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Engaging female science students through philanthropy and social justice

Kristina S. Mead

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Author: Dr. Kristina S. Mead

Institution: Denison University

Email: meadk@denison.edu

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Abstract (English):

While female science students are very strong and often class leaders, female students who are not science majors can feel intimidated by the general education science classes that they have to take to graduate. The traditional model of simplified introductory science courses doeas not always allow our students to reach their full potential. However, a new model of introductory science courses is emerging. This model shows how we can attract, motivate, support, and educate our female students by offering science classes that have a social hook or a philanthropic element. I will present information about a new non-majors course called "Sex, Gender and the Brain". This course differed from a traditional non-majors course in that it was not a survey course, it challenged students to dig deeply into a smaller but edgier range of material, asked students to question their assumptions about sex and gender, and it had a service learning component in which the students shared some of their new-found information about the brain with elementary students in a nearby struggling community. This paper will discuss the course, and theorize why this approach and other similar strategies are more successful than traditional approaches to non-majors science education. In addition, I will link student motivation in this course to a general trend of greater valuation of community outreach in a liberal arts environment.

Abstract (Spanish):

Mientras mujeres son estudiantes fuertes in ciencias y con frecuencia líderes en la clase, estudiantes femininas que no se especializan en las ciencias se muestran tímidas en estas clases y las toman usualmente porque las necesitan para graduarse. El modelo tradicional de cursos de ciencias introductorios no siempre permiten que nuestras estudiantes alcancen todo su potencial. Sin embargo, ha surgido un nuevo modelo de curso básicos de ciencias. Este modelo muestra que podemos atraer, motivar, apoyar y educar a nuestras estudiantes mujeres ofreciendo clases de ciencias que tienen un element filantrópico o de interés social. Aquí presentaré información sobre un curso para no especialistas titulado “sexo, gènero sexual y el cerebro”. Este curso es diferente de los tradicionales, porque no es un curso panoramico, y planteó el reto a los estudiantes de profundizar en temas más problemáticos como sus ideas previas sobre sexo y género sexual. También tenía un component de servicio a la comunidad porque las estudiantes tenían que compartir la información recientemente aprendida sobre el cerebro con estudiantes de escuelas elementales públicas en un pueblo vecino. Este ensayo va a describer el curso, y va a teorizar sobre las razones porqué este estilo de enseñanza tiene más éxito que otros acercamientos tradicionales. Además, estableceré conexiones entre la motivación de las estudiantes en este curso con la corriente general de valorar más positivamente el trabajo en la comunidad, en el context de la educación en artes liberals.

Keywords: science education, gender, neuroscience, engagement, philanthropy

Introduction:

Although progress has occurred, women are still under-represented in most science, technology, engineering, and math (STEM) fields (Hill et al., 2010). The reasons for this disparity are still being heavily debated. Some researchers discuss the possibility that this gender-based discrepancy is due to differences in specific cognitive abilities such as mental

rotation, number representation, or orientation to objects rather than people (Kimura, 2007; Spelke & Grace 2007; Valian, 1998; Valian, 2007). Others suggest that the willingness to work long hours, the degree of interest in professional careers, or the collision of career, spouse and family are what is at stake (Spelke & Grace 2007; Valian, 1998; Valian, 2007, Williams & Ceci, 2007). Still other researchers affirm that the ability to handle setbacks (Dweck, 2007; Hill et al., 2010), stereotype threat (Hill et al., 2010), experience, gender schemas, and other aspects of socialization, (Hill et al. 2010; Spelke & Grace 2007;Valian 1998, Valian 2007, Williams & Ceci 2007).

It is critical for the future success of our society that we find a way to reach and tap into everyone's talent, and that males and females both be supported in their science education so that they can make appropriate decisions about their own lives and as voters. Some of the suggestions put forth by the American Association of University Women to increase representation of women in the sciences (Hill et al. 2010) include exposing women and girls to positive role models in science, making them aware of stereotype threat, and adopting a growth mindset that includes the ideas that skills can be developed. This latter idea is reinforced by interventions that changed junior high school students' ideas about the nature of ability. Students who were told that their brains made new connections every time they learned earned better grades (Dweck, 2007). According to Hill et al. (2010), women tend to be harder on themselves during self-assessment, and tend to be more interested in applied fields and in scientific approaches that are more readily relevant to their lives (Yang, 2010). These points suggest that science experiences that allow women to develop skills in an applied setting could be positive ones that encourage more women to participate in science, whether as science professionals or as generally educated, contributing members of society.

