The State of Gender Equity in Science Classrooms

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Abstract

Much has been done to improve gender equity in the science classroom, but research shows there is still a need for improvement. Teachers have attempted to improve female performance by employing such techniques as giving both genders equal feedback or assigning roles in group work. There has been an improvement in female performance and an increase in females in the science fields, but it is still open to debate as to whether teachers' strategies in the classroom have contributed to this improvement. Most research points toward the positive effect of teacher influence and suggests we should continue our effort to improve equity.

Introduction

Achieving gender equity in the science classroom has the potential to improve female performance in the classroom and, ultimately, increase the number of female scholars who pursue science careers. The performance gap between males and females in the science classroom has gotten smaller over the past few decades (Gender Equity in Science Education, 2005), but the gap is still prevalent. In this literature review, we will review current research aimed at improving female performance in the science classroom. We begin by describing past and present classroom practices regarding gender equity. We then explore some benefits of achieving gender equity in the classroom. Finally, we will address the debate on whether teacher influence in the classroom can actually affect female performance.

Classroom Practices

Most instructors do not think much about why the percentage of male students in the classroom is much higher than the percentage of female students. It has come to be expected. It is common to believe that females leave the sciences or do not get into the sciences based on lack of ability. Research has shown this is not always the case (Seymour 1992, 284). The culture of how sciences are taught contributes greatly to this trend (Achieving Gender Equity in Science Classrooms, 2005).

A key cultural shift has to do with classroom participation. Nearly all research discusses how males and females communicate differently. Males tend to be more aggressive and quick to respond while females tend to be more reflective and deliberate (Achieving Gender Equity in Science Classrooms, 2005. Gender Equity in Science Education, 2005. Gondek, 2000). Males tend to shout out the answer before females have a chance to respond causing females to feel shut out. A technique to help overcome this is to prohibit students from calling out answers. By calling on students, the instructor can be sure that a proportionate number of females are called upon (Gender Equity in Science Education, 2005). The instructor should also mentally divide the classroom into quadrants. By shifting focus to quiet quadrants, the instructor notices when

students are not participating (ECPI, 2005). Finally, when a question is asked, the instructor should wait at least three seconds (Campbell, 2007. ECPI, 2005). This delay will allow female students time to reflect on the question and formulate an answer.

Increasing collaboration is also a topic most research points toward. Some introductory science courses get labeled as "weed out" courses. In these courses, the high level of competition causes many students to leave science majors. Allowing students to form small groups to solve the problems takes much of the anxiety from the course and allows many students to learn more effectively (Achieving Gender Equity in Science Classrooms, 2005. Gender Equity in Science Education, 2005. Campbell, 2007). In computer science courses this is called pair programming. In pair programming, a pair of students works together on solving a computing problem. Research has even shown pair programming to produce better overall student solutions (Barker and Cohoon, 2007).

There are a number of other suggestions researchers have made to improve the classroom environment. We highlight a few of them here in no particular order.

- Focus more on thought-provoking problems than on single answer questions (Gender Equity in Science Education, 2005).
- Challenge students to bring real-life examples of scientific applications. When students are able to get personally involved, they tend to derive more satisfaction (Achieving Gender Equity in Science Classrooms, 2005. Gender Equity in Science Education, 2005).
- Assign females to leadership roles in lab activities (Achieving Gender Equity in Science Classrooms, 2005. Gender Equity in Science Education, 2005).
- Invite public speakers from diverse backgrounds (Achieving Gender Equity in Science Classrooms, 2005).
- When teaching assistants (TAs) are available, consider using female TAs (Achieving Gender Equity in Science Classrooms, 2005. Gender Equity in Science Education, 2005).
- Praise correct answers. Make sure to praise both males and females equally (Achieving Gender Equity in Science Classrooms, 2005. Campbell, 2007. Gender Equity in Science Education, 2005).

Benefits

The benefits of achieving gender equity go beyond the classroom. The most prominent advantage is the new ideas and perspectives brought by females. One student that was interviewed said, "If half of society is discouraged from being a part of it [computer science field], then we're missing out on a lot of great ideas." (Blum and Frieze, 2005). In addition to the fresh ideas that women can bring to the field, there are many talented, intelligent women that can contribute to the workforce (Cuny and Aspray, 2000).

