histories of African Americans. This appears to lead to oversimplification and an unsupported view of correlations as causation. The fourth factor is the assumption that underrepresentation of African Americans in science is a result of students' choices, masking the fact that science career attainment is a social process and that desire of an aspirant is only one factor in this process. A fifth finding of the literature is that there is no determined link between student career decisions and race or ethnicity.

Keyword(s):
Academic preparation
African-American
Minorities
Science
Engineering
Career
Self-perception
Mentoring

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Li, Q. (1999). Teachers' beliefs and gender differences in mathematics: A review. *Educational Research, 41*(1), 63-76.

Summary: This paper reviews the research to date on the effects of mathematics teachers' gender and beliefs on their attitudes and behavior towards male versus female students. The results indicate that, while teachers' grading behavior is fair, teachers' expectations of student success may reinforce gender stereotypes. Female teachers are also more likely to use active and collaborative learning methods. In general, students rate their teachers of the same gender more favorably.

Recommendation(s): Examine any societally-created expectations that you may hold about your students' skills in math based on their gender. Observe your treatment of students in the classroom. Remember not to steer women away from math-related careers. Try to view students based on who they are, not who you think they are.

Extended summary: The author summarized and, to some degree, evaluated current literature on the effects of teacher gender and gender-related beliefs on mathematics education. He begins by stating that it is important to transmit "appreciation of thebeauty of mathematics" (Fennema, 1990) to women, since mathematics is culturally important.
The author proposes a graphical model which describes the following causal relationships: teacher gender affects teacher beliefs, both of which affect a circle of the following factors (all of which influence each other): student beliefs, student behavior, student achievement, and teacher behavior. This framework suggests possible observational goals for further research.
The research summarized in this paper shows that mathematics teachers in the U.S., while grading fairly on a gender basis and believing that their gender does not influence their teaching, continue to hold much higher expectations for male students. Teachers tend to interact more with male than female students and to consider male students superior in "ability. more competitive, more logical, more adventurous. enjoy[ing] mathematics more and more independent in mathematics." Female students observed that "the teacher appeared to believe that mathematical problem solving was not for them."
Students in a Nigerian study preferred teachers of their same gender. In the U.S., students tend to rate teachers who are of their same gender more highly. (This factor is not considered in typical evaluation of college-level instructors.)
In general, male and female teachers appear to be similar in skill level and to hold similar beliefs about mathematics. The only differences that the author notes is that female teachers tend to use active and collaborative learning methods, as well as discussion, more often, and to give praise and other "indirect" instruction (expanding upon student points and acceptance) more than male teachers do. The author recommends further qualitative research, more research into "gender differences of teachers'. beliefs about the content", and further exploration of "the relationship between the gender differences of teachers' beliefs and the gender differences in their decisions

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and classroom instructions."

Keyword(s):
Academic preparation
Stereotypes
Expectations
Active learning
K-12
High school
Sexism
Teaching
Collaborative learning
Mathematics

Lopez, E. M. (2001). Guidance of Latino high school students in mathematics and career identity development. *Hispanic Journal of Behavioral Sciences, 23*(2), 189-207.

Summary: This article discusses the mathematics performance and career decisionmaking process of Latino high school mathematics students and relates them to the level of guidance received from teachers, tutors, parents and peers. The author found that many students were giving up on choosing a career and had decided to accept whatever type of job was available to them. This pessimism increased as the students grew older. The author also found that, while 47% of students were taking college-preparatory math courses, 41% were in remedial courses in which their grades did not improve with instruction.

Recommendation(s): Encourage high school math instructors, tutors and guidance counselors to talk with minority students about their career options in math and science fields.

Extended summary: The author did not find that instruction received in math courses appeared to be influencing students to explore their career options. However, instruction in college-preparatory courses was correlated with an improvement in grades. This may have been because the higher-performing students were asking more questions. In the remedial courses, the relationship between grades and instruction was reversed.
The students in the research sample were from working-class backgrounds. The author suggests that economic problems may have contributed to the students' pessimism about being able to pursue a career of their choice. A minority of students (28%) considered themselves to be engaging in career exploration. The author did not explore the effects of conversations with guidance counselors.
In general, students received more guidance in their career development from parentsand friends than they did from their math teachers and tutors. The students'

teachers were their primary source of information about math, but were not mentoring them extensively. Given their sources of career information, the students may not have been exposed to the option of math-oriented careers.
Since this sample is from one high school, it is not necessarily representative of the Latino population in general.

Keyword(s):
Academic preparation
Advising
K-12
Latino
Careers
Mathematics
Mentoring

Malcom, S. M. (2006). Diversity in physics. *Physics Today, 59*(6), 44-47.

Summary: Malcom discusses the low percentage of Underrepresented Minorities (women, African Americans, Hispanics and American Indians) entering and earning degrees in physics. The author looks at the trends, starting with elementary school, which may be affecting the decision-making process of minorities. She then presents some possible ways to promote physics to prospective students.

Recommendation(s): Malcom gives several suggestions of ways to improve the educational system to promote diversity within physics. Some implementations are meant to begin at the earliest grade levels:
-Education and professional development so that those who teach physics are confident and comfortable teaching physics concepts.
-High-quality, hands-on, inquiry-based science for the primary grades.
-Development and dissemination of high-quality, research-based curricula for the middle grades.
-Experimentation with curriculum and instructional models, including such strategies as "physics first," to increase the number and diversity of students taking physics in high school.
The author also gives recommendations for schools with a significant number of URM students.
-Recruitment of female and URM students at all levels to take physics classes and to engage in informal physics experiences such as those offered in science and technology centers, after-school programs, and camps.
-Support of physics programs in institutions that serve URMs.
-Increased recruitment of bachelor's-level minority students for summer internships and research opportunities.

-Transfer of effective models from high-production to low-production institutions.
-Exploration of the efficacy of mentoring or a community of colleagues to improve the retention of minorities, including women, in graduate school.
-Understanding of the departmental climate as a factor in increasing student diversity.
-Awards and recognition for individuals and departments that effectively mentor URMs.
-Support, through professional organizations, for the professional development of women, URMs, and persons with disabilities, as well as for those who teach and advise them.
-Equal opportunities for employment and advancement.
-Focused attention on the needs of female URMs in physics at all levels.

Extended summary: In 2004, women received 15.5% of the total physics doctorates for that year, and both African Americans and Hispanics only received 1% (13) doctorates that year. Only a single doctorate was awarded to an American Indian the same year. Malcom points out the small number of ethnic Underrepresented Minorities (URMs) entering the physics field with intent to earn either a degree or a doctorate. She shows evidence from authors Gopnik, Meltzoff, and Kuhl that it is an innate human ability to reason and observe physics-related actions from a young age. Malcom then questions how the education and career advice students receive throughout their primary schooling reduce this natural ability and interest. She then goes on to present several ways to encourage students to pursue a career in physics, including the most basic: confidence, encouragement, and tangible proof of minorities' success in science-related careers post-graduation.

Keyword(s):
Physics
African American
Minorities
Latino
Women
Academic preparation
Career
Recruitment
Retention

Marra, R. M., & Bogue, B. (2004). The Assessing Women in Engineering project: A model for sustainable and profitable collaboration. *Journal of Women and Minorities in Science and Engineering, 10*(3), 283-296.

Summary: This article describes a successful collaboration between a Women in Engineering program director and an assessment professional. This collaboration allowed the director to strengthen the effectiveness of her program and use her resources more efficiently. The authors offer suggestions for other program staff wishing to emulate their methods. Close communication is key to achieving successful assessment.

Recommendation(s): This article is primarily geared towards directors of programs for women and other underrepresented groups in the sciences. The authors recommend developing a partnership with an assessment professional in order to conserve financial and human resources, attract funding, and enhance the effectiveness of programs.

Extended summary: The purpose of the collaboration between the Women in Engineering director and the assessment professional was to develop "exportable, valid, and reliable quantitative assessment tools" for other Women in Engineering directors and to educate them on the benefits and methods of assessment. The authors have conducted literature reviews and are working together with other programs to assess their needs and benchmark their activities. They have pilot-tested five assessment instruments, are studying the long-term effects on students of participating in Women in Engineering programs, and are developing documentation and a web site.
Collaborations of this type are important because the staff of Women in Engineering programs tends to be fragmented, and the directors are often balancing multiple duties. This fragmentation of responsibilities makes it difficult to achieve "continuity and comprehensiveness in activity execution and follow-up." Undergraduate retention programs for women are usually "aimed at supporting students and helping them develop [professional] skills." Women in Engineering Directors may engage in "recruitment and retention programming," counsel students, write proposals for funding, and interface with the rest of the university community. The assessment professional must collaborate closely with the director in order to "determine the goals, objectives, and outcomes of the intervention that is to be assessed, [develop] assessment tools" or seek out existing ones, implement the finalized instruments, report the data, and assist with data interpretation and making recommendations.
For the assessment process to be successful, it is essential for the assessment professional to have regular meetings with the director, as well as access to other key personnel and stakeholders.
The assessment instruments developed by the team reflect a combination of measures of objectives (suggested by the assessment professional) and measures of student program satisfaction (traditionally used in the field).
Feedback from a thoroughly executed assessment of a summer program for high school girls allowed the director to substantially reorganize the program so that it began to meet its objectives. Initially, the students enjoyed the program but did not follow through on applying to the university. A time analysis of student activities showed that they were spending very little time actually learning about science and engineering. The program was subsequently refocused on hands-on experiences, and peripheral activities were eliminated. This allowed the Women in Engineering program to conserve its resources.
The authors conclude that without the assistance of assessment professionals, Women

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in Engineering programs may not fully achieve their goals or use their time and energy efficiently. With the combination of the assessment professional's analytical skills and the Women in Engineering director's cultural knowledge and "subject matter expertise," programs can create "outcomes that are more than the sum of their parts." Effective multidisciplinary programs are also more likely to attract funding.

Keyword(s):
Women
Engineering
University climate
Assessment
Special programs
Mentoring
Social support
Recruitment

Maton, K. I., Hrabowski III, F. A., & Schmitt, C. L. (2000). African American college students excelling in the sciences: College and postcollege outcomes in the Meyerhoff Scholars Program. *Journal of Research in Science Teaching, 37*(7), 629-654.

Summary: This paper includes extensive assessment data on the success of African American science majors enrolled in the Meyerhoff Scholars Program at the University of Maryland, Baltimore County. The program was highly successful in graduating students with high GPAs who remained in the sciences and often went on to graduate school. It successfully changed the image of African American students in the sciences on campus. The program provided extensive social and financial support, as well as professional development opportunities.

Recommendation(s): Follow the example of the Meyerhoff Program in providing students from underrepresented groups with academic mentoring, strong social networks, encouragement to attend graduate school, and access to scholarships and internships. In fact, many of these support systems are important for students of all ethnicities and academic levels.

Extended summary: “Proportionately higher numbers of African Americans aspire initially to science graduate degrees than do Caucasians,” but they are often unable to achieve their goals. The Meyerhoff Scholars Program is a highly competitive and successful academic training program designed to produce future science Ph.D.s. Although it was initiated for African Americans, the program has since been expanded to include students of all ethnicities.
The paper begins by describing the roadblocks to success that face talented young African American students in the sciences. Gatekeeper courses often discourage bright

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students. Financial need requires many students to work off-campus, jeopardizing their opportunities to study. However, financial support alone is not sufficient to ensure student success. Students are also discouraged by “academic and cultural isolation,” lack of peer support for their success, “perceived and actual discrimination,” and stereotypes.

The Meyerhoff Program seeks to address academic factors as well as social and financial ones by encouraging the development of strong study habits, time management skills, problem-solving ability and resourcefulness among its students. The program includes the following 14 components: Financial Aid, Recruitment, an introductory Summer Bridge Program, Study Groups, Program Values (community service and high achievement), a close-knit Program Community, Personal Advising, Tutoring, Research Internships, and Faculty Involvement.

The study compared Meyerhoff students to students who had declined the scholarship and chosen to attend other institutions, as well as to a group of African American students who had attended the university before the initiation of the program. The comparison took into account demographics, academic background, freshman year coursework, final major, major and overall GPA, and student perceptions of the program (based on interviews and questionnaires).

The Meyerhoff students were dramatically more successful than their historical or contemporary counterparts. They were nearly twice as likely as the contemporary sample to graduate in science, engineering or mathematics (SEM). They were also more likely to stay in SEM majors than their Asian and Caucasian peers. Their GPAs within their major were significantly higher than those of the contemporary sample, comparable to the GPAs of their Asian peers, and higher than those of their Caucasian peers. However, the overall GPAs of the two groups (Meyerhoff and contemporary) were comparable. This suggests that the impact of the Meyerhoff program is field specific.

The Meyerhoff program students were also much more likely to attend graduate school. Students stated that the social support was crucial to their success and that they appreciated the financial aid. However, they did mention that the program visibility gave them a sense of being under pressure. Faculty said that the program had raised expectations of African American students, but also created hierarchies in the student body. Some faculty wished that other students could receive such extensive support.

Keyword(s):

Financial aid
Social support
Career
Mentoring
Advising
Academic achievement
African-American
Minorities
Recruitment

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Mawasha, P. R., Lam, P. C., Vesalo, J., Leitch, R., & Rice, S. (2000). Girls entering technology, science, math and research training (GET SMART): A model for preparing girls in science and engineering disciplines. *Journal of Women and Minorities in Science and Engineering., 7*(1), 49-57.

Summary: The authors present a model for training programs based on the workshop GET SMART (Girls Entering Technology, Science, Math and Research Training), which prepares female high school students to enter SMET careers. The program aims to motivate students, increase awareness, create positive attitudes, and improve the performance and retention of female students in SMET. The model focuses on four major areas: career orientation, knowledge, academic and social support, and selfconcept.

Recommendation(s): Professors should encourage students in class, discuss gender equity issues, and provide information about financial aid and scholarship opportunities. Describing SMET career opportunities is also important and can be enhanced by bringing in guest speakers (especially successful women). By speaking of personal motivations or important experiences that have led to his or her interest in SMET, an instructor can interest students in SMET careers.

To increase technical knowledge, the curriculum should emphasize real world, hands-on activities which promote students' self-confidence, enthusiasm, and problem-solving skills (see Table 3). Encourage collaborative work and study groups to help students develop peer networks, which are valuable to academic survival. Aid student confidence, growth and achievement by being aware of those who are struggling and being open and accessible to students who need help. Learn to be a role model for students and appropriately deal with the emotional, social, and economic issues which students may face through mentoring and counseling programs.

Support diversity initiatives, create peer competition, provide encouragement, treat all students equitably, and emphasize the competence and potential ability of students. Discuss diversity with all students, because lack of male peer support hinders female achievement. If the instructor states that diversity is important, then students will take diversity more seriously.

Extended summary: The workshop GET SMART (Girls Entering Technology, Science, Math and Research Training) was created to prepare female high school students for competitive SMET careers. The program focuses on four major areas:

1) career orientation: commitment to SMET as a career, reasons for pursuing SMET as a career, and opportunity to pursue a SMET career;

2) knowledge: courses completed, achievement, and hands-on activities;

3) academic and social support: diversity initiatives, role models, cooperative learning, and peer counseling; and

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4) self-concept: competence and peer competition.
The career orientation workshop focused on gender-equity issues, college preparation and programs, and financial aid and scholarship opportunities. The program also included math, science, and computer hands-on activities to promote self-confidence, enthusiasm, and good problem-solving skills. Parents, teachers, program coordinators, SMET professionals, college mentors, and other professionals provided academic and social support. The coordinators studied multicultural career and personal counseling. Successful female professionals conducted the workshops. Participants' self-confidence improved through the positive academic and social network and through a constant emphasis on competence and group work, which prevents possible "solo" or "token" effects (unrealistically high or low expectations of a minority member due to their status).
97% of participants rated the program as very supportive of females in SMET disciplines. The GET SMART workshop gave insight into potential problems the female students might face while pursuing a career in a SMET field, created engaging and meaningful activities for the students to perform, used cooperative learning to build students' social and academic networks, and provided peer tutoring. Some problems that were identified were: an inability to maintain academic and social networks due to age and distance; male peers' lack of understanding of the importance of female representation; poor educational preparation, which could be helped through earlier intervention; and social, emotional, or economic problems that prevented students from succeeding.

Keyword(s):
Women
Technology
Science
Mathematics
Retention
Mentoring
Career
Active learning
Networking
Social support

Mayberry, M., & Welling, L. (2000). Towards developing a feminist science curriculum: A transdisciplinary approach to feminist earth science. *Transformations, 11*(1), 1.

Summary: Mayberry and Welling examine the lack of feminist critique in the study of science and suggest that newly developed science curriculum will help to overcome this deficiency. Several science classes were developed that examine how science affects politics and culture and how these same forces influence what aspects of science are

researched and accepted.

Recommendation(s): The lack of feminist analysis in science should be addressed by integrating such subject matter into specific science courses. Students should have the opportunity to view knowledge as something created rather than discovered and view science in the context of how it affects society.

Extended summary: Mayberry and Welling argue that feminist analysis needs to be added to the study of science (and science to feminism studies). A feminist science curriculum does not just mean a focus on gender inequality. It is a view of science as a creation of particular cultures and not as an unbiased set of facts. When knowledge is viewed as created and not discovered, it becomes clear that this creation is most certainly influenced by the dominant group to the exclusion of other perspectives. The authors contend that science education often lacks any cultural perspective.
As a first step to altering this paradigm, several courses were implemented into a university science curriculum. In particular, Earth Systems: A Feminist Approach was an introductory course designed for students from a variety of disciplines. The class first includes self reflection about water, where it comes from and why it is important. Expanding this idea to a geological context, the course examines how science and social hydrological practices interact. A combination of readings, videos, and discussions help students to view science practices not merely in the abstract but grounded in their socio-cultural influences.
Mayberry and Welling argue that to fully achieve an integration of these practices into science education, courses need to be designed that
1) drop course specific content and embrace content from many different areas
2) focus on how nature, science, culture, and scientific practices interact.
3) let all students actively and critically examine methods of scientific investigation
4) nurture greater understandings of how science is used from political, social, and economic perspectives
5) help students create a conscious effort of applying learning to social actions.

Keyword(s):
Culture
Feminism
Women
Science
Course content and curriculum

Mbarika, V. W., Sankar, C. S., & Raju, P. K. (2003). Identification of factors that lead to perceived learning improvements for female students. *IEEE Transactions on Education, 46*(1), 26-36.

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Summary: Contradicting the supposition that women are less interested in technical topics than men, the authors found that female students in business and engineering greatly appreciated a multimedia case study exercise in which they made decisions relating to power plant machinery. The self-development, group work, and interactive learning in the exercise led to many positive comments from the female students. Male students also valued these experiences, but less strongly. Male students were more likely to approve of the logistics of the exercise, while females focused on the learning experience.

Recommendation(s): Rather than relying on "PowerPoint presentations" for effective teaching, involve your students in active learning. Female engineering students value exposure to the problem solving process as well as group discussion. These nontraditional methods are also beneficial for male students.