As part of my response to the ongoing discussion about women in science, I developed a new, non-majors undergraduate science course called "Sex, Gender, and the Brain". I have

offered this course (hereafter SGB) at Denison University[1] twice since 2008. It is cross-listed between Biology and Women's Studies, and students can take this class either to satisfy a science or an interdisciplinary general education requirement. The course typically attracts students from a variety of majors. My goals in the class are to: 1) work in the intersection of Women's Studies and Biology; 2) to develop student literacy in the area of feminist science studies and neuroscience, and 3) to have students read about and perform hypothesis-driven science on some aspect of gender and the brain.

In its current iteration, the course begins by broadening the students' understanding of sex and gender through the discussion of complex non-human mating systems that include third and fourth genders, the role of hermaphrodites, parthenogenesis, and asexual reproduction. Then, after an introduction to neurons and the brain, the course addresses topics such as the spectrum of physiological variation along the male-female continuum, focusing on the anatomy and physiology of the male and female brain. We also work through the neural origin of sex differences in the brain, and how social status affects sex hormones which then affect the brain. Throughout the course, the students grapple with the primary literature and become thoroughly conversant with experimental design, basic statistics, and hypothesis testing (Mead, 2009). Despite being beginners at science, they bring their critical analysis skills developed in other courses to bear on this new and challenging material.

The SGB course has an associated weekly three hour laboratory period. Typically, this lab consists of 14 "wet lab" observations and experiments based on the brain, physiology, and gender (see Mead 2009 for some examples). In the Spring 2010 version of the course, the last 6 weeks of lab was replaced with a service learning component. This service learning component consisted of a cluster of learning activities (crafts and games) relating to the brain and to sensory physiology. We spent two weeks preparing and practicing the activities, and

[1] Denison University is a small, liberal arts college in central Ohio. We have 2200 undergraduate students. While we have students from all over the United States and from many parts of the world, we have a large population of students from the Midwest region.

then divided into groups of four and visited six second grade classrooms in Newark each week for a total of twenty-four classroom interactions..

My goals for this service learning outreach were to give my students an opportunity to develop their knowledge about the brain and to theorize and to test hypotheses about gender-based responses to different types of learning activities. For instance, we read studies suggesting that boys and girls prefer different types of toys, with boys gravitating to balls, blocks, bikes, trucks, cars, weapons, and male figurines, and girls gravitating towards board games, puzzles, crayons, and dolls (Berenbaum and Hines 1992, Hines 2004, Berenbaum et al. 2008). Boys spend more time on rough and tumble games (Fabes et al. 2003, Hines 2004). However, about one third of girls and one quarter of boys engage in play behaviors more typical of the other sex, at least occasionally (Sandberg et al. 1993). The amount of cross-play can be influenced by the gender-roles demonstrated by the parents, the presence, number and age of opposite sex siblings, culture, exposure to gonadal hormones, and other factors (Hines 2004, McHale et al. 2004, McHale et al. 2005). Given these studies, we hypothesized that girls would be more engaged than boys with the brain puzzle, that the sensory activities (Mystery socks, Jelly beans, Mystery noises) would be gender neutral, and that the running around and competitive activities (Message transmission, neuron chain tag) would be more engaging for boys than for girls.

My teaching colleagues in the Newark elementary schools and our administrative colleagues at our respective institutions were excited about the science that we could offer, and also very enthusiastic about the important motivational role that my students could play in helping their students envision themselves as college-bound. This aspect of our classroom visits was particularly important because typically graduation from Newark secondary schools hovers around 70%[2], and even fewer students attend college despite the presence of three

[2] Josh Jarman, The Columbus Dispatch January 21, 2010

institutes of higher learning in the vicinity. This low educational performance has been exacerbated in the past decade by deep cuts in school funding and by a significant increase in low-income students with little or no experience of higher education within the family. To address these concerns, a new program called PEAK (Providing Early Awareness and Knowledge), was begun by "A Call to College[3]". This non-profit college access organization creates bridges between elementary and middle schools and institutes of higher learning. The initial relationship with the Newark, Ohio City Schools, and the eventual logistics, were coordinated by Denison's Alford Center for Service Learning[4] and "A Call to College".