The benefits are not just limited to the workforce. Encouraging females to study science opens up opportunities for the individual as well (Cuny and Aspray, 2000). There are many women who would thrive in the sciences, and may find themselves more professionally satisfied in those occupations. Additionally, by gaining access to science, women are given the "power to see" the world from a different perspective (Sinnes, 2006).

Instructor Influence

Most articles discuss the positive effect having a close relationship with students has on performance. It is suggested to encourage students to attend office-hours (Gondek, 2000) and even to require students to schedule a visit (Achieving Gender Equity in Science Classrooms, 2005). It is also recommended for instructors to exude a warm demeanor in class so that students feel valued (Gondek, 2000). The Center for Teaching and Learning at the University of North Carolina at Chapel Hill claims that some female students abandon their science majors due to a lack of instructor encouragement (Gender and your classroom, 2001). It is worth noting that there is no supporting evidence presented to back up any of these claims.

One article by Varma et al. does not agree that teacher immediacy has a significant impact on performance. The authors arrived at their conclusions through analysis of data gathered from extensive interviews with students from four different universities in either their second or third year. They found no significant relationship with regard to teacher immediacy (Varma and LaFever, 2007).

There is also controversy as to the benefit of instructors modifying their curriculum to match differing learning styles. From 1995-1999 a study was conducted, known as the Margolis-Fisher study, that concluding men are more programming oriented and women are more application oriented (Margolis, and Fisher, 2002). Subsequent research proposed modifying curriculum to account for the female application-driven learning style (Achieving Gender Equity in Science Classrooms, 2005. Gender Equity in Science Education, 2005. EPCI, 2005). Other research believes changing curriculum as a means to achieve gender equity reinforces stereotypes. This perceived disparity is a product of how we educate females not an intrinsic difference (Blum and Frieze, 2005).

Conclusion

Gender equity in the science classroom is important, and although progress has been made, there is still room for improvement. We discussed some popular classroom practices to help draw and retain females in the sciences. Two practices most researchers agree on are incorporating more group work and adding time for reflection between questions and answers. We then looked at the benefit of gender equity on women and on society. The new perspective females can bring to science is a major advantage. Finally, we showed differing points of view on how much impact instructor interaction has on gender equity. Many researchers believe that teachers have a great deal of influence while a smaller number have not seen any significant benefit.

Annotated Bibliography

Barker, Lecia J. and Cohoon, J. McGrath. "Pair Programming. Retaining women through collaborative learning." National Center for Women and Information Technology. http://ncwit.org/pdf/PairProgramming_RetainingWomenCollaborativeLearning_Practice.pdf, 2007.
This article discusses how pair programming helps retain women in the computing sciences. Pair programming is the concept of having students work on programming assignments as a pair.

Research has shown that students who participate in pair programming during introductory computer classes gain more confidence that they would if they worked alone. Women who participate in pair programming are more likely to stay in computer science and are more capable than their non-paired peers. Additionally, pair programming led to a higher percentage of women who declared computer science as a major.

Blum, Lenore, and Frieze, Carol. 2005. The Evolving Culture of Computing: Similarity Is the Difference. *Journal of Women's Studies* 26: 110-126.
This paper revisits the work done by the Margolis-Fisher study three years later. The three years targets the next group of females students in Carnegie Mellon's School of Computer Science. The authors applaud the work done in the Margolis-Fisher study, but disagree with some of the findings. They believe that modifying curriculum to accommodate female students reinforces stereotypes. They suggest that in a gender balanced teaching environment, gender differences dissolve.

Campbell, Patricia. "What Can I Do? Making Engineering Classrooms More Effective for Women (and Men) Students." Engineering Equality Extension Service. 2007.
This article covers a list of eight different classroom techniques to make learning more effective. First, relate teaching to real-world applications. Second, allow students time to reflect on questions before asking for responses. Third, use praise wisely. Fourth, encourage collaboration. Fifth, create a warm teaching environment. Sixth, seek outside research opportunities. Seventh, work out opportunities for students to transfer into engineering fields. Eighth, improve teaching skills.