Extended summary: This article disputes the claim that women are intrinsically less interested in technical problem solving than men are. The authors mention that women are increasing their participation in higher education and in medicine and law, but not in engineering and computer science.
The authors developed a CD-ROM case study based on an example of decisions being made in a power plant. The case study was not altered to make it more "femaleinclusive," but was made with photographs of the actual people who worked in the plant.
The case study exercises included technical problem solving, project management, and development and analysis of alternative solutions.
The results of the study show that "cognitive skills improvement" did not correlate with gender. However, female students' perception of their own technical abilities improved dramatically. Female students were most enthusiastic about the multimedia learning process, although male students also expressed satisfaction. The female students reported that the exercise was challenging and that they enjoyed learning from others. Interactive exercises such as these can effectively develop female students' selfconfidence and enjoyment of the technical curriculum. Many of the female students said that they could envision themselves as engineers after doing the exercise.

Keyword(s):
Active learning
Self-perception
Women
Engineering
Technology
Collaborative learning
Class discussion

McEneaney, E. H., & Radeloff, C. L. (2000). Geoscience in social context: An

assessment of course impact on attitudes of female undergraduates. *Journal of Women and Minorities in Science and Engineering, 6*(2), 131-153.

Summary: Pre- and post course surveys showed that female undergraduate students enrolled in an innovative introductory geosciences course significantly increased their classroom participation and their interest in the application of geosciences to social transformation. Their confidence and interest in geosciences remained unchanged. Confidence and interest in geosciences declined significantly among both male and female undergraduate students who attended a traditional course. Their predisposition towards classroom participation did not change. The study took place at the University of Nevada, Las Vegas in Fall 1997 and involved 129 students. Only 21 students, who happened to be all women, enrolled in the innovative course. Results argue on behalf of creating collaborative settings and using applications, physical experience, essay writing, and social commentary as a mechanism to increase classroom participation as well as confidence and interest in geosciences. The study has several limitations, including: self-selection of students into courses, unbalanced number of subjects across the two courses, and lacking controls to account for motivation, ability and gender differences among students enrolled in each course type.

Recommendation(s): Use collaborative settings and socially relevant applications as a device to increase classroom participation as well as confidence and interest in geosciences among females.

Extended summary: The PROMISE course, offered at University of Nevada - Las Vegas in Fall 1997, was designed to retain underrepresented students in earth sciences. Grounded in female pedagogy, PROMISE sought to increase classroom participation, interest in earth sciences and acquisition of knowledge of geosciences. The study's basic tenet was that women's cognitive and affective skills could be strengthened the most when the culture of the classroom fosters the "application of knowledge to social action."

The syllabi of the two courses were compared and were found to differ in certain cognitive aspects. The key differences were:

a) More field time for students enrolled in the PROMISE course

b) In-depth discussion of the "historical development of the theory of plate tectonics in more depth" in the PROMISE course, while the traditional course had an in-depth discussion of the "hydrologic cycle and the identification of rocks and minerals."

Both the courses had similar high attrition rates. The PROMISE course had an attrition rate of 27% while the traditional geoscience course had an attrition rate of 33%.

The authors created "pre- and post course attitudinal questionnaires" for evaluation purposes. They compared the level of students' confidence, classroom participation, and students' interest in the PROMISE course and compared it with the traditional geoscience course to assess the effectiveness of the PROMISE course. The results of the study indicated that there was an increased interest in geoscience among

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PROMISE students. Students taking the traditional geoscience course had a decreased interest in geoscience at the end of the course; this was true for both male and female students. Also, there was increased classroom participation in the PROMISE course, while no increase in classroom participation was observed in the traditional geoscience course. Furthermore, PROMISE students had greater changes in their praxis ("applying knowledge to social transformation").

Keyword(s):
Feminism
Retention
Self-perception
Collaborative learning
Women
Science
Undergraduate

Mendoza, V. (2006). Wanted: The retention of female graduate students. *Diverse Issues in Higher Education, 23*(3), 12-13.

Summary: Stanford has implemented a new maternity policy for female graduate students, which allows them to postpone their program requirements by six weeks within two academic quarters before or after childbirth. The policy is a move to recognize obstacles to women's success in academia and an effort to retain and increase the number of women in graduate programs.

Recommendation(s): Universities should recognize barriers to women pursuing masters' and doctorate programs and create policies to assist mothers who are pursuing degrees.

Extended summary: Stanford has implemented a new maternity policy for female graduate students, allowing an "academic accommodation period" before and after pregnancy during which they can postpone their academic requirements for six weeks while still remaining enrolled full time with housing and health benefits. The policy is the second of its kind and is modeled after MIT's "Childbirth Accommodations Policy."

While more women are pursuing master's degrees and doctorates, they are not earning tenure at colleges and universities. This problem is often attributed to the difficulty of balancing academic careers and family life. Research shows that women who have babies early in their career have lower chances of earning tenure.

The overall reception of the policy has been positive, though certain people have voiced complaints. Some think that the policy should be extended to 12 weeks, which the state

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of California offers its employees. Another critique is that there is no corresponding policy offered to male students who become fathers. The policy has also been criticized for favoring students in the sciences. One student claimed that female students in the humanities require additional funding. Stanford’s associate dean for graduate policy agreed that the policy helps students who work in laboratories or are TAing more than it helps those who are writing a dissertation, but argued that a student working on a dissertation already is allowed some flexibility.

Stanford’s chemistry department has gone beyond the university’s policy and granted female graduates who are expecting children 12 weeks of leave. An additional reason for this is that chemistry graduates are often exposed to chemicals that are not safe for pregnant women.

Keyword(s):

Middlecamp, C. H., & Moore, J. W. (1994). Race and ethnicity in the teaching of chemistry: a new graduate seminar. *Journal of Chemical Education, 71*(4), 288-290.

Summary: This article describes a highly successful graduate seminar which discussed race and ethnicity in chemistry instruction. The professors questioned the culture of science and explored what is included in traditional chemistry courses, how to incorporate multicultural considerations into chemistry teaching, effects of lab practices, and many other topics of interest to future teachers. Student feedback was positive and indicated that the course stimulated personal growth and critical thinking.

Recommendation(s): Involve future and current faculty in discussions of race and ethnicity in science. Create courses and campus programs to bring together faculty and graduate students. It is important that there be a space for discussion of political and social issues in science, as well as dialogue about teaching styles and teaching skills. If your schedule allows, read the recommended literature for the course, which is listed in the article.

Extended summary: The culture of science has been criticized for its reflection of "the dominance of whites" in the larger society. The authors of this article developed this course in an effort to address the lack of discussion of race and ethnicity in chemistry teaching. The course was geared towards graduate students in chemistry as well as undergraduates in science education. Over a dozen students participated in the class regularly, although only five were enrolled for credit. The authors collaborated with a professor from the School of Business, Brenda Pfahler, who is an expert in teaching and learning styles.
The reading list included many interesting publications, from "The Japanese and Western Science" (by M. Watanabe) to "The Education of a WASP" (by L. Stalvey). The

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students discussed many topics during the semester, including the following:
1) What is "ethnicity"? Who defines the "reference point"?
2) What counts as a book about racism? How do our perspectives affect our experiences and selection?
3) How do you observe your own culture?
4) Discussion of student ideas and reactions.
5) Are our questions culturally biased? What is "true science"?
6) Discussion of networking, resources, and student empowerment.
7) Issues faced by students of color.
8) Teaching and learning styles.
9) Classroom behavior.
10) Politics and power dynamics in science.

Keyword(s):
Minorities
Chemistry
Graduate school
Culture
Undergraduate

Miller, A. S., & Miller, C. B. (1993). The limits of intervention-lessons from Eureka, a program to retain students in science and math-related majors. *Initiatives, 55*(2), 21-29.

Summary: Eureka was a two-year intervention program at Brooklyn College for females in math and science. While the program was not a glowing success, examining it provides valuable information for how it impacted its participants and why some women choose to pursue graduate degrees in STEM while others do not.

Recommendation(s): Recruitment of students into intervention programs is easy, retention is difficult. Offering resources and support is not enough since students will not necessarily take advantage of them. Providing fellowships that stipulate students can not work while taking classes would likely foster deeper student commitment to STEM disciplines.

Extended summary: The intervention program provided students with peer tutoring, faculty mentors, extracurricular opportunities, and the potential for paid internships. The efficacy of the intervention was mitigated by the type of students at Brooklyn College. As a primarily commuter school, many of the students worked part-time or full-time jobs and this prevented them from engaging in extracurricular activities or fully utilizing the other aspects of the program.
The program required students to take a selection of courses. One of these was a career development course which helped students to understand the different

opportunities available to them in math and science. Some students actually left this course with an informed decision not to pursue graduate studies or a STEM major. They instead focused on business or computer science. The researchers found that several of the participants made decisions under the impression that pursuing graduate studies in STEM was to be a “super woman” and would not lend itself to a career that meshed well with motherhood. In addition, not every woman was interested in the women’s studies part of the course. Other courses were focused on women’s studies which did not always illicit a positive response from the female students. Everyone did not want to be a “feminist” or study women in science.
In general, the researchers concluded that the persistence of students in the Eureka program had less to do with math anxiety or performance than it did with self esteem, financial situations, and a feeling of belonging in the intellectual community.

Keyword(s):
Women
Reentry students
Feminism
Science
Retention
Financial aid
Expectations
Social support
Self-perception
Recruitment
Retention

Montgomery, S., & Barrett, M. C. (1997). Undergraduate women in science and engineering: Providing academic support. Retrieved January 14, 2008 from http://www.crlt.umich.edu/publinks/CRLT_no8.pdf

Summary: This paper extensively reviews the literature focusing on four areas deemed critical to women's success in STEM fields: classroom climate, self-confidence, interaction with faculty, and interaction with peers. For each area, the paper summarizes research findings from as many as 10 research studies. Each section then follows immediately with brief and to-the-point suggestions for educators based on those findings. The manuscript is well researched and the recommendations are grounded in the literature.

Recommendation(s): Suggestions for improving classroom climate: These suggestions are focused on recognizing that women have different learning styles. Allow more time after asking questions before calling for answers. Intervene if students are interrupted. Use students' names. Encourage student cooperation by assigning

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grades using fixed criteria rather than curves.
Suggestions for improving self-confidence: Focus on recognizing individual academic accomplishment. Greet students outside of classrooms and inquire about academic progress and future plans. Invite women guest speakers, particularly alumnae.
Suggestions for improving interactions with faculty: Encourage positive faculty contact, including informal discussions of career plans and graduate study. Treat all questions seriously. Watch for indirect messages of low self-confidence such as self-deprecating behavior or speech, and offer special encouragement to those students who exhibit them.
Suggestions for improving interaction with peers: Praise women's individual accomplishments, attempt to create cooperative vs. competitive learning environments (e.g. group work) and actively challenge sexist attitudes.

Extended summary: While female students in STEM fields begin their college careers with academic credentials comparable to men's, women abandon STEM majors in at greater proportional rates than men do. Undergraduate STEM fields are an area in which barriers to the persistence of women students still exist. But educators can positively impact the college experience of undergraduate STEM women and encourage their persistence by addressing classroom climate, self-confidence, and their interaction with faculty and classmates.
Classroom Climate: Research findings suggest that while most faculty are supportive of women in their courses, some support an overly competitive atmosphere unfriendly towomen, interact more with men, and respond more positively to men.
Self-Confidence: Research findings suggest that during their college careers, women's confidence levels decrease. Moreover, this decrease in confidence is unrelated to their actual ability or achievement. While men tend to attribute success to personal ability and failure to external factors, women conversely tend to attribute their success to external factors and their failures to personal inabilities. The general perception of scientists and engineers being men, coupled with a lack of confidence in their future ability to balance a STEM career with family, diminishes women's self-confidence.
Interactions with Faculty: There is a correlation between student confidence and persistence and informal contact with faculty, which is especially strong with positive student-faculty contact. The inapproachability of STEM faculty, coupled with lack of adequate advising, is of serious concern for women students.
Interaction with Peers: Research findings demonstrate that women in STEM fields often feel isolated and perceive resentment by male students. They are frequently interrupted, and their contributions often ignored. Confident women in STEM classrooms elicit negative responses from male peers, leading many to hide their academic ability.

Keyword(s):
Women
Self-perception
Faculty
Communication

Social support
Teaching
Mentoring
Classroom climate

Moore, J. L., III, Madison-Colmore, O., & Smith, D. M. (2003). To Prove-Them-Wrong Syndrome: Voices from unheard African-American males in engineering disciplines. *The Journal of Men's Studies, 12*(1), 61-74.

Summary: This qualitative study was based on interviews with African-American engineering students. The authors wanted to know how these students maintained their motivation in a sometimes discouraging environment. They found that, when the students encountered resistance from their majority peers, they responded by taking an assertive stance and becoming more resilient rather than giving up. The students were willing to make sacrifices to succeed in engineering.

Recommendation(s): Foster social connections between minority students and majority students in your classroom so that minority students will not be academically isolated. Educate yourself about racism and address it when it appears in the classroom. Be aware of stereotypes and inaccurate assumptions that are commonly made about African American college students.

Extended summary: Social scientists believe that the U.S. cultural perception of African American males as members of a group rather than as individuals can make it difficult for African American male students to adjust to life in primarily white colleges. There have been many studies highlighting the impact of prejudice on the everyday lives of these students.
This study sought to explore the reasons that some African American males persist in engineering and others do not, and to develop a theory of persistence based on these findings. The long-range goal of the study was to "identify ways to better serve and retain African-American males in engineering."
The author discussed existing theories for the scarcity of African American males in engineering, which included "(a) inadequate secondary education facilities and resources; (b) poor academic performance in math and science; (c) low expectations from teachers and school counselors.; (d) inadequate parental and familial support; (e) a shortage of positive mentors. in mathematics, science, and engineering."
The researchers gave the students an extensive biographical questionnaire which included open-ended questions relating to their social experiences, aspirations, family background, academic background and interests, formative experiences, and challenges faced in engineering. They also conducted individual and group interviews. The researchers then analyzed the responses using the "grounded theory" approach, looking for patterns in the data, coding the information, and discussing their ideas with

each other.
The researchers called the phenomenon they observed the "Prove-Them-Wrong" syndrome. The students were aware of stereotype threat- the prejudices that other young engineers held towards them- and made an extra effort to disprove these assumptions. The students maintained a constructive, proactive attitude when faced with adversity, and stated that they were determined to succeed. The author notes that, although these students manifested great strength under difficult conditions, this extra effort may take a toll on their emotional well-being.

Keyword(s):
African-American
Minorities
Engineering
Social support
Financial aid
Retention
Competition
Classroom climate
Stereotypes
Expectations

Mousley, K., & Kelly, R. R. (1998). Problem-solving strategies for teaching mathematics to deaf students. *American Annals of the Deaf, 143*(4), 325-336.

Summary: The authors explored three teaching strategies to aid deaf students in working on spatial and word problems in college-level mathematics. The three strategies were: 1) asking students to explain problems in sign language and in writing; 2) asking students to visualize the problem solving process before beginning work on a problem; and 3) modeling the solution process before introducing the problem. The authors found that the students understood the problem rules correctly, but that they were not following the rules when they solved the problems. When students were given time to visualize the solutions to the spatial problem before acting, their strategies improved. Instructor demonstrations of the problem solving process also improved student performance.

Recommendation(s): Guide deaf students through math problems and communicate solution strategies. Ask students to explain their methods and the problem. Encourage students to visualize solution methods and design their own math problems.

Extended summary: Previous research shows deaf students face challenges in math courses in problem solving and critical thinking. Specifically, students exhibit “a tendency to work quickly and make errors; an inability to attend to and sort out relevant features or information…; [and] an inability to analyze a problem carefully." Studies have also documented difficulties in the areas of reasoning, organizing and considering information, and understanding problem goals.

Some successful strategies that have been previously used include a) mediated learning experiences in which an instructor gives students opportunities to reflect on their own thinking process, b) instruction in problem solving strategy, c) observational learning, and d) guided participation.

The authors tested three sets of teaching methods with groups of deaf undergraduates in mathematics courses at the National Technical Institute for the Deaf. These students were mostly male and from the traditional undergraduate age group.

The first method involved asking the student who was solving the problem to explain the goal and rules to an observer (using ASL) before solving the problem, and then explain the strategy for solving the problem at the end. The students also wrote down the goal, rules and strategy after solving the problem. The purpose of this exercise was to show through explanation that the students understood the expectations, and to assess the effects of students' reading levels on their ability to explain the problem. The students each solved a spatial problem and a word problem. Reading levels were not associated with improved speed in solving the spatial problem. However, reading levels were associated with improved ability to solve word problems and to explain both types of problems.

The second method involved giving one group of students the opportunity to visualize solving the spatial problem before actually solving it, while the other students proceeded as the earlier test group had done. The authors found that the students who spent time visualizing made fewer errors.

The third method involved a teacher modeling the problem solving process before students worked on algebraic word problems. Students in the experimental group began to explain their answers more fully and use information more effectively.

Keyword(s):
Accessibility/disability
Mathematics
Undergraduate
Inclusively
Learning styles
Spatial ability

Muller, L. (2006). Research collaboration with learning-disabled students. *Journal of College Science Teaching, 36*(3), 26-29.

Summary: A chemistry professor shares how her personal experience of collaborating with a student with learning disabilities has helped her develop her own teaching strategies for student-faculty collaborations.

Recommendation(s): Work with LD students in research, since such collaborations are a valuable learning experience for both students and faculty. These partnerships may increase the retention of LD undergraduates, as well as enhancing your teaching and guidance strategies. In addition, make use of the following techniques:

- To teach students how to approach research literature, assign readings before lab work begins.
- Require students to write project descriptions, which help faculty to identify gaps in understanding.
- Use an agreed upon plan-of-work to clarify your expectations to students.
- Keep a chart that shows individual experiments and the connections between them; these charts facilitate students' data interpretation and clarify their scientific thought.
- Assign brief student presentations on their work during the project to force students to draw their own conclusions and realize their accomplishments, while allowing you to see the project through the students' eyes.

Extended summary: Because students with learning disabilities often require extra accommodations, they are generally not chosen as undergraduate research assistants. Yet undergraduate research experience may be vital to keeping LD students in school, as their success in postsecondary education has been shown to be influenced by their perception of faculty support for their learning. Research experience also gives students the ability to think critically and independently and to understand their fields.

The experience the professor in this article gained from working with an undergraduate LD student gave her new insights as to how to develop more effective strategies for future research collaborations with students.

Pam, the undergraduate student, hoped that her research experience would help her to see the larger picture of chemistry and prepare to write a senior thesis. Through the experience, she found that she enjoyed research. She has continued on to graduate school, and plans to study physical chemistry. The research experience helped her develop new skills and confidence. It also improved her independence and ability to adapt to new learning situations. She no longer considers her learning disabilities a burden, but views them as a gift, since overcoming them has improved her research skills.

The faculty member and author of the article found that the experience improved her ability to teach research skills to students. She developed a set of strategies for

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effective student-faculty research collaboration, which are given in the recommendations section above.

Keyword(s):
Chemistry
Accessibility/disability
Undergraduate
Graduate school
Mentoring
Communication

Napell, S. M. (1976). Common non-facilitating teaching behaviors. *Contemporary Education, 62*(2).

Summary: Through observation of teachers, the author compiled a list of common teaching behaviors that impede learning. These actions are usually unintentional or benign, but force students to remain at a low level of comprehension rather than challenging them to develop a deeper understanding of the material.