To simultaneously meet the goals of our class and the variable abilities and time availabilities of the second grade classrooms, we designed 6 brain-related activities that could be used independently and in any order (described in Mead 2010). We collected data for our hypothesis testing by monitoring student engagement multiple times over each of the activities and by comparing the engagement of boys and girls. Students were considered engaged when they watched the Denison students leading the activity, followed directions, interacted with peers when instructed (as in the tag and message games), and worked independently as assigned (as in the brain puzzle), etc. Students were considered unengaged when they were not looking at the students leading the activities, were talking out of turn, had their head down on their desk, or were otherwise not following directions. Briefly, we found that girls were indeed more engaged in the brain puzzle, but were also more engaged in some of the sensory physiology activities (which we had expected would be gender neutral), and

[3] "A Call to College", founded in 1991, provides financial aid advising and college scholarship assistance to qualified Newark, Ohio students The program seeks to increase college awareness and readiness by intervening in classrooms as early as the second grade. Among other activities, PEAK provides local college students mentoring opportunities with elementary and middle schools students in the district.

[4] The Alford Center for Service Learning has full-time and part-time staff that develop long-term relationships with community organizations and identify community needs that our students can help to fill while meeting their academic learning goals.

the competitive and running around games were gender neutral, rather than biased towards the boys. More details on our methodology and our results are given in Mead (2010).

Results:

Eighteen out of 23 students (78%) thought that the experience of teaching about college and about the brain enhanced their understanding of the content material. Students reported that "because I had to explain it to the kids, I really had to know what I was talking about", and "[it] helped solidify the information in my mind"; "when the students asked questions or gave us examples … it helped not only the students grasp concepts better, but it also helped me". Students added that "being able to simplify the material … is another effective way [of] learning", and that this experience "allowed [them] to understand the development of the brain and the fact that students have different learning styles". Furthermore, they successfully made the connection between theory and practice: the "articles and chapters we read in class explained the behaviors of boys vs. girls". Typical responses from the 22% who did not feel that service learning helped them directly with course content included that the experience "didn't enhance class subject matter but [they] did learn more about kids and learning styles", or "I wouldn't say that it dramatically increased my knowledge of bio [but] I learned a lot about how to handle a variety of situations."

This overall sense that the service outreach experience facilitated learning the concepts discussed in class was reinforced by the substantially higher GPA of students in this class versus nonmajor students in traditional biology classes. When I have taught nonmajor students in either survey-based introductory biology courses (n=3 sections) or case-study-based biology courses (n=4 sections), mean final grades and standard deviations per course section have ranged from 75% ± 8% to 83% ± 6% (C to B-). Both times that I have taught this new introductory course, Sex Gender and the Brain", the mean final grades and standard

deviations have been 87% ± 5% (mostly Bs and B+s). T-tests (JMP 8.0, SAS Institute) indicate that this difference is significant ($p<0.05$). Granted, part of the increase in performance may come from the subject matter, in that more college students are interested in the brain and in sex than in more general biological topics, but I think that part of the increase in performance came from the added motivation provided by the community outreach portion of the class.

The service learning experience in the Newark schools motivated the college students by giving them a reason to learn the biology of the brain (see also Gerstein, Wilkeson, & Anderson, 2004). Not only did my SGB students see real life examples of the theory that they had been reading: "some of the material we talked about in class we could actually see examples of in the classroom", but they also could see how their presence made a difference to the second graders: "our outreach may have left a lasting impression on some students; engaging some students who might otherwise get little attention felt really great". Twenty-one out of 23 students (91%) felt that the experience gave them a window into solving community problems, saying that "by understanding gender differences socially, biologically, and culturally, we can have a better chance of constructing more solutions for the community", and that this outreach "exemplifies and supports Denison's mission," and that they felt proud to have "taken action". They felt that "lead[ing] activities, shar[ing] experiences and interact[ing] with the kids really encouraged the interest in college in these kids' minds", and that "seeing people who are actually in college is important". The two Denison students who did not respond affirmatively felt that the college awareness part was certainly important, but didn't think that greater brain awareness could solve this community's problems: "talking about the brain may not solve community problems, but working with 2nd graders sure d[oes]".