Equitable Classroom Practices Institute (ECPI). "Best Practices for Achieving Gender Equity in the Classroom." http://www-bioc.rice.edu/precollege/ei/best_practices.html, April 6, 2005.
This is a summary of ideas developed throughout the course of the Equitable Classroom Practices Institute. The material is split between classroom practices and equity resources. Classroom practices is further broken down into student/teacher interaction, lesson planning, classroom management, and curriculum content.

"Gender Equity in Science Education." West Virginia University.
http://www.as.wvu.edu/~equity/gender.html, April 25, 2005.
This article is used by West Virginia University to address the gender gap in math and science. It gives some background to the problem and then provides checklists of strategies for improving different areas. These areas are avoiding bias, classroom strategies, discussion and interaction, extracurricular activities, experiential strategies, institutional, use of equity materials, parents, personal, and stereotypes. The article is well-organized and easy to pick out topic-specific ideas.

Gondek, Rebecca. 2000. "Promoting Gender Equity in the Science Classroom. A Practical Guide to Accessing and Implementing Gender-Fair Strategies,"
http://www2.edc.org/WomensEquity/pdffiles/sciguide.pdf.
This paper is aimed at educating middle school teachers to gender equity in science and math. What makes this paper good is the way it is written in outline form with topics divided into sections. The author points out that this approach was used to allow instructors to choose sections to work on. Different sections can be applies as the instructor's classroom evolves.

Margolis, Jane, and Fisher, Alan. 2002. *Unlocking the Clubhouse: Women in Computing*. Cambridge, MA: MIT Press.
This book examines the lack of female enrollment in the School of Computer Science at Carnegie Mellon University (CMU). One of the key components of this book is the famous Margolis-Fisher study conducted from 1995-1999. This study tracked the progress of female students through the computer science program at CMU. The goal of their study was to increase female enrollment in computer science. One of their discoveries was that females did not get exposed to computers in high school. In an attempt to solve this problem, they conducted training sessions with high school teachers from around North America. The result was an increase of enrollment from 7% to 42%.

New England Consortium for Undergraduate Science Education. 2005. *Achieving Gender Equity in Science Classrooms*. Brown University, http://www.brown.edu/Student_Services/WiSE/gender.html.
This article is used by faculty at Brown University to offer techniques for improving gender equity in the classroom. The idea for this article stemmed from a group of undergraduate student concerned with the underrepresentation of females in science. The article presents a series of problems that affect gender equity in science classrooms. For each problem, multiple suggestions to overcome it are offered.

Sinnes, Astrid. 2006. Three Approaches to Gender Equity in Science Education. *Nordina* 3: 72-83.
This article takes a look at increasing gender equity from three different approaches. The first approach is based on the belief that there is no difference between how males and females approach science. The second approach considers males and females to approach science differently. The third approach argues that males and females cannot all be grouped into a specific category.

Gender and your classroom. 2001. In *Teaching for inclusion*. Center for Teaching and Learning at the University of North Carolina at Chapel Hill, http://ctl.unc.edu/tfi3.html.
This chapter's goal is to describe the characteristics female students typically exhibit. The chapter begins with a discussion of differing communication to include classroom participation and group dynamics. It then explains learning styles and provides ideas for modifying curriculum. It ends with an explanation of how factors outside of the classroom can affect female performance.

Varma, R., and LaFever, M. 2007. Importance of gender homophily in the computer science classroom, *IEEE Technology and Society Magazine* 26, no. 2: 43-47.
This paper uses data collected from students within computer science (CS) programs at four different universities to draw conclusions about satisfaction with the CS program. Specifically, the authors consider the impact of teacher immediacy, peer immediacy, and gender homophily on satisfaction. The authors are able to conclude that there is a tie between gender, climate, and satisfaction. They also conclude that peers have an impact on satisfaction. They were not able to establish a tie between teacher immediacy and satisfaction.

Additional Resources

Cuny, Janice, and Aspray, William. 2000. Recruitment and Retention of Women Graduate Students in Computer Science and Engineering. *ACM SIGCSE Bulletin* 34, no. 2: 168-174.

Seymour, Elaine. 1992. Undergraduate Problems with Teaching and Advising in SME Majors: Explaining Gender Differences in Attrition Rates. *Journal of College Science Teaching.* February: 284-292.