Recommendation(s): The author encourages teachers to become aware of the following actions that impede student achievement:
1) "Insufficient wait-time" after asking a question. Allowing more wait time encourages students to think, give "unsolicited responses", answer difficult questions, and discuss the answers with one another.
2) Agreeing with the first answer that a student gives. If the teacher allows a period of silence after the answer or requests additional answers or participation, other students may join in. It is also important to move around and to interact with students who are in the back of the classroom.
3) Giving a student the answer as a part of the question. This practice limits student creativity, although it is not intended to do so. A teacher should only offer an answer when the student needs guidance.
4) Asking for non-specific feedback. Students who are not sure what to ask may feel intimidated. Specific questions challenge students to think and allow the teacher to learn how much the students know.
5) Making comments that cause students to feel inferior. Interrupting students, talking over students, intimidating or threatening them interferes with the learning process. On the other hand, giving credit to students, framing open-ended questions, treating mistakes with understanding, inviting students to comment on their learning process, letting students assist in class, and admitting fallibility all help students to feel at ease.
6) Asking questions that only require memorization rather than original thinking. Teachers should encourage students to analyze, evaluate and synthesize information.

Extended summary:
Keyword(s):
Teaching
Inclusively
Communication
Expectations
Academic achievement

Nelson, D. J., & Rogers, D. C. (2003). A national analysis of diversity in science and engineering faculties at research universities.

Summary: "The first national and most comprehensive analysis to date of tenured and tenure track faculty in the "top 50" departments of science and engineering disciplines shows that females and minorities are significantly underrepresented." This shortage of role models, as well as the poor treatment of female faculty, discourages other women from entering and remaining in science and engineering.

Recommendation(s): This article is geared towards faculty and administrators in decision-making positions in science and engineering departments. It recommends a cultural shift in which women students receive more mentoring and female faculty are evaluated and promoted fairly. This shift may require changing some fundamental assumptions about the way that science is practiced, as well as about who "is" a scientist.

Extended summary: "Even though a growing number of women are completing their Ph.D.'s, there are few tenured and tenure-track women faculty in the top science and engineering departments." This shortage of professors as compared to graduate students is especially noticeable where there are greater numbers of women- in the biological sciences, chemistry, math, and computer science.
Female professors seem to be experiencing a "glass ceiling"- they are usually stopped at the rank of assistant professor, and are only half as likely to receive tenure as men. This makes it challenging for women to change the culture of their departments. Female faculty attrition is higher than that of male faculty, and many women choose not to apply for professorships because of "climate". Undergraduate and graduate students are aware of this fact, and it may affect their career choices.
As the number of women in BS programs continues to increase, these students find themselves without role models. "In 2000, 48.2% of students graduating with a B.S. in math were women, but only 8.3% of the faculty was female." It is possible for a female engineering student to go through her entire program of study without having a female professor.
The situation is doubly compounded for underrepresented minority females, who are almost nonexistent in the departments surveyed. Their absence appears to be due to a

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combination of disenchantment with academia, and inequitable hiring practices. Since there are so few female professors, male faculty should encourage female students in their careers and make sure that the women in their departments are treated fairly and hired and promoted as they deserve to be. If female professors are treated well, women will be more likely to pursue careers as science and engineering faculty.

Keyword(s):
Faculty
Graduate school
Mentoring
Career
Women
Competition

Nettles, M. T., & Millett, C. M. (1999). The human capital liabilities of underrepresented minorities in pursuit of science, mathematics and engineering doctoral degrees. *Research News On Minority Graduate Education (MGE), 1*(2).

Summary: The study sought to examine the extent to which doctoral students in Science, Mathematics and Engineering (SME) are being socialized into their academic disciplines. Substantial differences in participation in research activities were noted across ethnic groups. Lower percentages of African American and Latino students in science and math, as compared with whites and Asian Americans, reported having presented research papers before national conferences or submitted papers for publication. The study's research design prevents inferring causal connections. The study is descriptive at most of the characteristics of underrepresented graduate students pursuing doctoral degrees in SME.

Recommendation(s): Create opportunities to engage underrepresented graduate students in research activities. Make certain to socialize them into the academic discipline and encourage them to submit papers for publication and to present at professional conferences.

Extended summary: This paper presents some findings from a national study involving over 13,000 doctoral students from 21 universities. Using a "human capital" approach, the research sought to assess the extent to which quality of doctoral students' experiences and performance could be attributed to family background, gender, race, finances and undergraduate education performance and experiences. Particular attention was placed on breaking down the analyses in terms of gender and race across academic disciplines.
The authors found significant differences in race, sex, social class and other demographic distinctions among doctoral students on a broad array of variables relating

to progress and performance. Engineering students in general tend to come from more wealthy and more highly educated backgrounds than other science and math students. There was a high correlation between African Americans' fathers' occupation level (e.g. social status) and their publication rate. African American engineering students were also likely to have mothers with well-paying jobs, while white and Asian engineering students were more likely to have mothers who were homemakers and fathers who had advanced degrees.

There were racial differences in the college and employment background of the students surveyed. African American students were most likely to take a significant amount of time to work between college and graduate school. Hispanic and White students are most likely to go directly from college into a graduate program. Asian and White students were most likely to have attended a prestigious college.

Both gender and race are strongly correlated to levels of publication. In science and math fields, African American and Hispanic students were less likely to publish and present at professional conferences than were white and Asian students. In engineering, these differences were not significant. The author's main conclusion is that African American students are disadvantaged by their "deficits in human capital." This article, while reporting on a forceful descriptive study, unfortunately does not address the causative connections between the components of human capital and the performances of the groups studied, nor does it examine inclusive and engaging classroom activities which could benefit underrepresented minorities.

Keyword(s):
Graduate school
Minorities
Engineering
External influences
Competition
Social support

O'Neal, C., Wright, M., Cook, C., Perorazio, T., & Purkiss, J. (2007). The impact of teaching assistants on student retention in the sciences. *Journal of College Science Teaching, 36*(5), 24-29.

Summary: The authors surveyed undergraduates to assess how much teaching assistants can affect a student's decision to stay in a science-related major. They found that teaching assistants' influence on student decisions is not very obvious to students. However, since TAs are responsible for grading, serve as role models for students, and affect the climate of their labs or study sections, teaching assistants should be trained to support student retention.

Recommendation(s): Train and mentor science TAs. Here are some recommended practices for TA training programs: 1. Presentations of science retention data provided by the local institution, as well as national retention figures. 2. Discussions of undergraduate students' experiences with TAs, including case studies relating to why students leave the field and why they stay. 3. Discussions of TAs' contribution to the lab climate (enthusiasm, anxiety, welcoming students, etc.) The trainer should also discuss how to use lab groups, how minority students' experiences may differ from those of majority students, and how to handle uncooperative students. 4. Discussions of the importance of mentioning one's experiences and career choices in class. 4. Raising awareness of the expectations for the course and individual assignments. TAs should explain grading decisions to help eliminate student anxiety.

Extended summary: The co-authors conducted their own research after reading the research of Seymour and Hewitt (1997), which claimed that TAs have no effect on the retention or attrition of science undergraduates. After implementing a web-based survey with primarily freshmen and sophomore college students from introductory science and mathematics courses, they have come to the conclusion that TAs indirectly influence student decisions. While students did not mark TAs has a significant factor in their decision, the reasons they did include directly relate to the role of the TA, such as their grades and the lab climate. TA enthusiasm, communication, grades and behavior are all factors that influence undergraduates. The authors noted that, "encouragingly, the vast majority of students reported that their plans to major in science actually became more likely over the course of the term." However, with the national statistics still declining, it is important for TAs to receive the proper training to support student retention. It is important to remember that, for training to transfer to classroom practices, it is necessary to do follow-ups, mentoring, and perhaps advanced training.

Keyword(s):
Science
Retention
Undergraduate
Laboratory
Classroom climate

Oldham, J., & Kasser, T. (1999). Attitude change in response to information that male homosexuality has a biological basis. *Journal of Sex & Marital Therapy,* (25), 121.

Summary: The authors of this article studied the change of attitudes toward homosexuals among college students after exposure to an article suggesting homosexuality has a biological basis. They found that attitudes become more negative for math and biological science majors, while the attitudes of undecided majors became more positive. Furthermore they found that students who had a better memory of the details of the article became more negative in their attitudes while those who did not remember as well became more positive about homosexuals. Thus they suggest that information about the biological cause of homosexuality can have both positive and negative impact on the attitudes toward homosexuals.

Recommendation(s): This article is a report on an attitude survey and is not meant to be used as advice on how to deal with homosexuality in the college classroom. Given the small sample size (28 respondents) these results may not be significant enough for purposes of policy formulation. However, it does suggest that more research needs to be conducted into the use of education about biological origins of homosexuality as a way of reducing prejudice against homosexuals in college classrooms.

Extended summary: Some of the main factors affecting people's attitudes toward homosexuals are gender, religiosity and beliefs about the cause of homosexuality. In general, people who believe homosexuality has a biological origin seem to have less negative attitudes toward homosexuals. This study aimed to find the changes in attitude toward homosexuals after the presentation of information suggesting a biological cause for homosexuality.

The sample size was 28 (16 women) at a non-church-affiliated private liberal arts college in the Midwestern United States. These students (age range 17-22) were at all four levels of seniority in college and represented all fields of study: Math, Natural Sciences, Social Sciences, Humanities, and undecided majors.

The method of study involved 1) surveying attitudes before presenting an article about the biological origins of homosexuality, 2) collecting information of the religiosity of the respondents, and 3) surveying attitudes one week after presentation of the article. The changes in attitude were tested against several variables: student's major, memory of the details of the article, gender, and religiosity. The attitudes were tested before and after presenting the article by using an established Homophobia Scale, and the religiosity was tested using a Religious Ideology Scale.

The results suggest that being presented with information that homosexuality has a biological component does help change attitudes toward homosexuals. However, these changes are not related to one's gender or religiosity, but rather one's field of study and memory of details on the information presented. In particular, those majoring in Math and Natural Sciences, especially Biological Sciences, had a more negative change in attitude than did Social Science or Humanities majors. Also, the higher the level of retention of information about the biological cause of homosexuality, the more negative the change in attitude toward homosexuals. Thus the conventional strategy of presenting information about the biological causation of homosexuality may not be universally effective in reducing homophobic prejudice. The results of this study make it clear that more research needs to be done, especially using large sample sizes, about the use of biological education to effect changes in attitude toward homosexuals.

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Keyword(s):
Homosexuality
Attitudes
Biology
Science
Male
Undergraduate

Pinel, E. C., Warner, L. R., & Chua, P. (2005). Getting there is only half the battle: Stigma consciousness and maintaining diversity in higher education. *Journal of Social Issues, 61*(3), 481-506.

Summary: This article uncovers gender differences in the effect of student awareness of stereotypes, or "stigma consciousness", on their college performance and self-esteem. Male students who perceived stereotypes as affecting their lives tended to have lower GPAs and to separate their self-esteem from their academic performance. Female students who were aware of stigma, on the other hand, became more identified with their academic performance and had lower self esteem.

Recommendation(s): Reduce the academic stigma faced by minorities on campus by educating students and faculty about stereotypes, emphasizing that everyone is the subject of stereotypical views, raising empathy, and dismantling myths about affirmative action. Give stigmatized students the opportunity to experience less-stressful academic environments and explain to them that not all majority group members are prejudiced. Encourage professors to get to know their students. The authors note that some programs which single out minority students for academic assistance may actually raise their awareness of their stigmatized status.

Extended summary: Although ethnic minorities' enrollment in college has increased, their college completion rates are still lower than those of their majority counterparts. In an attempt to explain this discrepancy, the authors used Pinel's Stigma Consciousness Questionnaire, which has been tested on many population groups, to evaluate students' perceptions of the effects of prejudice in their lives. The questionnaire includes measures of students' perception of discrimination at the personal level and the group level. It also includes experiences of discriminatory acts and negative feedback from non-minority students.
Research shows that many ethnic minority students are viewed as "token" in college because of their small numbers and the stereotype that affirmative action is not merit-based. Studies have demonstrated that being aware of being a "token" minority can reduce students' feelings of competence and ability to concentrate under pressure. When stereotypes are mentioned openly, minority students are less likely to succeed. Stereotyped students may also detach their sense of self-worth from academic pursuits.

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Some researchers attribute the academic performance gap between majority and non-Asian minority students to awareness of stigma.
The authors surveyed 128 undergraduates in a psychology course at a large, majority university and excluded outlying data from their analysis. Students answered questionnaires about their awareness of stereotypes before and after arriving at the university, and reported their GPAs and their level of identification with academic pursuits.
Male students from stigmatized groups appeared to perform less well academically and to disengage from school when they were aware of stereotypes. Female minority students already had lower grades than their majority counterparts, but tended to be more identified with their academic performance when they were aware of stigma. Female students who were less identified with academics tended to have higher self-esteem.
An examination of the existing minority student programs at Big 10 universities shows that these programs are not effectively educating the majority student body about the merit basis of affirmative action or about the illusory nature of stereotypes. The programs are focused on providing academic support, mentoring, counseling, and social support for the minority student population.

Keyword(s):
Minorities
Mentoring
African-American
Latino
Stereotypes
Academic achievement
Identity and personality
Special programs

Reddick, L., Jacobson, W., Linse, A., & Young, D. (2005). A framework for inclusive teaching in STEM disciplines. In M. Ouellett (Ed.), *Teaching Inclusively: Diversity and Faculty Development* (pp.). Stillwater, Oklahoma: New Forums Press.

Summary: The authors advance a framework to assist STEM faculty in inclusive teaching. The framework is based on five dimensions, including: 1) Accurate Problem Definition, 2) Provision of Redundant Systems, 3) Expert Practice, 4) Management of External Constraints, and 5) Comprehensiveness. Each dimension involves examination of the course in light of learning objectives, student learning styles and classroom climate issues. The document does not provide examples of inclusive teaching practices. No data are provided to ground the advanced framework.

Recommendation(s): The article is aimed at faculty development professionals. It does

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not illustrate instructional practices; however, STEM instructors may find the five dimensions useful in examining the extent to which they are using inclusive teaching practices.

Extended summary: The manuscript is organized into three sections. Section 1 proposes a conceptual framework for inclusive teaching in STEM disciplines and is accessible for people familiar with STEM educational development literature. Section 2 describes James Banks' Five Dimensions of Multicultural Education and is appropriate for practitioners comfortable with the literature of diversity and multiculturalism. The authors suggest that those primarily interested in helping STEM faculty develop more inclusive teaching practices should begin with Section 3 (which offers examples of "entry points for talking about inclusive teaching with STEM faculty"). The authors, however, do not provide specific examples of teaching practices.

Section 1 offers extensive and troubling statistics on the lack of retention of women and minorities in STEM. Female and minority students who are often more academically qualified than their majority peers are leaving the field, perhaps because of negative experiences during college or their perception of a "chilly climate" awaiting them in the workforce. The promise of financial well-being has not been enough to change these students' minds.

The author's five "inclusive teaching in STEM" dimensions include: Accurate Problem Definition, Provision of Redundant Systems, Expert Practice, Management of External Constraints, and Comprehensiveness. This framework builds upon James Banks' (1996) five dimensions of multicultural education: Content Integration (utilizing multicultural resources), Knowledge Construction (questioning assumptions and biases within a given field), Prejudice Reduction, Equity Pedagogy (teaching to address students' perspectives and backgrounds), and Empowering School Culture (reenvisioning institutional culture as a culture of respect).

Accurate Problem Definition involves clearly identifying goals, rationales, starting conditions, appropriate design, and principles of implementation to achieve optimal learning outcomes. The authors ask STEM faculty to examine course design, beginning with identifying what is important for students to know and explicitly articulating why that information is important, followed by considering the ways in which students achieve mastery in their particular discipline.

Provision of Redundant Systems involves recognizing that an effective system is designed to monitor and respond to feedback, adapt to changing conditions, and provide alternate strategies when difficulties occur. The author asks STEM faculty to recognize that even well-designed systems face unanticipated obstacles, making it necessary to provide more than one means to a desired end. Ultimately, this involves designing learning experiences based not just on how instructors have taught before or how they originally learned the material themselves, but on the complexity of the learning goals and full range of students' capacities to learn.

Expert Practice involves effective teaching which is not biased to favor particular outcomes for particular learners. Many instructors may believe that their classrooms provide neutral conditions for learning, but research demonstrates that some learners

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come into STEM classrooms expecting to find the field biased against them. Expert Practice requires proactive demonstration by instructors that all students who fulfill their course requirements have an equal opportunity to learn. (Examples are given in the article).
Management of External Constraints involves anticipating, minimizing or compensating for ways in which teaching and learning processes and outcomes are influenced by environmental factors and other external constraints (the numerous factors which affect students before they take a course and while they are taking it). Several examples are discussed in the article, as well as suggested approaches for resolving some of these issues.
Comprehensiveness includes maintaining the thoroughness and rigor of what is taught, and grounding assignments in actual (rather than idealized) conditions. Again, multiple examples are given that emphasize that attention to Comprehensiveness adds the positive message that it is possible to succeed as a female or a person of color, provided that the learner is willing and capable.

Keyword(s):
Teaching
Learning styles
Women
Minorities
Inclusively

Rey, C. M. (2001). Making room for diversity makes sense. *Science, 293*(5535), 1611.

Summary: This article profiles three successful diversity programs for underrepresented students in the sciences: the Biology Scholars Program (BSP) at the University of California-Berkeley, the Science, Technology and Research Scholars (STARS) program at Yale, and the Meyerhoff Scholars Program at the University of Maryland- Baltimore County. Key features of these "student-centered" programs are "relevant and timely academic advice, a community environment, strong mentoring, and early involvement in research," as well as introduction to scientific culture.

Recommendation(s): "Level the playing field for women and minorities" by mentoring them, introducing them to scientific culture, creating supportive academic/social networks for them, and involving them in research. Personal support is essential for student success in these challenging fields. Ensure that students have basic foundational knowledge in math and science. Provide financial support to allow students to concentrate on their studies.

Extended summary: "Successful diversity programs level the playing field for women and minorities by addressing their needs and teaching undergraduates the unwritten

rules of academic science." The author describes the successful features of three undergraduate programs for underrepresented groups in the sciences:
1. The UC-Berkeley Biology Scholars Program helps minority students to succeed by providing a "student-centered approach" geared towards giving students "'system smarts'- tools to navigate a campus's academic system and scientific community." The director of the program teaches a course called "Studying the Biological Sciences: an Introduction to the Culture of the University and the Culture of University Science." The program intends to provide "relevant and timely academic advice, a community environment, strong mentoring, and early involvement in research." The program staff are easily accessible to students because of their location. Participation in the program doubles the likelihood that a minority student will graduate with a science degree.
2. The UMBC Meyerhoff Scholars Program is "one of the leading producers of African-American students who… earn medical degrees and science doctorates." The program also includes some Caucasian students. Students receive individual attention and advising, and take courses which ensure that they have a foundational set of skills for academic success. Financial support allows students to focus on academics, rather than balancing their course work with a part-time job.
3. The Yale Science, Technology and Research Scholars program requires students to participate in conceptual discussions of science topics. Students participate in internships and take courses in scientific reasoning, analysis and data presentation. The director gives students personal encouragement and matches them with appropriate mentors.
All three programs receive strong institutional backing from their universities, which has been an essential ingredient of their success.