In addition to helping Newark students, many Denison students felt personally transformed by the experience. Twenty out of 23 students (87%) felt that they had developed a greater sense of themselves as agents of change as a result of the experience. They felt empowered by the "simple things we can do to give back." The three who did not respond affirmatively felt that earlier volunteering experiences had changed them already. Some positive responses included "this course has really encouraged my want to give back to the community and help these kids learn how critical college is to their future", and "I became passionate again about volunteering". Some students reflected that the experience "made me realize that people in the surrounding community don't have the great opportunities and constant encouragement that I do." At least two of the seniors who graduated after taking this class have gone on to become teachers partly as a result of this service-learning experience.

Unanimously, the students validated the importance of engaging in the community. They noted that simple things, like sitting at the table with the second graders, and giving them a lot of attention and encouragement, made a big difference. Some comments included: this "definitely enhanced my Denison experience", the "PEAK program [was] extremely beneficial to both volunteers and participants", "it is hardly a time commitment because it goes by so quickly and the children appreciate it so much". Students said that they "wanted to stay longer to have more impact", and that the outreach "made me examine myself as a teacher and as a student at the same time."

Discussion:

While this was a good experience for male students, I think that this link to community service struck an especially deep chord in female students. Despite Denison's campus being fairly evenly male and female, 76% of the students in the SGB class were female, possibly suggesting that more females than males were attracted to this type of class. This idea is

supported by an unpublished survey documenting volunteering at Denison (Fisher, *unpublished*). Nearly double the number of female students as male students participated in service learning clases in 2009 (206 vs. 113), and the women who did participate gave more than 50% more hours than the men to their service learning projects (19.8 vs 12.6 hours). More generally, volunteering at Denison is dominated by females: 78% of females versus 69% of males participated in some philanthropic activity in 2009 (Fisher, *unpublished*), and female students spent nearly 2.5 times more hours volunteering than males did (28.2 hours vs. 11.4 hours). This type of gender difference in altruistic behaviors is supported in some arenas (Andreoni and Vesterlund, 2001; Themudo, 2009; Trudeau and Devlin, 1996), but not universally (Wilson, 2000).

These observations suggest that gender can be taken into consideration when planning non-majors science courses. Introducing a service learning component may make the class more attractive to female students. This could be partly because many of our female students already have experience with service learning or other forms of volunteering, so that the service learning portion of the laboratory experience seems comfortable and familiar, even if the topic is new and challenging. Furthermore, the service learning model of introductory biology allows students the opportunity to engage in problem-solving outside of the classroom. According to Yang (2010), college women who are not science majors are more likely to want to engage in science problem solving outside of the classroom rather than within the classroom. Also, college women women who are not science majors are apt to see science as only moderately or hardly relevant to life, rather than highly relevant to life (Yang, 2010). Service learning experiences are likely to give the scientific content a more meaningful and relevant context (Bhattacharyya, 2009; George & Brenner, 2010; Reynolds & Ahearn-Dodson 2010).

I was fortunate that the outreach that we could sustain simultaneously furthered my learning goals for my SGB students and served an important community need. I was also lucky that Denison University's Alford Center for Service Learning could support this effort by communicating with the appropriate teachers and administrators and by coordinating transportation. These two factors- serving a real need and institutional support- are important factors in determining the overall success of service learning projects (Bowers-Sipe; Butin 2006). However, this service outreach came with a cost: Altogether, we devoted six out of our fourteen lab times to planning and performing this outreach. Since this class was a non-majors class, I felt that the benefits of this experience outweighed the cost of losing time for additional wetlabs or independent projects.

Summary:

Introductory science courses with appealing topics and service learning components can attract and support female non-major students while still being rigorous and content-rich. Volunteer opportunities can tap into philanthropic leanings while simultaneously reinforcing learning goals. We can thus recruit, support, and motivate an essential and underserved portion of our population by including socially relevant themes and practical elements that include outreach and service learning to promote local social justice.

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