Keyword(s):
Special programs
Retention
Recruitment
Minorities
Women
Financial aid
Advising
Mentoring
Culture
Social support

Riley, D. (2003). Employing liberative pedagogies in engineering education. *Journal of Women and Minorities in Science and Engineering, 9*(2).

Summary: "This article summarizes the use of liberative pedagogies in engineering education and presents their application in an engineering thermodynamics course.

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Implementation areas include relating course material to students' experiences, facilitating students' responsibility for learning and authority in the classroom, incorporating ethics and policy issues, and decentering Western civilization. Assessment approaches are discussed, as well as limitations of liberative pedagogies in an engineering context."

Recommendation(s): Although allowing greater student participation may be intimidating at first, it improves student morale and encourages students to take more responsibility for what they are learning. This will equip students for the challenges of the workplace and help them to connect abstract course material with their own experience. Encouraging students to be comfortable making mistakes and to realize that many great theories were developed through a process of trial and error encourages student self-sufficiency. Incorporating examples of multicultural contributions to science and discussing ethical issues creates engineers who are global citizens, which is important in today's business world.
These innovations take time to implement, but they can strengthen student confidence, create cultural awareness, and deepen students' understanding of technical subject matter.

Extended summary: The paper describes a student-centered thermodynamics course which includes many exercises designed to encourage student self-sufficiency and incorporate female and multicultural perspectives. Student feedback is included. Students participated actively by teaching and solving problems in class. The professor created an egalitarian environment of dialogue in which students felt comfortable making errors, discussing their learning styles, doing derivations on the blackboard, and talking about ethics problems. Quantitative skills were emphasized throughout the course.
Pedagogies of liberation such as those developed by bell hooks and Paolo Freire focus on empowering students to become active learners, take interest in the course material, develop their critical thinking skills, and contribute to the classroom with confidence. In a time when many professors complain about students' preoccupation with grades rather than learning, these pedagogies can create classrooms where students are more engaged and understand the relevance of the course material.
Integration of the subject matter with "real life" is especially important in fields such as engineering that require application of knowledge. Creating such empowerment and confidence is especially important for female students or students who do not have extensive hands-on experience with machines or electronics. The traditional model of the "obedient student," the "receptacle for knowledge," has left young engineers unsure of how to deal with ethical problems or other questions that require independent thinking.
Feminist scholars have critiqued conventional engineering education as being "reductionist"- oversimplifying the process of teaching and ignoring the contributions of other disciplines- and substituting a nominal "objectivity" for social concern. Because engineers have followed industry- the assembly line- as a model for education, the

teaching process is seen as a flow chart in which engineers are produced, rather than a system of personal interaction with the goal of creating capable and self-aware professionals. "Objectivity" translates into professors' unintentionally ignoring issues of personal relationships, ethics, race, class, and gender, as well as power differences in the classroom. It also means that students are encouraged to operate without ethical values in their professional careers. Although independent thinking can carry with it a professional cost, it can also prevent safety hazards such as the Challenger's "o-ring." In order to create classrooms that encourage participation of male and female students of all cultures, multicultural and female contributions to engineering must be integrated smoothly into the curriculum. The current globalization of industry, and the increasing pace of international development, means that today's engineers need to be aware of global cultural differences, environmental issues, and the contributions of non-Western cultures. In workplace environments, diverse groups have been shown to produce more creative solutions to problems. Traditional engineering diversity programs assume that the problem lies with the student rather than the institution, and are limited in their ability to effect institutional change.

Keyword(s):
Feminism
Retention
Self-perception
Active learning
Culture
Assessment
Engineering
Women

Riley, D. (2003). *Pedagogies of liberation in an engineering thermodynamics class*. Paper presented at the American Society For Engineering Education Annual Conference & Exposition,

Summary: This article describes an unusual but productive reframing of engineering education using feminist and critical thinking "liberation pedagogies." The specific changes in the course were: an emphasis on student participation and discovery, connecting thermodynamic theories to everyday physical phenomena, discussions of engineering ethics and the philosophical and subjective aspects of scientific research, and inclusion of the inventions of women and people from non-Western civilizations.

Recommendation(s): Depending on the course sizes that you are working with and your time availability. Integrate student-centered methods into your teaching. Equip students to become self-directed learners who can discover the applications of abstract concepts and develop their ethical and critical thinking abilities - this will allow them to see engineering as a part of society rather than a purely profit-driven pursuit. It will also

appeal to the more altruistic students in your classes and benefit the profession as a whole.
Instill in students an appreciation for life-long learning", and encourage them to think critically. When students are empowered and feel respected, their attitudes often improve because they are less discouraged and apathetic. Discussion of ethics and societal concerns "often provides both context and motivation" for students to solve quantitative problems.
When field trips, discussions and demonstrations are added to a course, this means that students must read the textbook on their own. For students used to passive learning, this can be frustrating at first, but the change will help them to develop good working habits.

Extended summary: Pedagogies of liberation have been discussed outside of engineering circles for some time. It is an unusual innovation to implement these principles in an engineering setting. Key to the "liberation" concept is empowering students to feel comfortable making mistakes, speak up in class, and share examples from everyday life to make the course material a part of their experience.
This process involves the instructor actively changing the dynamic of competition in the classroom into one of mutual respect between the professor and all the students. When students feel respected, they are more likely to participate and become active, aware, creative and self-motivated learners - crucial skills for success in today's workplace.
"Liberation" pedagogy combines the principles of good engineering education - clear objectives, relevant course material, inductive teaching, combining concrete and abstract information, active and cooperative learning, and personal congeniality - with feminist principles that include a broad contextual and even interdisciplinary focus, connection with everyday experience, a social rather than military emphasis, communication skills, ethics, critical thinking, cooperative and interactive teaching strategies, and inclusion of women scientists' work. Many of these principles have been recommended in ABET's national reports on engineering education.
"No education is politically neutral," the author states. She believes that the social values of engineering are highly conservative, and that this fact is not acknowledged by faculty. She questions the ethics of raising generations of engineers to operate in a "values vacuum" which prepares them to work for any employer, regardless of dangerous products or exploitative practices.
The following changes were made to the Engineering Thermodynamics course in order to implement the values described above:
1. "Connecting Experience to Life." Students completed three open-ended assignments each semester to connect thermodynamic principles with everyday activities. ¼ of the students said on their course evaluation forms that this was one of their top three favorite activities in the course.
2. "Students as Authorities in the Classroom." Students were asked to teach each other and develop educational projects as a group.
3. "Creating Community." The classroom was rearranged so that the students could sit in a circle. This structure created a less-competitive atmosphere and was rated highly

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by 40% of the students.
4. "Taking Responsibility for One's Own Learning." The class discussed the importance of learning to do derivations, took ungraded concept tests and participated in "weekly reflections on learning." Some students were disappointed that they were required to do the reading before class. The instructor did not change her policy, believing that selfreliance is an important skill.
5. "Ethics." The instructor used four case studies on a variety of topics to stimulate discussion. This assignment was rated highly by 40% of the students.
6. "De-Centering Western Civilization." In the future, the instructor plans to include many technical innovations by inventors not usually recognized in the engineering curriculum. Many products developed in early China and the Islamic world, as well as American women's inventions, will be highlighted and integrated with the tests, problem sets, and reading.
7. "Problematizing Science as Objectivity and Normalizing Mistakes." This concept, originally from the social science and liberal arts fields, lends itself well to Thermodynamics because of the historical sequence of theories that attempted to explain the subject. 25% of students rated the history and philosophy of science pieces highly. The course also included many problem-solving exercises in class in which students were encouraged to develop their own solutions and to become comfortable making mistakes.
8. "Assessment." Exams were deemphasized in favor of quizzes, homework and projects.
Small class sizes and time for curriculum development facilitate the transition to student-centered learning. However, some of these principles can be implemented even when time is limited or the class is larger (>20 students). In general, with a skilled instructor, students may benefit from increased critical thinking, a more collaborative environment, and an emphasis on participation and application.

Keyword(s):
Women
Engineering
Feminism
Class discussion
Classroom climate
Teaching
Assessment
Competition

Rosser, S. V. (1993). Female friendly science: Including women in curricular content and pedagogy in science. *Journal of General Education, 42*(3), 191-220.

Summary: This article paints a comprehensive picture of what "female friendly science" might look like. The author believes that this new approach to science would involve sweeping changes in the culture of scientific inquiry as we know it. She offers a biting social critique of the scientific establishment's failure to include women, its emphasis on competition and violence, its denial of female experiences and interests, and its narrow/deductive focus. The article is more theoretical than research-based.

Recommendation(s): Redesign curricula to include non-violent scientific problems relevant to women's lives and societal values. Emphasize observation, collaboration, and life experience. Encourage female students to explore interdisciplinary work, to apply their knowledge, and to question current paradigms and assumptions.

Extended summary: This article presents a sequence of recommended changes for greater inclusion of women and "female" values in the scientific arena. The changes are organized into five phases of progress; 1) institutional blindness to the issues, 2) recognition of male majority and perspective, 3) barrier identification, 4) recognition of women scientists, 5) women practicing science, and 6) an inclusive redefinition of science.

The steps recommended are organized as follows:

Phase 2:

A. Undertake fewer military experiments and replace them with socially relevant work. This preference among women for non-violent activities that contribute to the social good has been well-documented, but is not being addressed in science and engineering curricula.

B. Consider problems relating to fields in which women feel more comfortable, e.g. traditionally "feminine" areas of interest. There is no research listed in the article supporting that this works in the classroom, although it is plausible.

C. Focus on more holistic global problems and emphasize synthesis and interaction rather than reduction and deduction. Gilligan (1982) has suggested that girls approach problems from a more relational perspective. Emphasize empathy and emotional connection with subjects of study.

Phase 3:

A. Support women scientists in making their own observations from their own perspectives. These observations are not usually validated.

B. Spend more time in the observational stage before coming to a conclusion.

C. Incorporate and validate personal experience.

D. Include gender in hypothesis formulation.

E. Reduce cruelty to animals in experiments.

Phase 4:

A. Give credit to women scientists.

B. Use fewer competitive teaching methods and more interdisciplinary ones. A course program emphasizing synthesis and connection has been used successfully at Mills College.

C. Discuss life integration strategies for women interested in pursuing scientific careers.

D. Demystify scientific language and thereby remove the intimidation factor for people

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interested in science.
E. Discuss applications of science in the classroom.
Phase 5:
A. Combine qualitative and quantitative methods in data gathering.
B. Refrain from gender biased language in describing scientific observations.
C. Clarify biases of gender, race, class, sexual orientation, and religion which may affect the quality of the scientific product.
D. Develop theories which are multi-dimensional and interdependent rather than mechanistic and hierarchical.
The paper is more theoretical than data-based in nature. However, it does offer a long list of citations as a starting point for researchers interested in more information. The author is presenting a synthesis of scholarship on women in the sciences. The paper asks questions that are useful to provoke academic discussion about a topic that is often ignored.

Keyword(s):
Women
Science
Competition
Culture
Feminism
Biology

Rosser, S. V. (1994). Who is helped by friendly inclusion? A transformation teaching model. *Journal of Women and Minorities in Science and Engineering, 1*(3), 175-192.

Summary: In this article, Rosser evaluates a multi-institutional effort to integrate the insights of feminist scholarship with the practice of science teaching. The results were quite positive, showing that both female and male students benefited from the faculty's increased awareness. Female students gained considerable confidence in their science and math ability. Both female and male students' grades improved; interestingly, male students' grades improved more than female students'. The new method of teaching also increased retention, especially in upper-level courses.

Recommendation(s): Incorporate the insights of Women's Studies scholarship into science classrooms. Improved teaching can enhance student grades and confidence.

Extended summary: This project involved educating faculty on the instructional differences between teaching male and female students. The faculty then applied their knowledge in the classroom setting. The new teaching methods caused significant improvements in student confidence and retention. "Evaluation of the project centered on three questions:

1) Does awareness of gender-related differences in learning and teaching produce a change in instruction?
2) Does this gender-related awareness produce a change in learning?
3) Does awareness of gender-related differences in learning and teaching help instructors to retain students and improve their grades?"
"The findings indicate that female students of the participants became more confident of their own science and math ability. Both male and female students' confidence increased, and in some project courses, female students' confidence increased to a significantly higher level than males'.
"Students' grades in participant courses before and during the project were better. Analysis revealed that the project improved the grades of male more than female students. Females usually started with a higher grade mean than males, but males surpassed the females at a significant level."

Keyword(s):
Women
Science
Culture
Inclusively
Feminism
Academic achievement
Retention
Assessment

Rosser, S. V. (1998). Group work in science, engineering, and mathematics: Consequences of ignoring gender and race. *College Teaching, 46*(3), 82-88.

Summary: Understanding the dynamics of race and gender in group work are critical to the enhancement of learning for all students, especially for women and men of color. Most faculty members are unaware of the research on group work and could greatly benefit from incorporating inclusive group work strategies into their classroom. Rosser discusses the importance of taking into account students' background while setting up groups (size, ability, intersection of race and gender), assigning leadership and group roles (rotation and stereotypes), and designing projects (overcoming resistance and fair assessment). The manuscript is well grounded in the literature and offers many suggestions to improve the classroom environment for all students.

Recommendation(s): Group structure and initial setup requires considerably more forethought than it might seem. Do not worry particularly about achieving a diversity mix within small groups, but ensure that all students have some support within groups from similar students. Group size should be related to the task. Group composition must be rotated throughout the semester, and assurances should be in place that all students fill a variety of roles. Group projects should not simply be individual assignments to be done in a group, but should be of a kind that requires cooperative effort. The paragraphs in the heading "overcoming resistance" are so well articulated that the reader is strongly urged to read them in full, as are those relating to ensuring fair assessment within and outside of a student's group work.

Extended summary: Rosser opens this article with a case description of a "mythical" new associate professor's sincere but misguided attempts to reach diverse students in his class and the unintended negative consequences of his having proceeded without understanding the issues. While more experienced eyes can see where his attempt will lead, the reader is forced to confront the potential of having made similar mistakes or of having been spared some mistakes purely through luck. The paper then details concrete references to small group dynamics research and weaves this body of knowledge back to the real-life challenges of college faculty who want to reach and support students of all backgrounds, especially the brightest.
While not reporting on original research directly, this paper integrates other research relating to STEM education. The author describes ways to reach, engage and support minorities, women, minority women, international students and diverse students of all kinds. She discusses ways to ensure that group work is undertaken successfully and is rewarding to students and faculty alike.

Keyword(s):
Assessment
Communication
Minorities
Women
Collaborative learning
Teaching
Stereotypes
Classroom climate
Group work

Safford, S. M., & Worthington, J. E. (1999). Computer anxiety in individuals with serious mental illness. *Computers In Human Behavior, 15*(6), 735-745.

Summary: Computer anxiety can be an obstacle for people who are new to the work force. This study evaluated the effects of two similar, but not identical, computer training programs – one, at a community college, and one, at a vocational rehabilitation center for people with mental illness. The study found that training courses in basic computer skills did not significantly reduce computer anxiety in either group. In addition, the vocational rehabilitation participants had significantly higher anxiety about working with computers.

Recommendation(s): When designing introductory computer courses, consider including anxiety-reduction components in addition to the regular content. Also, be aware that students with acute mental health problems may have higher anxiety about using computers.

Extended summary: Some studies have suggested that experience with computers reduces computer anxiety. However, not all of the research is in agreement. All of the studies on computer anxiety, before this article was published, involved healthy individuals in school or business settings.

The authors' goal was to compare the computer anxiety level of individuals with mental illnesses (psychotic disorders, affective disorders, anorexia, and other illnesses) to that of college students in an introductory computer course. The hypotheses of the study were that the individuals with mental illness would have higher anxiety levels, but that their anxiety levels would be reduced by taking the course. The students in both courses took a test called the Computer Anxiety Rating Scale. The test was administered before the courses, 1 month into the course sequence, and 3 months into the course sequence.

Because the vocational rehabilitation participants had difficulty being in large groups, concentrating for long periods of time, and concentrating in distracting environments, their course was not taught in a traditional college format. Instead, it was an ungraded set of flexible modules with most of the components being optional. All of the rehabilitation program class sizes were small.

Neither course appeared to reduce the students' anxiety about using computers. Among the mentally ill participants, the women had higher levels of computer anxiety than the men. However, the class was also only 30% female; this may have affected the results. In general, the vocational rehabilitation participants had significantly higher anxiety about using computers than the college students did. It is not clear whether this anxiety was due to a generally anxious state from health problems or low self-esteem, or whether it was due to inexperience with computers in work settings.

There were some problems with retention among both the college students and the vocational rehabilitation participants. In addition, the sample sizes were relatively small and were not representative of the general population in gender and ethnicity. These factors make it hard to generalize the results from this study. Further research in this field is needed.

Keyword(s):
Accessibility/disability
Special programs
Reentry students

Technology
Computer science

Sakimoto, P. J., & Rosendhal, J. D. (2005). Obliterating myths about minority institutions. *Physics Today, 58*(9), 49-53.

Summary: This article describes a long-term initiative in which NASA scientists and staff encouraged the development of space science programs at minority-serving institutions in the United States. Key to the success of this program was NASA's willingness to look critically at its past mistakes and develop an outreach program that was flexible enough to take into account the needs of the individual universities. It was also essential to involve faculty and students in an respectful way, giving them opportunities to contribute to important projects and to be productive rather than handing them token or trivial work.
The results of the program "dazzled" the authors. After three years, the participating institutions had creatted 68 new courses in the field and 12 new or revised degree programs. 50 collaborative research projects took place with major research institutions. The universities were also involved in 10 NASA space flight projects. Nearly 100 students signed up to major in space science at the participating institutions during the time period, and many held science internships. As a result, the program has been expanded.

Recommendation(s): Federal agencies can play a powerful role in aiding the development of science programs at minority universities. However, such efforts in the past have marginalized minority university faculty by not recognizing them as equal to their peers from majority institutions. It is essential to involve minority institution faculty in important research and create productive partnerships which meet the needs of everyone involved. Minority institution faculty are often eager to participate as equals in scientific efforts, and are frustrated with past tokenism.

Extended summary: The authors believed that earlier efforts by NASA to collaborate with minority-serving institutions (MSIs) were "misguided." Faculty mentors from majority institutions often had only a superficial working partnership with their mentees at MSIs, and mentees were not given the opportunity to participate in ground-breaking research. Meanwhile, the myth persisted at NASA that MSIs were not interested in space science.
However, when the authors approached MSIs with an invitation to become an integral part of NASA's research program, the MSI faculty were excited by the opportunity. Since the space science community is hierarchically structured, institutions of lower prestige are often simply viewed as sources of graduate students, rather than research schools in their own right.
NASA set up partnership opportunities for the MSIs to work with "major players in space

science research" and organized a program which was highly flexible, allowing projects to contain "research capability development, academic program development, and public outreach program development." These programs were very successful. The authors believe that their success hinged upon their respectful professional connection with MSI faculty members and their responsible attitude towards the process.

Keyword(s):
Science
Minorities
Discrimination
Faculty
Recruitment
Retention
Mentoring

Sax, L. J. (1994). Retaining tomorrow's scientists: Exploring the factors that keep male and female college students interested in science careers. *Journal of Women and Minorities in Science and Engineering, 1*, 45-61.

Summary: The article explores the different factors that influence female and male college students to persist in science or engineering careers through a study of the science career aspirations of 15,519 college freshmen. The study takes into account multiple factors, including background characteristics (such as race, parents' careers, high school activities, reasons for coming to college, etc.) and students' intended major. In addition, the study includes environmental variables such as living arrangements, peer and faculty environment, institutional characteristics, and student involvement (courses taken during college, experiences and activities during college, etc.). While 20.6% of men enter college with science career aspirations, only 6.4% of women have the same goals. However, persistence rates for science careers for men (40.2%) are close to that of women (35.1%) (see Table 1 and Table 2). The majors which most men change to after leaving a science major are business, the military, and law; for women, business, education, and medicine are the most popular majors to change to after science (see Table 3).

Recommendation(s): As an instructor, it is important to be aware of all the factors that may affect students' persistence in science, and how they might differ between genders. Being more flexible towards students' non-academic time commitments (family, volunteering, jobs, etc.) can allow more people to engage in science. Emphasize the "social good" of science careers through assignments (as opposed to military issues), introduce new career opportunities through guest lecturers, and discuss the income of many science careers to change the prevailing stereotypes. Create a positive learning

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environment through cooperative group projects and inclusive (non-sexist, racially diverse) language and textbooks. Providing students with research opportunities can give students experience in science careers and help maintain interest.

Extended summary: Persistence in science for both men and women is related to good high school grades, high self-rating in math ability, and having a father who is an engineer. Having the goal of raising a family appears to discourage students from science careers. Men tend not to persist in science if they hope to be self-employed, grew up in a high-income family, expected to change majors during college, or doubt their own social skills and writing ability. Male students who are attending college because their "parents wanted [them] to go" and/or have a mother who is a research scientist are more likely to stay in science. Women tend to stay in science if they have the goal of being self-employed, have a mother who is a college professor, or had four years of physical science in high school. If women expect to change their major, have the goal of helping others, or have a diverse set of personality characteristics, they are less likely to persist.

In terms of environmental variables, the proportion of students at an institution holding jobs is the only factor that may have a positive influence. The author reasons that this is because this type of institution has many working students, is usually not highly selective, has smaller social science departments to attract students away from science majors, and has more students who live at home and have less interaction with peers. Men also benefit from receiving financial assistance from parents or loans and having a major-dominated curriculum. Male students are less likely to stay in the sciences if the institution has nonfaculty teaching general education courses, they are attending college far from home, and the environment is competitive.

Taking more science courses encourages both men and women to persist. Students who have taken a multiple-choice exam or chosen a career for interpersonal reasons are less likely to persist. (The author comments that both having taken many science courses and having taken a multiple-choice exam may be results of persisting in a science field, rather than causes.) Women who worked on a professor's research project or took many math courses in college tend to stay in science, while women who held a part-time job and took an essay exam were more likely to leave. (The study does not distinguish between essay exams in the sciences and essay exams in other disciplines.) Men who spent many hours per week studying, chose their career because the work is interesting, or made a career choice based on parents' expectations were more likely to stay in the sciences. Men who volunteered extensively, received personal or psychological counseling, took many writing skills courses, or had a paper critiqued by an instructor tended not to stay in the sciences.

The overarching themes found from this data are that early commitment to science, good educational preparation and confidence, and having a parent involved in science are the most important factors influencing the persistence of males and females in science careers. Interestingly, the stereotypical perception of science careers as either lucrative (according to women) or not lucrative (according to men), very time consuming, not oriented toward helping people, very competitive, and isolating or

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impersonal, has as great of an influence on persistence as actual commitment and preparation. This flawed image is a significant obstacle for the scientific community to overcome. This can be accomplished by emphasizing the collaboration among scientists, the growing diversity within the sciences, and the connection between science research and social good.

The study also reveals how men and women have differing perceptions that affect their choice of science careers. Men view science careers as not providing financial success, as shown through the large number of men who change their major to business or law. On the other hand, women see science careers as lucrative, and financial success is the strongest predictor for women. Also, helping others in a career affects women's persistence, but not men's. Having the goal to raise a family has a much stronger negative influence on women than on men (nearly twice as much). Self-rating of math ability and parents' expectations are the strongest predictors for men, implying that in the future, women may benefit from parents' and teachers' expectations rather than being deterred by them.

These results demonstrate that science departments should try to become more flexible for students with many outside interests or commitments (such as family, volunteering, etc.), and should bring in scientists from an array of careers to stimulate students' interest in science and provide students with ideas. Also,creating a more cooperative and inclusive learning environment through increased group work, non-sexist language and textbooks, collaboration with professors, and work involving social concerns could help to retain more women.

Keyword(s):
External influences
Social support
Retention
Women
Undergraduate
Career

Schafer, A. I. (2006). A new approach to increasing diversity in engineering at the example of women in engineering. *European Journal of Engineering Education, 31*(6), 661-671.

Summary: The low retention of female students in engineering has been attributed to “the unfriendly, even hostile culture of engineering.” The author of this article emphasizes the importance of raising awareness of women’s situation in engineering. She believes that men need to be convinced of the benefits of and need for a change in the engineering climate women face. To educate the student population at one university about the problems that confront women and to show them the benefits of a diverse workforce, a mandatory “diversity lecture” was included in the curriculum for fourth-year engineering students. Students' interest was high, and their responses were generally positive.

Recommendation(s): By creating a required "diversity lecture," in which the diversity problem is addressed, instructors can increase awareness of women's situation in engineering. These types of interventions can create a more supportive environment for female students.

Extended summary: To change what has been referred to as the "unfriendly, even hostile culture of engineering," an Australian university developed a diversity lecture. This lecture was developed with the belief that raising awareness and understanding among students was the first step toward changing the climate that women experience in engineering. Because engineering professions may lose valuable contributions when women are excluded, another important objective was to convince men that the whole field would benefit if the situation of women improved.

As the main idea was to instill a culture of support and collaboration, reaching all students, as opposed to only women, was important. The lecture was incorporated into a fourth year management course that was required for engineering students. In addition to the lecture, there was also a two-hour tutorial and a brief assignment.

The main objectives of the lecture were:

- to raise awareness of diversity issues using the example of gender diversity
- to emphasize that female engineers bring unique qualities that benefit the engineering profession
- to demonstrate the economic benefits of keeping women in the workforce
- to show the advantages of family-friendly workplaces for men

In the lecture, the problem was outlined by both engineers and directors from Equal Employment Opportunities and Flexible Learning Services. Among the speakers was a postgraduate who described her experience in chemical engineering. She emphasized the need to encourage cross-gender cooperation and make supervisors aware of the different needs and abilities of women. Another speaker, a local engineer, emphasized that women operate differently and that they can contribute another dimension to the male workforce. Currently, engineering does not attract women because its culture does not value or recognize the ways that women can add to the field.

There was enormous feedback following the lecture. Except for a few negative comments, participation was active and interest was high. In a post-lecture questionnaire, students reported a significant increase in awareness of gender issues. Many students also suggested that this lecture be presented in the first year rather than the fourth.

Keyword(s):

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Undergraduate
Social support
University climate
Women
Engineering
Discrimination
Sexism
Culture

Schellenberg, E. G., Hirt, J., & Sears, A. (1999). Attitudes toward homosexuals among students at a Canadian university. *Sex Roles, 40*(1-2), 139-152.

Summary: This article is a report on a study that surveyed the attitudes toward gay men and lesbians among college students from different fields of study. The key findings were that attitudes toward gay men were more negative than toward lesbians, Science and Business students had more negative attitudes toward gay men than Art or Social Science students, and that male students had more negative attitudes than female students. The authors also found that the attitudes toward gay men and lesbians become more positive (or less negative) with the number of years spent in college, especially among male students. The article suggests that a college education may promote a reduction in anti-homosexual prejudice among young people.

Recommendation(s): The purpose of the article is not to present recommendations, but to report findings of an attitude survey. However, based on the findings that anti-homosexual prejudice decreases with time in college, they suggest that young people, especially men, should be given access to a college education since it may enhance their ability to accept human diversity.

Extended summary: Negative attitudes toward homosexuals have resulted in verbal abuse and even physical violence against gay men and lesbians. Although several previous studies have found such attitudes among college students, this is the first study that surveys these attitudes as a function of the student's field of study. The authors found that students in Science and Business fields have more negative attitudes than do Arts and Social Science students. They hypothesize that Business and Science fields attract students who value traditional sex roles, since these fields are considered politically conservative relative to the other fields.

The research method involved a survey that was administered to 199 students (of whom 101 were men) at the University of Windsor, located a few miles from Detroit, MI. These students, who ranged from 18-35 years old, were from the middle and lower economic classes and represented four general fields of study (Arts, Business, Science and Social Sciences). The survey, which took about 5 minutes to complete, included 10

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statements about gay men and lesbians to which the students responded on a scale ranging from 1 (strongly disagree) to 9 (strongly agree). The higher the number, more negative the attitude. The attitudes were examined as a function of three variables: gender, field of study, and number of years in college. Furthermore, the differences in attitudes toward gay men were compared to those toward lesbians for each of the above variables.

The main findings were as follows:

- Men had more negative attitudes about homosexuals.
- Science and Business students had more negative attitudes against gay men than did Arts and Social Science students.
- Attitudes towards homosexuals became more positive with time spent at college.

This article can be used as a source for others' research study findings on the issues of homosexuality and the college experience. Some of the other study findings cited in this article include:

- Men have more negative attitudes about homosexuality than women.
- People with higher levels of education have less negative attitudes toward homosexuals.
- College courses that include discussions of homosexuality promote tolerance of homosexuals.
- Men have more negative attitudes toward gay men than toward lesbians.
- Negative attitudes about homosexuality is related to the relatively high rate of suicide among homosexuals.
- Personal interaction with "out" homosexuals reduces prejudice against homosexuals.

The findings of this study agree with most others in that it identifies men as harboring more negative attitudes towards homosexuals, and especially against gay men. However it also finds that this attitude differs based on field of study. This also supports findings from other longitudinal studies that show negative attitudes towards homosexuals decrease with time at college. Thus the authors suggest making a college career accessible to young people, especially young men, as a way to help them become better able to accept human diversity.

Keyword(s):
Homosexuality
Science
Attitudes
Gay men
Homophobia
Lesbians
Men
Undergraduates

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University
Business
Social science

Schwartz, S. K., & Kowalski, E. M. (2007). Collaborative teaching across freshman information technology and chemistry courses. *Journal of College Science Teaching, 36*(5), 34-39.

Summary: A chemistry teacher teamed up with an IT professor, both of whom work at the United States Military Academy in West Point, to test the theory of classroom collaboration with a select group of 17 cadets. The two teachers worked together to create assignments relating to one another's classroom teaching, to try to improve student understanding of the materials. This experimental way of teaching was found to improve grades and to provide more real life experience.

Recommendation(s): If faculty members are planning on collaborating and interlinking course materials, it is important to begin preparation as early as possible. The authors suggest "beginning the collaboration at least a semester in advance to provide the time necessary to sit in on each other's classes, design interesting assignments, and identify where collaboration would be most valuable." It is also important to make sure that each of the chosen assignments correlates to the goals or objectives of each course. It is important to make the necessary connections between the classes and to reinforce the course objectives.

Extended summary: Schwartz and Kowalski used collaborative teaching by assigning projects within their chemistry and IT classrooms that related directly to the correlating subjects. The 17 students in the study had lower GPAs than their peers, and tended to be dependent on authority figures for their ideas about science. They used computer technology in the chemistry lab. The problem-solving assignments in their IT class related to the chemistry theories they were learning. They used computer programs such as Java to process information and solve chemistry problems. The results of this collaboration between faculty were a rise in the students' overall chemistry and IT grades, as well as a sense of familiarity and comfort with both the teachers and the classmates that attended both classes together. (However, some students also expressed discomfort with the fact that their professors were working together.) The students said they felt as if their homework and assignments were better than those of their fellow classmates taking the regular IT and Chemistry courses. They stated that they were "more real world" than what others were doing. Overall, the collaboration was a success.

Keyword(s):
Chemistry

Computer science
Faculty
Course content and curriculum
Laboratory
Teaching
Technology
Interdisciplinary

Scott, A. B., & Mallinckrodt, B. (2005). Parental emotional support, science self-efficacy, and choice of science major in undergraduate women. *The Career Development Quarterly, 53*(3), 263-273.

Summary: This research study examines the college career choices of a group of women who participated in a NSF-funded science preparatory program for high school students. The researchers examined the correlations between students' relationships with their parents, their self-confidence in science, and their choice of major. They found that having a father who was controlling and withholding of affection seemed to predispose girls not to pursue non-traditional careers. This result is in agreement with previous research.

Recommendation(s): Family influences affect young women's career decisions. Creating a culture in which more young women have positive relationships with their fathers may encourage more of them to consider non-traditional careers. Because of this, male mentors may be more effective than female mentors in assisting young women with science talent.

Extended summary: Women are significantly underrepresented in science and engineering. Factors that work to maintain this discrepancy include sex role stereotypes, concerns about having time to raise a family, lack of female role models, low social support, lack of information about career options, and lack of feminist identity. Early theories about career choice held that college students with less emotionally "warm" families were more likely to major in the hard sciences. However, later studies found the reverse to be true. A more recent theory proposes that young people whose families are more supportive are more likely to explore a variety of careers, including non-traditional ones.
Another theory suggests that higher task-related self-confidence can influence women's career choices and persistence. The women in this study who chose science majors had higher scientific self-confidence than those who did not.
Controlling parents who express affection conditionally can decrease the self-confidence of their children and make it more difficult for them to adjust to college. The results of this study show that young women whose fathers are controlling and conditionally affectionate are less likely to pursue science careers, even when their

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aptitude is high.

Keyword(s):
Women
Undergraduate
Retention
Aptitude
Identity and personality
External influences

Scott, E. C. (1997). Antievolution and creationism in the United States. *Annual Review of Anthropology, 26*, 263-289.

Summary: This article reports on the different varieties of creationist and science-based beliefs about evolution that are current in the United States, locating them along a continuum from “Flat Earthism” to “Materialist Evolution.” The Catholic Church, as well as mainline Protestant denominations, accepts scientific explanations for evolution. The article offers a detailed critique of intelligent design theorists’ work. The author views opposition to evolution as idiosyncratic, given that many other scientific theories contradict Biblical explanations. Like other authors in this review, the author believes that science cannot prove or disprove the existence of God.

Recommendation(s): Since anthropologists study both evolution and religion, they are uniquely positioned to inform college students about evolution. It is important to teach evolution in post-secondary education, especially in astronomy, geology, anthropology and biology, where the topic is especially relevant. Approach the topic from a “scholarly, rather than an ideological, position.” Make it clear to students what the scientific definition of “theory” is. Also, explain that evolution is not a “chance” process.

Extended summary: The continuum of religious views on evolution can be divided into two “sections”: Young Earth Creationists and Old Earth Creationists. Young Earth Creationists include people who believe the earth is flat (a small minority), people who believe the earth is the center of the solar system and reject most scientific views, and people who believe the earth was created recently, according to a Biblical timeline. This third viewpoint is promoted by the Institute for Creation Research, an organization that has many publications and adherents. The Institute confers degrees, but does little research.

Old Earth Creationism, which includes Intelligent Design, is considerably more popular. Its adherents range from those who believe that each day of Genesis was an age long, to Progressive Creationists, to Theistic Evolutionists. Finally, Materialist Evolutionists do not believe in divine intervention at all. Progressive Creationists agree with modern

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physical science, but disagree with some biological science theories regarding the differentiation of species. Theistic evolutionists – some of whom are proponents of intelligent design – believe that God intervenes at certain key points in history.

The article also reviews the history of controversies around creationism in the United States. What was once strong, purely religious opposition has changed into “intelligent design,” a point of view that agrees with most scientific data but holds that God still has intervened in the evolutionary process. The evidence for this, many scientists believe, is not convincing. Intelligent design is popular with some academics. Therefore, it has received more press coverage. Creationists have turned to promoting “evidence against evolution” in schools, which is a less explicitly religious approach, although it is based in the same values. Most Americans seem to be unaware that most religious denominations, both Christian and Jewish, accept evolution as it is currently explained by scientists.

Because of the controversial nature of this subject, many K-12 science teachers are reluctant to teach evolution. This reluctance may eventually lead to decreased funding for evolution-related research as the public becomes less informed about what the theory of evolution is – and what it is not.

Keyword(s):
Undergraduate
Science
Biology
Religion
Faculty
K-12
Course content and curriculum

Smyth, F. L., & McArdle, J. J. (2004). Ethnic and gender differences in science graduation at selective colleges with implications for admission policy and college choice. *Research in Higher Education, 45*, 353-381.

Summary: This study seeks to explain the variance in science graduation rates based on gender and ethnicity as a function of students' pre-college academic preparation. The authors found that attending a selective college did not increase students' likelihood of graduation. Therefore, they propose that students of all demographic groups who have low to mid-range math SAT scores attend colleges where their peers are at a similar academic level to them (i.e., less-prestigious colleges).

Recommendation(s): Although this paper does not offer instructional recommendations, the results indicate that additional assistance should probably be

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made available for students struggling with math concepts that they did not learn before entering college. The authors also recommend that affirmative action programs maintain strict standards regarding students' SAT scores.

Extended summary: National science organizations have expressed concern about the higher attrition rates of female and underrepresented minority (URM) students in science majors. The authors agree with Elliott et al. (1995), who believe that affirmative action processes at highly selective colleges result in minority students with lower math SAT scores opting out of the physical and biological sciences to graduate in other fields instead. However, they acknowledge that, as Bowen and Bok (1998) pointed out, minority students are more likely to graduate at more selective schools, even if they do not remain in the "science track." Based on a set of statistical models, the authors conclude that students with lower math SAT scores are actually better off attending less-selective colleges if they want to pursue a science degree.

The authors matched demographic information with students' intended majors, and found that White females were the least likely of all groups to select science majors. Black students were twice as likely as White students to be interested in the field. In almost all ethnic categories, males were more likely than females to express interest. (Black female students were equally as likely to express interest as Black male students.)

The authors also evaluated records of student persistence. Hispanic females were equally as likely to persist in their program as Hispanic males, but males were more likely to persist than females in all other ethnic categories.

A 75-point increase in math SAT scores corresponded to a 50% greater chance of graduation in the sciences. The hypothesis that SAT score explained science persistence held for differences between White and URM students. However, gender has a residual effect that cannot be explained by SAT score alone. There also appear to be other variables, outside of the scope of the study, which explain Asian students' success relative to all other population groups.

This study raises a number of questions about outside factors that the SAT and college courses have in common. The reliance of some science departments on multiple-choice testing, an assessment method that also appears on the SAT, may favor students whose learning style is more compatible with that type of testing. In addition, students' access to resources such as study groups and tutors, and their willingness to seek out assistance, may be related to their cultural background and gender. The assistance that students receive when studying math may contribute to their success on the SAT and, later, in college.

Keyword(s):
Mathematics
Minorities
Women
Retention
Gatekeeper courses

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K-12
Recruitment
Academic achievement
ACT/SAT
Academic preparation

Sorby, S. A. (2001). A course in spatial visualization and its impact on the retention of female engineering students. *Journal of Women and Minorities in Science and Engineering, 7*(2), 153-172.

Summary: Three dimensional spatial skills (3-D) are a predictor of success in a variety of technical fields ranging from engineering and computer design to basic and structural chemistry. Those skills are particularly critical for design courses, which comprise most of the introductory courses in engineering. Unfortunately, many women's 3-D spatial visualization skills lag far behind men's. Under a grant from the National Science Foundation, researchers at the Michigan Technological University developed a series of electives and workshops to better prepare freshmen who scored poorly on the Purdue Visualization test. Students participating in the Spatial Skills courses were found to make significant gains in the visualization test. Moreover, they secured higher grades in graphics courses and were more likely to be retained in engineering than those who did not enroll in the spatial courses. The article is well grounded in the literature. Students were selected by their advisors to participate in the project and followed across time to better ascertain the impact of the program on their academic performance and persistence.

Recommendation(s): Not all students, male or female, have developed those spatial visualization skills which will eventually enable them to succeed in technical majors. However, spatial visualization skill deficiencies can be addressed by courses that teach the following sequential topics: 1) isometric sketching, 2) orthographic projection, 3) flat pattern development, 4) 2-D and 3-D visualization, 5) object translation, scaling, uniaxial and bi-axial rotation, and reflection, 6) use of planes and cross-sections, 7) creation of solids of revolution, and 8) Boolean operations (union, intersection, etc.) on solid bodies. Hands-on exercises are also beneficial for student learning, especially for those with limited shop or drawing experience.

Extended summary: The paper describes the successful development of two elective courses at Michigan Technological University designed to improve students' spatial visualization abilities. Advisors recommended the courses to incoming students who scored less than 60% on the PSVT:R (Purdue Spatial Visualization Test: Rotations) during freshman orientation. Female engineering students are statistically 3 times more likely to fail this test than are males. The PSVT:R is a statistically sound predictor of performance in engineering graphics courses (Gimmestad (now Baartmans), 1990).

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Dr. Sorby and her co-investigator, Dr. Baartmans, developed a curriculum and complete program materials for these courses. The program included both a 3-credit and a 1-credit elective. The differences between student test scores in these two courses were inconclusive because of preexisting differences between the experimental samples. Solid modeling and object handling were the tools used to develop students' visualization abilities. At first, the researchers used I-DEAS modeling software (Unix-based).
Later, a multimedia substitute was developed by another researcher, Dr. Wysocki, in response to requests from many educators who did not have the necessary hardware. Students expressed satisfaction when surveyed about the effectiveness of the multimedia modules; their comments were used to refine the final version. The effects of the courses were evaluated rigorously, including a long-term analysis of student grades in graphics courses and retention in both the School of Engineering and the University. Students were tested before and after the course using the PSVT:R and other tests; their scores showed statistically significant improvement. The researchers determined, through comparison of calculus grades, that the students who elected to take the course were an academically representative sample. In their subsequent graphics courses, students who took the electives outperformed unprepared students by half a letter grade. Women showed greater improvement in their graphics grades than did men. The effect for male students, although positive, was not statistically significant. A multivariate analysis of student retention, gender, and grades in calculus and graphics revealed that the new course effectively reduced the "gate-keeper" effect that graphics courses have for many female students.

Keyword(s):
Women
Computer science
Engineering
Technology
Spatial ability
Aptitude
Academic achievement

Stage, F. K., & Milne, N. V. (1996). Invisible scholars: Students with learning disabilities. *Journal of Higher Education, 67*(4), 426.

Summary: This paper discusses a qualitative study of students with learning disabilities. The researchers explored institutional factors, students' coping skills, and students' attitudes and behavior. They found that the students were hard-working and resourceful in adapting to instructional environments, gave themselves credit for their successes, were reluctant to reveal their disabilities, had often experienced discrimination, and benefited from more interaction with faculty (e.g. smaller classes).

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Recommendation(s): Widespread education is needed to counter stereotypes of students with learning disabilities. “Uniform and widely publicized means within and across universities for identifying students with disabilities are needed.” Faculty should consider varying their presentation methods for students with differing learning styles. Students should receive information on their tutors’ teaching experience to aid in their selection. Universities should pay for the entire cost of tutoring. Support groups could also benefit students with learning disabilities. Students could also use assistance in communicating effectively with faculty and selecting optimal learning strategies.

Extended summary: Students with learning disabilities, or LD, have normal to above normal
intelligence, but have difficulty with routine academic tasks. They tend to perform less well in college than their high school grades predict. Research shows that faculty are often misinformed about LD or are unwilling to accommodate students who need extra time on tests or assignments.

This exploratory, qualitative study used ethnographic interviews to reveal the experiences of eight undergraduates with LD at one university. The topics included a) college experiences, b) experiences with faculty, peers and tutors, c) students' comparisons of their skills to those of others, and d) study strategies. The results were divided into a) dispositional factors, b) institutional factors, and c) study strategies.

Students tended to be self-conscious about their disabilities, often keeping them a secret. This reticence was often due to years of negative messages. Students compensated for their disabilities by relying on their strengths and avoiding activities which would reveal their
weaknesses. Students also rewarded themselves for accomplishing goals.

Faculty were a powerful influence in students' academic lives. Their responses ranged from helpfulness to resistance when making accommodations. In general, students valued one-to-one interaction with professors.

Students commented that tutors were not always knowledgeable about teaching or disabilities, and also that reimbursement for tutoring costs was not sufficient to pay for the full expense.

Peers sometimes responded with disbelief or stereotyping when the students revealed that they had LD. However, some peers were supportive.

Students' primary study strategies were relying on their strengths and spending extra time at the library.

The authors recommend that disability services offices provide guidance in selecting

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study strategies and communicating with professors. In addition, they recommend greater efforts towards identifying students with LD, as well as education for peers and faculty to create a more
tolerant climate.

Keyword(s):
Accessibility/disability
Mathematics
Undergraduate
Expectations
Social support
Inclusively
Learning styles
Spatial ability
Assessment
Course content and curriculum

Stahl, J. M. (2005). Research is for everyone: Perspectives from teaching at historically Black colleges and universities. *Journal of Social and Clinical Psychology, 24*(1), 85-96.

Summary: This article reports on effective mentoring strategies that have been used at HBCUs in the Atlanta University Center to encourage students to pursue graduate studies in psychology and the biomedical sciences. The author recommends that other universities follow this model.

Recommendation(s): Involving students in research and recognizing their accomplishments aids in their career development. Giving students opportunities to present their work at professional conferences and in newspaper articles enhances their self-esteem. Be open to students' research ideas, give them general guidelines on how to conduct literature searches, and encourage them to develop independent thinking habits.

Extended summary: Historically, researchers in psychology have had difficulty understanding issues facing minority groups. Although more women have entered the field in recent years, ethnic minorities are still underrepresented. Encouraging students from underrepresented groups to enter science assures that the scientific community will produce research that benefits the entire population.
At the HBCUs in the Atlanta University Center, faculty partner with students and teach them research skills. Having research relationships with faculty enhances students' self-confidence and support systems. Morris Brown College identifies students who are interested in research during or even before their freshman year. Students receive research grants, signs of status such as public posting of photos and news about their

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accomplishments, keys to the lab, and office space.
It is important for faculty to be willing to let students explore outside their own areas of research interest. A simple approach to take is to give students a framework or structure for their work, and then ask them to report on the information that they find. During the first two weeks of class, for example, the author asks students to produce a copy of the benchmark study in their area of interest, information on the measurement method used, and a relevant recent paper using that method.
Through her students' work, the author has become familiar with research in a number of areas of psychology, many of which are relevant to the lives of African-Americans.

Keyword(s):
African-American
Career
Undergraduate
Communication
Expectations
Motivation
Social support
Mentoring
Advising

Strawser, S., & Miller, S. P. (2001). Math failure and learning disabilities in the postsecondary student population. *Topics in Language Disorders, 21*(2), 68-84.

Summary: This paper reviews the existing literature on math failure and learning disabilities (LD) in college students, presents the obstacles that students with different types of LD face in math courses, and provides recommendations for intervention and further research.

Recommendation(s): Encourage students with LD to take more math at the high school level so that they will be ready to complete any college requirements. Whenever possible, try to provide individualized instruction to students based on their specific learning needs (listed below). Some students may benefit from having problems read aloud. Others may need assistance in understanding mathematical language and verbalizing concepts and ideas. Many students benefit from opportunities to discuss mathematics. Math journals may be helpful. Social support (e.g. study groups) may also be beneficial, especially during college, where there are reduced support systems for students with LD.

Extended summary: “The number of students with learning disabilities who enter postsecondary educational settings has increased dramatically in recent years.” Although many existing studies treat this population as monolithic, it is not. Learning

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disabilities can manifest in many different ways. The author categorizes math-related learning disabilities into two categories.

Students with Type One learning disabilities- general learning disabilities- may have cognitive problems that lead them to have difficulty evaluating their problem-solving skills, selecting appropriate problem solving strategies, organizing information, monitoring their problem solving, evaluating accuracy, and choosing alternate problem-solving strategies. They may also have difficulty:

1) processing auditory information (listening to lectures, taking notes),
2) processing visual-spatial information (copying from the blackboard, solving problems accurately, organizing their work neatly),
3) being physically coordinated (writing numbers accurately, taking efficient notes, and writing in small spaces),
4) paying attention during homework or lectures, and
5) remembering facts or assignments (short-term or long-term memory).

Students with language disabilities may misunderstand explanations, have difficulty with reading, or be unable to articulate their questions.

Students with Type Two learning disabilities have problems specifically related to math. These students have both deficits and strengths related to math. Their strengths include language skills, reading and spelling skills, and memorization skills. However, they may have difficulty in the following areas:

1) Nonverbal problem solving (working with patterns, recognizing figures, geometry);
2) Dealing with novel stimuli (relying on only a few problem solving strategies);
3) Visual/spatial organizing (interpreting tables and graphs, organizing their work on a page);
4) Remembering nonverbal information;
5) Doing arithmetic and higher-level math; and
6) Understanding higher-level reading material.

Often, secondary education doesn't prepare students with LD for college-level math. Accommodations may oversimplify course material, make grading less rigorous, or allow students to avoid working on areas where they need improvement. Also, if students take insufficient math during high school, where there is more support for students with LD, they may be required to take more math in college, where there are fewer support systems. In college, students with LD must be prepared for the same course load as any other student would take.

The authors also identify inconsistencies in assessment and recommend strategies for improved identification of learning disabilities. They express concern about curricula that are not research-based, and assessment that is not curriculum-related. They note the need for further experimental research to determine successful intervention strategies.

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Keyword(s):
Accessibility/disability
Mathematics
Undergraduate
Expectations
Social support
Inclusively
Learning styles
Spatial ability
Assessment
Course content and curriculum

Study, N. E. (2006). Assessing and improving the below average visualization abilities of a group of minority engineering and technology students. *Journal of Women and Minorities in Science and Engineering, 12*, 367-380.

Summary: Dr. Nancy Study investigated the use of remediation learning for visualization skills in an introductory level engineering class of primarily minority students. She found that the addition of remediation materials improved test scores and decreased the normally high dropout rate of minority students in science and math.

Recommendation(s): Include remediation materials and assignments within your introductory course curriculum. The remediation materials used in this study were 5 additional assignments, given both in class and as homework, that consisted of 6-20 sketches. These exercises can improve students' spatial visualization abilities.

Extended summary: The need for this study originates from the continuing problem of lower Purdue Spatial Visualization Test (PSVT) scores among minority students. Such scores could be due to a lack of exposure to visually oriented activities in the K-12 level of schooling. However, Study asserts that spatial visualization skills, which are crucial to students pursuing a science or mathematics curriculum, can develop through instruction. Therefore, introductory-level teachers may be able to provide the missing skills through remediation coursework.

Study's research shows that students with low pretest averages who received remediation coursework throughout their entry level course exited with statistically higher posttest scores than those who went through the class without. The first two observed groups of students participating in courses of remediation received average posttest scores of 23.3 and 21.6, instead of the average of 17.6 earned by students in non-remediation courses. The overall mean of the PSVT scores nationwide is between 22 and 24; this means that the minority students were close to, if not within, the average range.

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Test scores were not the only focus of this study. There is also a growing problem of significant numbers of minority students dropping out of science, engineering, and math between their senior year of high school and their junior year of college. Nationally, there is still a disparity between the amount of minority youth in the population and the percentage of minority students in science and engineering fields. Study cites researchers Tjaden and Tjaden, as well as Seymour and Hewitt, who mention that minorities and women have less previous experience, have more negative experiences, and have an overall lack of confidence. This could be due to non-interactive classes and lack of preparation.

Study states. "it is essential to assist them [minorities] in overcoming barriers that may discourage their continued education." By adding remediation materials to introductory level classes, Study observed both an improvement in test scores and an improvement in the level of retention among minority students pursuing a degree in science, engineering or mathematics.

Keyword(s):
Engineering
Mathematics
Science
Retention
Minorities
Academic preparation
Assessment
Teaching

Terhune, C. P. (2006). “Can we talk?” Using critical self-reflection and dialogue to build diversity and change organizational culture in nursing schools. *Journal of Cultural Diversity, 13*(3), 141-145.

Summary: The author of this article believes that, to achieve a diverse nursing workforce, educational institutions must go beyond their current diversity efforts, which primarily focus on recruitment. For lasting change to take place, individuals’ beliefs must change from within. This can be achieved through critical self-reflection and dialogue that expose biases so that people can understand the sources of their prejudices and deconstruct them.

Recommendation(s): Nursing schools need to promote open discussion on diversity issues - and not be afraid to address the causes of existing stereotypes - to achieve a nursing workforce that better reflects and provides for a diverse population.

Extended summary: Diversity efforts within the nursing profession have, to date, mainly focused on recruitment. But achieving diversity is not as simple as just "increasing the numbers." Lasting change cannot be achieved through outward measures alone, but must also include inward reflection. More energy needs to be placed on examining the cultural climate and redefining attitudes, values, behavioral norms, and expectations. This involves the examination and deconstruction of old paradigms, assumptions and prejudices, both individually and collectively

Cultural diversity is essential to the future of nursing. A diverse nursing workforce is beneficial to patients. The racial and ethnic diversity of the population should be reflected in the nursing profession. Educational institutions should be the starting place for this change. The author of this article suggests that diversity should be built through critical self-reflection and dialogue, which uncover and dismantle the more subtle forms of discrimination. The author's goal is to transform individual mental models and to expand knowledge, awareness and appreciation of differences.

Keyword(s):
Science
Recruitment
Classroom climate
Culture
Stereotypes
University climate
Class discussion

Tillberg, H. K., & Cohoon, J. M. (2005). Attracting women to the CS major. *Frontiers: A Journal of Women's Studies, 26*(1), 126-140.

Summary: The authors conducted focus group interviews with 182 students at sixteen computer science departments to determine what influenced them to enter the field. Students reported having early experiences with computers, believing that their abilities were a good fit with the profession, and finding the career prospects appealing. Women were more likely to report creative play with computers, peer encouragement, transferring from a non-technical discipline, viewing programming as a "language", and wanting to use computers to help others. Men were more likely to have been directed into the field by a parent and to take an interest in gaming and mechanical repair. Both sexes reported encouragement from parents and teachers, enjoying problem solving, and wanting to work in a team environment.

Recommendation(s): Take into account the motives that may attract women to computing when designing programmatic initiatives for gender equity.

Extended summary: Although more girls are taking advanced high school math and science courses than before, the gender gap in computer science is growing.
Rather than taking the traditional approach of focusing on "what deters women," the authors studied what attracts both men and women to this major. Focus groups, almost all single-gender, were held at sixteen departments across the United States. These departments were selected for variation in location, type of institution, degree levels granted, prestige, and student gender ratio. 43% of the participants were women, although the average percentage of female students in the departments was only 24%.
The authors claim that standardized career assessments contain implicit gender bias and do not accurately predict student choices. Differences in standardized test scores such as the SAT also do not predict the gender gap in math and science fields.
The gender differences in student results are outlined in the summary above.
Students were strongly influenced by pre-college experiences with computers, including encouragement from parents and teachers, gaming, creative play, and work experiences in which they discovered their talent. Some students' employers were funding their college education.
Unlike men, women typically transferred to computer science from non-technical majors.
Social influences seemed to be somewhat more important for female students. On the other end of the spectrum, some women entered the field to challenge gender stereotypes.
Both women and men described the feeling of empowerment that comes from writing a working computer program. Men were generally more interested than women in hardware repair.
The prospect of good salaries motivated some students. However, others preferred to think of computer science as a profession that serves the greater good of society. Many students were eager to work in a team environment.

Keyword(s):
Careers
Computer science
Course content and curriculum
Women
Technology
Culture
Motivation
Recruitment

Tobias, S. (1990). They're not dumb. They're different. A new "tier of talent" for science. *Change, 22*(4), 11-30.

Summary: The author of this study believes that science educators have concluded too

soon that low-quality K-12 education makes many students "unqualified" for science careers, while unappealing media depictions of science discourage women and minorities from entering the field.
In the author's opinion, college-level science teachers should take responsibility for the high dropout rates in science programs (40% of students drop out of the sciences after the first course taken; 40% more leave before graduation). And key to salvaging the "second tier" of students, she claims, is the following:
1) Engaging teaching practices,
2) Efforts towards recruitment and retention,
3) Increased dialogue and demonstrations in class,
4) Greater emphasis on independent thinking and context,
5) Encouraging cooperation rather than competition among students.

Recommendation(s): Do not present introductory science course material as dull, meaningless, or without context. Do not assume that your students have already decided on science careers. Make the course appealing by encouraging thoughtprovoking discussion and debate. Explain the reasons behind scientific principles.
Connect the basic course material to the larger context of the field. Teach your students to be self-sufficient thinkers and team players so that they will be competent and comfortable in the work force.

Extended summary: This study objects to the popular view that one needs to have a "scientific bent" to do science, citing a study that identifies the quality most successful scientists share: single-minded dedication to the subject since high school. This dedication, the author says, is necessary to persevere through the daunting college and graduate school science curriculum.
Many students who are equally talented but less single-minded drop out of science programs. Only 31% of students who drop out of science majors in college do so because the courses are too difficult. The greatest percentage of students leaving the sciences (43%) leave the field because they find other subjects "more interesting." The author believes the college science curriculum discourages all but the most dedicated students. These are not necessarily the most talented ones in the class.
In this qualitative study, the author recruited seven academically talented students who had taken all the prerequisites for introductory college-level science courses but had avoided majoring in the sciences. These students were paid to work as participant observers in freshman courses, taking tests, doing homework, attending lectures, and keeping a journal of their observations and criticisms of the class. The professors later were given the opportunity to view and respond to these comments.
Although most of the student observers earned high grades, few of them concluded that they would be interested in a science career. They expressed concern about large class sizes, "no sense of community," students' competition over grades, students' inability to explain what they were learning, lack of dialogue and demonstrations in class, and an overall emphasis on memorization and imitation rather than understanding. In general,

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the student observers noted, neither the professors nor the students enjoyed these introductory classes.

Keyword(s):
K-12
Undergraduate
Academic preparation
Stereotypes
Science
Career
Recruitment
Retention
Class discussion
Culture
Competition
Collaborative learning
Teaching

Tobias, S. (1992). Can introductory science be multidisciplinary: Harvard's chem-phys. In S. Tobias (Ed.), *Revitalizing undergraduate science: Why some things work and most don't* (pp.). Tuscon, AZ: Research Corporation.

Summary: Chem-Phys was designed at Harvard to effectively train "future physicians." This was an innovative course which, unfortunately, was not successful in attracting many students. Tobias examines the pitfalls of this course and details the corrective measures taken by the conceivers of this course to encourage more students to benefit from their innovative pedagogy.

Recommendation(s): Ensure that students are comfortable asking questions.
Give students an opportunity to interact with each other.
Inform students of how knowledge gained in class can be used in the "real world."
Introduce collaborative teaching strategies.
Demonstrate linkages between concepts.
When designing a new course, tailor it to the abilities and skills of targeted students.
Modify the course, if necessary, to engage all students in class.

Extended summary: Chem-Phys combined first-year physics, general chemistry and twentieth century atomic physics with a new approach to introductory physics that involved more reading and writing. This two-semester course was to provide students with a strong foundation in molecular and cellular biology, as well as modern chemistry. It omitted the topics of sound and optics and replaced them with topics on atoms, quantum theory and statistical thermodynamics.

The course was designed to provide students with a small class size, individual attention, collaborative learning, a flexible syllabus, and opportunities to pursue interesting questions in physics and chemistry in depth and to demonstrate their understanding of concepts. “Students could progress at different rates according to their knowledge of science.” Students were not graded on a curve; their performance was assessed based on their assignments and discussions that tested and challenged their overall understanding of the course material. Key formulas were mathematically derived and accompanied by the history of thought that led to their discovery. Assignments were designed to improve students’ problem solving, writing and discussion skills and their ability to read and understand scientific and mathematical texts. Also, the assignments were thoroughly discussed during two ninety minute sessions each week, “after which it was assumed students understood everything they had read.”

Students worked with “real problems” and had to write out their ideas. This exposed them to different learning styles and approaches towards understanding concepts. Students were encouraged to question science theories and concepts and to assess their own performance. They enjoyed the discussion and collaboration. A lab section for the course equipped students with skills, taught them experimental problem solving and made theoretical subject matter more concrete.

In spite of the promising course design, chem-phys was rejected by the core committee due to its prerequisites, which included advanced placement chemistry, physics and calculus. The committee believed that this course would not be accessible to students who did not have the required background to successfully complete the course.

The course suffered from poor enrollment. Seventeen students enrolled during the first year chem-phys was offered. However, only seven enrolled during the second year. Although students enjoyed the course, they felt that the course demanded advanced math and literary skills. Students did not know how to approach problems they did not immediately understand and that involved multi-step solutions. Also, students were at a loss regarding what they were supposed to get out of discussions. The instructors overestimated tudents’ ability to master difficult concepts and the underestimated the time required for students to complete weekly readings and assignments. A lack of recognition of the multidisciplinary nature of chem-phys from other departments magnified the lack of interest among students to enroll in this course. The course was modified, in the second year, in accordance with the feedback received from students. The level of math required was lowered and students were taught mathematical techniques. Also, “the sequence of topics was revised so that mathematical concepts came in the “right order and with the right spacing.”” Materials, assignments, and mathematics components in the course have been altered to engage future students.

Keyword(s):

Chemistry
Physics
Undergraduate
Gatekeeper courses
Collaborative learning

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Tobias, S. (1992). High morale in a stable environment: Chemistry at UW-Eau Claire. In S. Tobias (Ed.), *Revitalizing undergraduate science: Why some things work and most don't* (pp.). Tuscon, AZ: Research Corporation.

Summary: This piece examines the role of the chemistry department at UW-Eau Claire in increasing student retention rates, especially female students, in chemistry majors.

Recommendation(s): Employ collaborative teaching practices such as collaborative research.
Improve course content on a regular basis so that students gain knowledge in applying course material to real-life scenarios.
Offer alternative courses to students who are unable to take a course that they are interested in.
Provide faculty members with incentives to improve teaching practices.

Extended summary: More than half of the students enrolled in the School of Arts and Sciences at Eau Claire are female. Also, 41% of students majoring in chemistry and chemistry related fields are women, which is a significant number of female students in a technical field such as chemistry relative to most other undergraduate institutions. More than half of the chemistry undergraduates from UW-Eau Claire have gone to graduate or professional schools. This trend in higher student retention is explored by this article.
Instructors at UW-Eau Claire chemistry department are extremely dedicated to teaching. This is obvious with respect to the care with which classes are assigned, the accessibility of faculty, the real research opportunities provided to chemistry majors, and the commitment to the continuous improvement of the chemistry curriculum. Also, interest in and aptitude for teaching is given high priority while hiring faculty members. Furthermore, although current faculty members are all male and white, there was no “gender gap” in student recruitment and no class gap between faculty and students. The department is now trying to hire female faculty members to correct the gender imbalance in the department and to provide female students role models in chemistry. However, chemistry faculty members are not rewarded for using inclusive teaching practices such as collaborative research. Most of the students recruited at UW-Eau Claire do not have the necessary background in science to be able to successfully major in the field. Hence, introductory courses are often designed to guide and encourage these students. Also, undergraduate chemistry students are encouraged to present chemistry demonstrations at high schools to increase the number of students recruited into the chemistry program. Moreover, chemistry students are given placement advising and help in locating jobs by faculty members. The chemistry department at UW-Eau Claire constantly improves its curriculum. For instance, the chemistry department is considering restructuring chemistry 103, an introductory course for all

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chemistry and non-chemistry majors, so that the course deals with and revolves around everyday lives and shows students that knowledge in chemistry can be empowering. Two interdisciplinary programs were created – chem-biz and chemistry teaching. Chembiz students take courses in both chemistry and business. During their senior year, students are informed of jobs through seminars with industry representatives. Chemistry teaching opportunities were also offered to students who wanted to teach high school chemistry. However, the enrollment levels for chemistry teaching was substantially low compared to other interdisciplinary chemistry programs such as biochemistry-molecular biology. This could be because chemistry education is a five year program, during which time students have to major in chemistry along with a minor in biology, math or physics. Also, high school teachers earn very little relative to chemistry and chem-biz students, in spite of the relatively long duration required in acquiring a degree in chemistry teaching. Moreover, the chemistry department does not have a faculty member with a background in chemistry teaching who could negotiate with the education department to make the current chemistry teaching curriculum more attractive to chemistry students.

Keyword(s):
Chemistry
Undergraduate
Gatekeeper courses
Women
Retention
Course content and curriculum
University climate

Treisman, U. (1992). Studying students studying calculus: a look at the lives of minority mathematics students in college. *The College Mathematics Journal, 23*(5), 362-372.

Summary: A department mathematics team extensively researched issues surrounding minority student performance in college introductory calculus. Their initial perception indicated that minority black students' low-performance relative to white and Asian American students could be attributed to one or more of four factors: income, low motivation to perform, inadequate academic preparation and lack of family support. Rigorous research saw every one of these hypotheses wholly refuted. The authors re-researched
the issues and their subjects, found that course structure and student teamwork were critical, and in response designed a powerfully, demonstrably successful series of intervention programs. Treisman describes challenges and how they were overcome, and calls for supporting faculty who are interested in working on course and minority development to do so as part of their professional work, and for administration to re-think departmental collective responsibility for the future of mathematics.

Recommendation(s): Engage African American students, as well as other students who do not study together, in collaborative learning. This is especially important in gatekeeper courses.

Extended summary: This paper is a transcript of an inspirational lecture describing the efforts of a mathematics department to improve minority student performance in college introductory calculus. Students were extensively observed as to how they lived, their study habits, their interactions with other students and so on. No substantial differences in family income, motivation to perform, academic preparation or family support were found between blacks and other students. Their most significant finding was that while virtually all black students religiously studied, attended class and did their homework, they worked alone, in contrast to (for example) Chinese students, who most often formed informal academic networks and helped each other extensively.
In response, the team developed workshop courses to assist black students to overcome patterns of isolation. Equally important, they developed a core of challenging and suitable problem sets that helped crystallize emerging understanding of calculus and fully demonstrate the beauty of the subject. They successfully demonstrated to their students that college success would require them to work with their peers and create a community based on shared intellectual interests and professional aims. Surprisingly, the team also had to teach its students how to work together. Results were dramatic. Black students with Math SAT scores in the low 600s were performing comparably to Asian students with Math SAT scores in the mid-700s. "In effect, the workshops provided a buffer easing minority students' transition into the academy."
The author further describes efforts in the 1980s to explore student failure generally in introductory STEM courses, with a focus on physics. Again they researched the problem and again their initial hypotheses (student inability) failed. And again, alterations in the course structure (including reformatting the course's problem sets to make them both genuinely challenging and relevant) had enormous potential (in addition to supporting peer-learning) to positively affect student performance. A similar effort at CUNY, and its dramatic results in significantly elevating grades, GPA and retention in mathematics, is cited.

Keyword(s):
African-American
Gatekeeper courses
Mathematics
Active learning
Collaborative learning
Special programs
Motivation
Academic preparation
Social support
Group work

Veal, W. R. (2002). Content specific vignettes as tools for research and teaching. *Journal of Science Education, 6*(4).

Summary: This is not a research study, but a demonstration of a series of case studies with suggestions for their use for teacher training. The vignettes address high school educators and contain numerous examples of problematic classroom behavior such as miscommunication, overly permissive behavior, cheating, and misperceptions on the part of the students about science topics.

Recommendation(s): Seek out case studies of student-teacher interaction, watch videos, and gain new perspectives about the dynamics of teaching. Discuss these case studies with a colleague and decide what solutions you would recommend. Have you ever seen these types of problems occur in a classroom?

Extended summary: Case studies are useful to teachers in learning what behaviors work and do not work in the classroom. Discussing potential solutions to discipline and organizational problems can give instructors new ideas and help to defuse any problems that they may be experiencing with their own students. There were a number of ideas in the paper on how to use vignettes in teacher education. These included: 1) reading followed by large or small group discussion, 2) reflection and commentary as a homework assignment, 3) developing lessons around the content included in the vignette (to show what the teachers would do differently), 4) evaluating the vignette at the beginning and the end of a semester. Issues that the vignettes brought up included the following: incorrect transmission of scientific information, ignoring students, students dropping out of class, cheating, disrespectful behavior, favoritism, questioning techniques, planning and organization, effective grading, and ways of stimulating student thinking. Gender and multicultural issues were not addressed directly; however, the vignettes are all STEM-related.

Keyword(s):
K-12
Teaching
Class discussion
Assessment
Science

Vogt, C., Hocevar, D., & Hagedorn, L. S. (2007). A social cognitive construct validation: Determining women's and men's success in engineering programs. *The Journal of Higher Education, 78*(3), 338-364.

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Summary: The authors tested the theory that female attrition from engineering is due to classroom climate rather than lack of ability. The study also examined the way women reported being treated in classrooms and laboratories, and how their comfort level with their classmates and professors may affect their academic achievement. The authors found a number of factors, such as professors' unwelcoming attitudes toward female students, male students' higher confidence with computers and hands-on activities, greater peer criticism of female students' comments, and male students' higher self-efficacy, which may add up to give male students an advantage. However, the female students in the study were academically skilled, willing to ask questions, and hard-working.

Recommendation(s): The article recommends raising the awareness of faculty about the subtle ways that women are discouraged in engineering. The authors also recommend making classrooms less impersonal and hierarchical. Taking steps to improve the self-efficacy of female students is also recommended, but the details of how to carry out such an approach are not specified.

Extended summary: Vogt, Hocevar, and Hagedorn sampled engineering students at highly ranked West Coast research universities with similar admission requirements. They also decide to ensure an oversampling of women in engineering by including students from professional societies, such as the Institute of Electrical and Electronics Engineers (IEEE) and the Society of Women Engineers (SWE). They assessed the participants based on five criteria: general academic ability, analytical and problem-solving skills, critical thinking ability, mathematical abilities and computer skills. These evaluations showed that overall, women ranked their skills lower than men did; often, their self-assessments of their skills were inaccurate. This study also dispels the idea that females are less likely to ask questions. The results show that women do, in fact, ask questions more than men do. The authors further concluded that the females in their sample performed very well academically, in comparison to the males. This leads them to believe that a great deal of the attrition of women in engineering is due to self-perceived differences in ability. Women are not comfortable in the classroom climate due to the unwelcoming social environment.

Keyword(s):
Engineering
Women
Learning styles
Classroom climate
Self-perception
University climate
Undergraduate
Retention

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Wachelka, D., & Katz, R. C. (1999). Reducing test anxiety and improving academic self-esteem in high school and college students with learning disabilities. *Journal of Behavior Therapy and Experimental Psychiatry, 30*(3), 191-198.

Summary: The authors developed a cognitive-behavioral treatment for test anxiety and evaluated its success with high school and college students who had learning disabilities. The treatment significantly decreased students' anxiety levels, improved their study habits, and increased their academic self-confidence. Participants especially appreciated the relaxation exercises that were part of the program. The program also included instruction in study skills, test-taking skills, "rational self-talk," and the use of guided imagery. Few researchers have attempted to develop methods to reduce test anxiety in college students.

Recommendation(s): Develop short-term therapy programs to help students with test anxiety acclimate to college. These programs should give students confidence by teaching them study and test-taking skills – as well as how to relax, develop a positive attitude, and overcome anxiety through techniques such as visualization. The author notes that test anxiety is more common among minority students.

Extended summary: This study evaluated an 8-week cognitive-behavioral treatment for students with learning disabilities. (The students all had normal intelligence but had difficulties with reading, writing or arithmetic.) There were 11 students in the experimental group and 16 in the control group. Some students were enrolled in a community college, while others were in high school. The students were Caucasian, with an average age of 29.

The experimenters measured students' anxiety using the Test Anxiety Inventory. They also measured academic self esteem using part of the Coopersmith Self-Esteem Inventory and measured study orientation using a section of the Survey of Study Habits and Attitudes- Form H.

The authors state that "high test anxiety is… associated with low self-esteem, poor reading and math achievement, failing grades, disruptive classroom behavior, negative attitudes towards school, and… an intense fear of failure." Reducing students' anxiety around taking exams may improve their self-esteem and address some of these problems.

The students listened to relaxation tapes within and outside of class, learned to respond to their own irrational beliefs by focusing on the facts, and practiced guided imagery techniques to reduce their fear of exam taking. They also learned exam preparation strategies (regular studying, self-rewards, studying alone, sticking to one topic, and exercising), and strategies for taking different kinds of tests.

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Students’ anxiety scores decreased, their study skills scores improved, and their academic self-esteem scores improved. In general, the participants were quite satisfied with the course. This was confirmed by the 85% retention rate.

The authors recommend further investigation of the individual components of the treatment to find out which are the most effective.

Keyword(s):
Accessibility/disability
Special programs
Reentry students
K-12
Academic achievement
Minorities

Wallace, J. E., & Haines, V. A. (2004). The benefits of mentoring for engineering students. *Journal of Women and Minorities in Science and Engineering, 10*, 377-391.

Summary: This is a study of gender effects in mentoring relationships. The authors explore correlations between having a mentor and students' academic socialization, experiences of personal support and role modeling in the mentoring relationship, career commitment, identification with engineering, academic performance, experiences of discrimination, and satisfaction with their education. The results indicate that female students experienced more social integration when they had a mentor. Male mentors provided more academic socialization for both male and female students, while female mentors provided emotional support and role modeling for female students. This discrepancy may be due to male mentors' greater access to, and experience with, academic social networks.

Recommendation(s): Male students may benefit most from male mentors, while female students may benefit most from working with both male and female faculty. (As female faculty gain seniority in engineering, these differences may shift.)

Extended summary: The authors applied Kram's (1985) framework for classifying and linking the benefits of mentoring relationships, and used this information to develop a survey for engineering students. The survey addressed career development benefits, social integration, student attitudes and confidence, and role modeling.
This study is notable because of its efforts to obtain a representative sample of students at one Canadian university, rather than a convenience sample. The survey response rate was 95%. The percentage of respondents who were female was 23%, which corresponded closely to the population at the school (22%). The survey sample was large enough to contain a significant number of male students with female mentors,

which is unusual.
The researchers hypothesized that students with mentors would report greater career development, self-esteem, and positive attitudes towards the field than their same-gender peers who did not have mentors. They also hypothesized that male mentors would be more effective in assisting students with career development than female mentors, and that students would experience more self-esteem and attitude improvement when mentored by faculty of their same gender.
The results show that mentoring provides female students with academic socialization and a sense that their personalities are a good fit with their career. Male students also reported increased academic socialization, but in fewer areas. Mentoring did not appear to be related to students' academic performance or experiences of discrimination, but was positively correlated with students' overall satisfaction with their education. However, having a mentor also correlated with a lower likelihood of pursuing engineering as a primary career.
Male mentors provided more academic socialization and greater social integration into engineering school than did female mentors. This may be due to the culturally differing positions of male and female engineering faculty. In general, the gender of the mentor did not affect students' self-esteem or satisfaction with their education.

Keyword(s):
Engineering
Women
Sexism
Culture
Social support
Mentoring
Networking
Advising

Wechsler, S. P., Whitney, D. J., & Ambos, E. L. (2005). Enhancing diversity in the geosciences. *Journal of Geography, 104*(4), 141-149.

Summary: At California State University-Long Beach, minority students are underrepresented in the geosciences (geography, geology, and anthropology), even though the university is a minority-serving institution. The Geoscience Diversity Enrichment Program, or GDEP, at this university was developed to increase the numbers of minority students with educational and research experience in these fields, improve awareness of geoscience careers at community colleges and high schools, enhance the quality and quantity of geoscience teaching, and encourage students from underrepresented groups to continue on from high schools and/or community colleges into geoscience programs. Student participants engaged in field activities, laboratory work, and data analysis during a summer research program with CSULB faculty. The

program strongly increased students' ambitions to enter the geosciences and, in some cases, to pursue advanced degrees. The students were impressed by the career options available in these fields and the friendly atmosphere of the program. The numbers of students from underrepresented groups in the geosciences have increased significantly at CSULB since the program began.

Recommendation(s): Connect with other faculty in related fields to develop recruitment and retention programs. Communicate about job opportunities in your field to students, even in introductory courses. Explain the relevance of math and physics courses.

Extended summary: CSULB is designated as a minority-serving institution. NSF-defined underrepresented groups account for 31% of the university's total student population. However, before the GDEP program began, only 15% of geography majors, 17% of geology majors, and 27% of anthropology majors were from a minority group. Students in introductory courses reported not being aware of career opportunities in these fields, and were generally not interested in pursuing these majors.
The GDEP program addressed this problem using a "multifaceted approach" to achieve both short-term and long-term results. CSULB created internal research partnerships between departments and external research partnerships with community colleges and high schools. Nine faculty members participated in designing a summer research program for minority students. Students learned about research and study skills, presentation techniques and web design, safety, geophysical technology, ethics, field and laboratory techniques, mapping, and analysis.
The participating students were quite interested in the opportunities available to them in this field, and many began to aspire to graduate degrees. Since the program began, the numbers of Latino students in geoscience courses have increased dramatically.

Keyword(s):
Science
Latino
Minorities
Recruitment
Motivation
Undergraduate
Special programs

Whitten, B. L., Foster, S. R., & Duncombe, M. L. (2003). What works for women in undergraduate physics? *Physics Today, 56*(9), 46-51.

Summary: The authors used a study examining the environment of the physics department of nine diverse universities to determine the best ways to make women comfortable in physics departments. They have discovered that by diversifying the faculty and staff, creating family-friendly policies, and providing outreach and mentoring, schools can attract and keep more female physics majors.

Recommendation(s): Ways of creating a welcoming working environment for all students:
-Provide a student lounge
-Offer a tutorial service
-Use student lab assistants
-Schedule departmental seminars
-Create a Society of Physics Students chapter or other physics club

Ways to foster a female-friendly department:
-Monitor the student culture
-Foster a cooperative spirit
-Mention female and minority scientists
-Emphasize applications to environmental and social issues
-Encourage student-faculty research
-Ensure that students feel safe working in the department alone or at night

Essential family-friendly policies:
-Encourage both the hiring of faculty partners and networking with other institutions.
-Design family leave policies for different kinds of families at different stages in life.
-Offer partially subsidized childcare on-site.
-Welcome faculty children.

Extended summary: The authors' study of nine different universities and their physics department policies helped to develop a plan for creating a welcoming and warm environment for all students and faculty. There are many small ways to effectively make departments more female-friendly. Diverse faculty, mentoring programs, and family-friendly policies can help to make women comfortable within a department, especially if they have been there for over a year. However, it is also especially important to make women comfortable from the beginning. These outreach concepts need to be extended to freshman students, so that women feel accepted and integrated from the beginning. This will help ensure an increase in the retention of women students.

Keyword(s):
Physics
Women
Retention
University climate
Undergraduate
Faculty
Classroom climate

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Whitten, B. L., Foster, S. R., Duncombe, M. L., Allen, P. E., Heron, P., McCullough, L., Shaw, K. A., et al. (2003). What works? Increasing the participation of women in undergraduate physics. *Journal of Women and Minorities in Science and Engineering, 9*(3&4), 239-258.

Summary: The authors sought to identify factors enabling college physics departments to enroll and retain women at rates higher than the national average. The authors visited nine undergraduate physics departments, five of whom were deemed successful in attracting and graduating women and four that were considered typical of the national norm. No single factor was found to explain the higher than anticipated attraction and graduation rates among successful departments. Rather, success was found in the form of a female-friendly departmental culture resulting from a combination of efforts on the part of faculty, students and the institution itself. Successful departments were also found to reach out to introductory students and integrate them early into their departmental cultures. The authors indicate that additional research results are to be published in a forthcoming article.

Recommendation(s): There are no "magic bullets." Successful schools integrate a larger number of features that make for a female-friendly culture. Features found to be positively correlated include:
Faculty Focus: Create a family friendly departmental culture in which female faculty are supported by the following: a) dual career policies, b) family leave policies, and c) childcare services.
Courses & Departmental Climate: In introductory courses, pursue innovative subjects and interactive teaching. Consider open-ended, project-based labs. Early on, identify potential majors and integrate them into the department culture. Pay particular attention to the 1st year, and specifically invite potential majors to seminars and social activities.
Students: Support students in creating a successful department culture. Spend department money on student support, including:
i) Comfortable student lounges where departmental students are able to study together, tutor other students and interact socially.
ii) Tutorial services, usually involving other students.
iii) Seminars appropriate for undergraduate students.
iv) Membership to National Physics Association chapters, clubs or similar collegial opportunities.
v) Social activities, especially those in which efforts are made to include potential majors from the introductory courses.
Participate in potential student outreach and encourage alumni participation, networking, recruiting, and seminars.

This material is based upon work supported by the National Science Foundation under Grant No. 0227592.

Extended summary: Even after taking into account academic ability as measured by standardized tests, the percentage of American women in physics lags behind the percentage in most other sciences. Prior research found that the most important factor influencing women to abandon STEM majors is a significant disjunction between the style of undergraduate STEM education and the socialization of young women. The authors suggest that STEM fields are often "cold climates." They assert that males are better able to survive such "cold climates," but that all students benefit from a "warm" department culture.

Seeking to answer the question "what works?" the authors conducted a series of site visits to 4 typical and 5 successful undergraduate physics departments. Successful departments were those that enrolled 40% or more women in courses and graduated at least 5 women majors during 1994-98. Traditional departments were those enrolling 15% to 17% women and graduating at least three women during 1994-98. Successful departments offered a supportive, female-friendly departmental culture. The research findings are discussed along three main lines: Faculty, courses and climate, and students.

The authors report that a strong faculty support structure is a positive influence. The presence of women faculty is important but not essential. However, family-friendly departmental policies matter, and such policies influence potential physics majors, as partner and family issues are critical to the career decisions of female faculty members. Female-friendly policies are essential to recruiting and retaining women to physics faculties. These female-friendly policies involve four components: 1) institutional support for dual careers, 2) family leave, 3) childcare, and 4) a supportive atmosphere for family life.

In the area of courses and climate, the authors suggest more innovative subjects and interactive teaching in the introductory course, especially open-ended, project-based labs. Successful departments make efforts early on to effectively identify potential majors and integrate them into the department culture. This effort was one of the most significant differences between typical (low female participation) schools and successful (high participation) schools. Even so, while upper class students generally feel at home approaching faculty, first year students rarely feel that faculty are approachable, regardless of "open-door" policies. Therefore, some form of social setting in which students could get to know their professors is recommended.

A female-friendly departmental climate is positively correlated with female physics persistence. This includes insuring that sexist remarks and unprofessional behavior are not tolerated, that the department fosters a cooperative (rather than exclusively competitive) spirit, that females and minorities are mentioned and included in the classroom environment, that physics is shown as applicable to broad societal problems and issues (which is often more important to women than to men), that student-faculty research is encouraged, and that female students feel safe coming to the department and working there at night.

Effective departments often include faculty who make efforts via recruiting and outreach activities. Such faculty maintain websites encouraging the participation of women,

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participate in open house functions of their admissions departments, and encourage students to attend a typical class. Alumni are also recruited to participate in the recruitment process. In successful departments, faculty create a structure in which students become used to working together. Older students look out for younger students and faculty act as role models, cooperating and supporting each other in both their professional and personal lives. An important component of a thriving physics department is a strong sense of community with many opportunities for informal student-faculty interactions. While typical (low participation) schools do many of the foregoing, successful schools integrate more of the features that make for a female-friendly culture.

Keyword(s):
Physics
Women
University climate
Classroom climate
Mentoring
Recruitment
Undergraduate
Faculty

Williams, K. (2001). Understanding, communication anxiety, and gender in physics: Taking the fear out of physics learning. *Journal of College Science Teaching, 30*(4), 232-237.

Summary: This article documents women's apprehension about communicating in physics classes, and speculates that this apprehension may be correlated with a "rote learning" orientation and poor conceptual comprehension. However, the hypotheses were not entirely supported. Although the women in the author's class were more apprehensive about speaking up than the men were, there is no conclusive evidence that they were inclined towards rote learning or did not understand the material.

Recommendation(s): "Encourage but don't require speaking in front of the class. Provide other alternatives for communication apprehensive students to demonstrate achievement. Don't assign seats for students." Students who are communication apprehensive, the author writes, often dislike sitting next to others who are more talkative. Encourage students to ask and answer each other's questions in small groups.

Extended summary: This article opens with the statement that a quiet student may not be a "smart" student. In fact, quiet students may simply be afraid to ask questions. As a result, their performance may suffer. Reluctance to speak out in class may be related to

a "rote learning" orientation- a preference to memorize, rather than to understand. The author researched this hypothesis in two stages. The first study was exploratory, and found that students who had a rote learning approach had difficulty with conceptual questions. Students who were apprehensive about speaking up tended to score less well on multiple choice questions. So, although rote learning and communication apprehension both can diminish student success, they seem to act independently of each other.
The follow-up study looked at gender, communication apprehension, and comprehension of the physical principles of forces (Force Concept Inventory). The author found that women were more communication-apprehensive than men were. However, women learned equally as much as men did about force principles during the course. This discrepancy casts the initial hypothesis in doubt.

Keyword(s):
Identity and personality
Women
Physics
Communication
Stereotypes
Academic achievement

Wright, J. C. (1996). Authentic learning environment in analytical chemistry using cooperative methods and open-ended laboratories in large lecture courses. *Journal of Chemical Education, 73*(9), 827-832.

Summary: This paper is a report on the success of implemented changes to an introductory college chemistry course. The author argues that a need exists to move from passive learning styles to an active style in which students assume responsibility for their learning, linking such participation to authentic student achievement. He describes a one-semester introductory analytical chemistry course which uses openended laboratories, cooperative learning, and spreadsheet programs in a team-based laboratory structure. As implemented, such changes markedly improved student attitudes towards learning chemistry and towards each other, in addition to increasing the depth of coverage of the material and the students' comprehension levels. These benefits can be achieved in large-enrollment universities as well as small colleges.

Recommendation(s): A number of elements are cited that are considered fundamental to the success of the restructured course. These include:
- utilizing an absolute grading scale
- appointing a student board of directors to oversee all aspects of the course
- having students read and analyze research papers
- utilizing interactive techniques in the lecture

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- utilizing spreadsheet programs for homework and laboratory problems
- cooperative examinations to complement traditional examinations, and
- implementing open-ended laboratory projects to replace many standard laboratory experiments

Extended summary: The entire laboratory course structure, as well as the student projects making up the lab course, is detailed in this paper. The course elements are described and the lecture, examination and lab projects are detailed. The effort of the course structure is to approximate the research experience of working chemists, and to provide students with a sense of accomplishment. Evaluation was accomplished via student responses to questionnaires, free-written responses and informal discussions with students. The author concludes that one of the most effective ways to accomplish effective learning is to involve students in original research. The open-ended lab is an effort to approximate the actual research experience.

Keyword(s):
Chemistry
Gatekeeper courses
Active learning
Laboratory
Collaborative learning
Technology
Teaching
Group work

Wyer, M. (2003). Intending to stay: Images of scientists, attitudes toward women, and gender as influences on persistence among science and engineering majors. *Journal of Women and Minorities in Science and Engineering., 9*(1).

Summary: The author challenges the prevailing assumption that women and men have different motivations to stay in science and engineering. She hypothesized that having positive images of scientists and engineers, positive attitudes towards gender equality, and positive classroom experiences would encourage both men and women to persist in the field. She found that having positive images of scientists and engineers was the only one of the three factors that strongly motivated students to stay in the field. Female students were more likely to expect to leave the field, more likely to believe in gender equality, and more likely to be aware of unfairness in the classroom. Their positive experiences in the classroom were strongly related to their desire to continue for advanced degrees.

Recommendation(s): Since positive images of scientists and engineers are so influential in encouraging students of both genders to stay in the field, try to popularize

your work. Write articles or do demonstrations demystifying science concepts and showing that science is an interesting and engaging activity. Connect with students of various backgrounds who are interested in science and technology, and encourage them to pursue their curiosity about the field.
Talk with your female students about opportunities in science and find out what they are interested in. If they express that they would like to continue their education, encourage them to do so. Encourage your male students to educate themselves about gender equality issues. Make sure that your own classroom interactions are unbiased.

Extended summary: The author questions the concept of a "pipeline" which students "leak" out of. Rather than this being a "female/minority student problem," the author says, female and minority students have unique perspectives to contribute which are different from the prevailing norm and can bring greater "flexibility" and cultural awareness to the work environment. This is why we should be concerned that they are underrepresented, not because we are pursuing quotas.
The paper addresses the "shortage of research that focuses specifically on linking why students stay in their majors with students' perceptions of gender and race inequality in society and in their undergraduate classroom experiences." The author posed three hypotheses:
1. Men will be more likely to persist than women in the short, medium, and long term.
2. Positive images of scientists and engineers, support of women's equality, and positive classroom experiences will be positively related to persistence.
3. The combined effect of these variables with gender will be "over and above the effect of any of the variables individually." 285 biology and engineering students took the survey. The Biology sample was 71% female; the engineering sample was 71.4% male. 211 of the students were Caucasian.
The author used the Image of Science and Scientists Scale, the Attitudes Toward Women Scale, the Women in Science Scale and the Perceptions of Prejudice Scale to evaluate student attitudes and experiences.
Hypothesis 1. Gender affected persistence, but not degree aspirations.
Hypothesis 2. The only one of the three variables that affected persistence was a positive image of scientists and engineers. This variable, along with belief in gender equality, strongly increased students' odds of aspiring to postgraduate degrees.
Hypothesis 3. Female students were more likely to be interested in graduate study if they had positive classroom experiences. The article leaves us with the sense that, although women and men in science have some differences in their persistence level, there are also common factors, such as a positive image of scientists and engineers, which encourage both men and women to remain in the field. Classroom fairness appears to be related to female students' aspirations to continue on to graduate school. "There may well be greater gender differences behind why students leave science and engineering than behind why students stay," the author observes. Perhaps recruitment efforts would be more effective if they focused more on motivating factors for retention rather than gender influences on departure.
The author notes several areas of doubt. First of all, it is impossible to draw causal

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connections from the social factors in this study directly because of the nature of the inquiry. Secondly, since these students selected science and engineering majors, it is not surprising that their opinion of engineers and scientists was positive and their classroom experiences were positive as well. (They may well have been mentored by science teachers and been comfortable participating in class.)

Keyword(s):
Women
Retention
Biology
Engineering
Classroom climate
Motivation
Social support

Wyer, M., Murphy-Medley, D., Damschen, E. I., Rosenfeld, K. M., & Wentworth, T. R. (2007). No quick fixes: Adding content about women to ecology course materials. *Psychology of Women Quarterly, 31*, 96-102.

Summary: This article describes an intervention in which instructors integrated relevant material about women scientists into an introductory ecology course. The survey results indicated that, although students' attitudes about women in science remained unchanged when the new material was added, students perceived the classroom climate as becoming more welcoming. Students' knowledge of women in science also improved.

Recommendation(s): Although adding course content about female scientists can improve student awareness and classroom climate, additional intervention may be needed to counter the effects of preexisting beliefs about women in science.

Extended summary: The authors point out that omission of content about female scientists from course materials can create a hostile climate, which may discourage female students from pursuing science careers. In ecology texts, for example, women's accomplishments are rarely featured, although many women are entering in the field in recent years. Building connections between women's studies and the sciences has proved to be challenging.

The authors introduced relevant material on women in science into an introductory ecology course over a period of three semesters. They used two levels of exposure (in different semesters): 5 to 10 minutes per week and 10 to 20 minutes per week. Students were quizzed on the material. The content was also reinforced during review sessions.

The researchers conducted a pre-test and post-test of the beliefs and classroom experiences of 398 undergraduates in the course. 62.6% of the students were female and 84.4% were Caucasian. The survey measured students' attitudes toward women in science and society, as well as their perceptions of classroom climate. The researchers also analyzed student grades and course evaluations.

Although student knowledge of women in science improved with the addition of the new course material, and both female and male students noticed an improvement in classroom climate, students' attitudes toward women in science did not change significantly.

Keyword(s):
Women
Biology
Classroom climate
Course content and curriculum
Feminism
Sexism
Stereotypes
Science
Expectations

Yanowitz, K. L. (2004). Do scientists help people? Beliefs about scientists and the influence of prosocial context on girls' attitudes towards physics. *Journal of Women and Minorities in Science and Engineering, 10*, 393-399.

Summary: The author conducted an experiment to measure whether fifth- and sixth-grade girls prefer societal or discovery descriptions of physics. She found that the girls were much more interested in science that would benefit society. The girls initially perceived science as discovery-oriented. The brief exercise did not change their career aspirations.

Recommendation(s): Discuss the social context and benefits of science with your female students.

Extended summary: This study raises the possibility that one reason women are more likely to enter the life sciences than the physical sciences is that they perceive the life sciences as more "prosocial," or socially helpful. Girls who read a story about a female physicist helping society reacted much more positively than girls who read a story about the same person engaging in a process of scientific discovery.
Eighty-eight girls participated in the study. Fifty-six of them were in a science careers

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program at a university. The girls came from low- to middle-income rural schools. The girls were given surveys about their perspective of what scientists do and their liking for science. Then, they read a simple scenario describing a female physicist talking about her interest in her work. Afterwards, they rated their liking of the story and their interest in physics as a career.
The girls who had chosen to attend the science camp were more interested in science than the other girls were. Initially, 99% of the students described scientists as engaging in discovery, while only 19% of them mentioned that science could benefit society.
The author cites other studies that have shown that even very young children are aware of stereotypes of scientists, and that girls identify less with scientists than boys do.

Keyword(s):
Physics
Women
Stereotypes
Teaching
Motivation
Course content and curriculum

Zeldin, A., & Pajares, F. (2000). Against the odds: Self-efficacy beliefs of women in mathematical, scientific, and technological careers. *American Educational Research Journal, 37*(1), 215-246.

Summary: This article is an interview-based study designed to reveal the "keys to success" of a non-random sample of successful female STEM professionals. The study was based on extensive interviews designed to reveal the effects of mastery experiences (experiences of success), vicarious experiences (learning from watching others succeed), verbal persuasions (feedback from other people), and physical and emotional states (feelings involved with pursuing a task) on women's success in these "non-traditional" fields. The results revealed that successful women had strong support systems and role models from a young age that enabled them to weather social pressures and develop strong determination. Social support and mentoring were much more influential in encouraging women to pursue STEM careers than their own experiences of success were. This contradicts existing mixed-gender studies.

Recommendation(s): Giving honest feedback that includes praise, sharing enthusiasm about science, and being fair in the classroom make a positive impression on female students. You will be modeling professional behavior for them and influencing them to persist in the field.
Encourage students to form social groups to learn from and support each other.
From a young age, girls' curiosity about science and math should be acknowledged and their competence supported by taking their questions and interest seriously and

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encouraging them to join science and math clubs.

Extended summary: The study compared the relative effects of four factors that influence self-confidence; mastery experiences (experiences of success), vicarious experiences (learning from watching others succeed), verbal persuasions (feedback from other people), and physical and emotional states (feelings involved with pursuing a task). 15 women (a non-random sample) participated in the study.
Past research shows that male students tend to focus more on academic successes, while women focus more on feelings, teaching quality, vicarious learning, and verbal feedback as evidence of their ability in math. Higher self-confidence is, in many cases, a greater predictor of success than academic talent is. Women are less likely to aspire to high positions in their field; however, they are strongly influenced by encouragement to attend graduate school.
The women who participated in the interviews were influenced the most by verbal persuasions and vicarious experiences. They remembered supportive feedback from family members and teachers at a young age. Many of the teachers, although they were "tough", were also fair, and the girls recognized genuine praise when they received it. The women recalled having both male and female teachers as role models. What distinguished a good teacher, they said, was enthusiasm for the subject and an ability to explain science or math in everyday terms. Supportive peers and supervisors also played a key role in encouraging women to achieve.
When the women faced societal difficulties later, they persevered because they already had a solid foundation of self-confidence. The difficulties that they faced included the social stigma placed on "smart females" during and after college, disparaging or unfriendly attitudes from fellow students, sexism at trade shows, and the fact that the field has an "unfashionable" reputation. However, none of these challenges discouraged the women or caused them to doubt their own competence.

Keyword(s):
Sexism
Engineering
Women
Mathematics
Computer science
Career
Mentoring
Social support
Retention
K-12