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## **A WiSE Approach: Examining how Service Learning Impacts First-year Women in STEM**

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Lora Leigh Chrystal has been committed to increasing the representation of women in the Science, Technology, Engineering and Math (STEM) workforce for the past 17 years at Iowa State University. As Director of the Program for Women in Science and Engineering, Lora Leigh has oversight for all outreach, recruitment and retention programs serving over 12,000 students in the state of Iowa each year. Prior to her role as director, Lora Leigh spent over 13 years building recruitment and retention programs for women in STEM fields. She is ABD in the Educational Leadership and Policy Studies Program at Iowa State University with a specific research interest in the retention of STEM women. Prior to her work at Iowa State University, Lora Leigh worked as a Research Technician for the Human Genome Sequencing center at Baylor College of Medicine in Houston, TX.

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A WiSE approach: Examining how service-learning impacts first-year women in STEM

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## **Introduction**

Women are drawn to science, technology, engineering, and math (STEM) fields with a purpose to “change the world” and the opportunity to engage in a meaningful STEM experiences early in their academic career can serve as a strong recruitment and retention tool (Carlone & Johnson, 2007). Service-learning is one vehicle to offer intentional, high impact, and meaningful experiences for students in STEM. Service-learning provides a space for students to implement theory to practice and increase the likelihood of persistence. In particular, Vogelgesang, Ikeda, Gilmartin, and Keup (2002) report that students participating in service-learning projects in their first-year of college, indicate higher levels of success than those that did not, including academic and personal development. The area of STEM and service-learning is an essential partnership because of the opportunity for students to experience how they can make a difference together through improvement of lives and communities. In other words, the population of students in STEM fields, lends itself to align with the primary purpose of service-learning at the institutional level.

## **Research Purpose**

Enrollment of women in higher education has surpassed enrollment of men (Renn & Reason, 2013). However, the overall enrollment trend of women in postsecondary education is different than the enrollment of women in Science, Technology, Engineering, and Mathematics (STEM). Though trends show a steady increase of women majoring in STEM fields from 1977-2011, women are still underrepresented in STEM majors (Mann & DiPrete, 2013) and jobs (Beede, Julian, Langdon, McKittrick, Khan, & Doms, 2011).

Negative experiences in STEM environments can be related to women’s perceptions of a chilly climate (Shapiro, C. A., & Sax, L. J., 2011, Wilson, Bates, Scott, Painter, & Shaffer,

2015). These experiences include competitiveness in STEM majors (Seymour & Hewitt, 1997), lack of women faculty representation (Seymour & Hewitt, 1997; Tonso, 1996), gender bias, and sexist behavior of male peers (Tsui, 2010). Perceptions of self can impact women's experiences as well. Many women experience a lower sense of belonging, self-efficacy to perform in math and science classes (Erwin & Maurutto, 1998; Sax, Lehman, Jacobs, Kanny, Lim, Monje-Paulson, & Zimmerman, 2017; Wilson et al., 2015), and leader-efficacy to take on leadership roles (Dugan, Fath, Howes, Lavella, & Polanin, 2013).

The socially oriented goals of women in STEM are consistent with women's understandings of leadership definitions that value collaboration, personal qualities, and difference making (Haber, 2012). Coupling the goal of retaining women in STEM programs and answering their desire for promoting social change, provides developmental insight into addressing the needs of women in STEM fields. The purpose of this study is to examine how women in STEM benefit from socially responsible leadership education and add to the existing literature on leadership and women in STEM.

## **Literature Review**

### **Enrollment Trends of Women in STEM**

According to the National Science Foundation (NSF) (2015), while not every STEM program is male dominated, 14.3% of women were enrolled in the biological and agricultural sciences, 12% in social and behavioral sciences, 3.9% in engineering, 1.9% in physical sciences, and 1.4% in mathematics, statistics, and computer sciences (NSF, 2015). Additionally, there has also been low progression of women holding jobs in STEM fields after graduation. The U.S. Department of Commerce, Economics and Statistics Administration (2011) reported women holding 24% of STEM jobs, compared to 48% of all jobs being held by women. While there

continues to be a large focus on diversifying STEM fields, much work remains to increase the persistence and retention of diverse groups of people, including women. This is why it is imperative to examine the leadership and interpersonal styles of women in STEM fields.

### **Collaborative and Individual Benefits of Women Engaging with Service-Learning**

Historically, an increased number of women are drawn to STEM fields with a purpose to “change the world”; the opportunity for them to engage in a meaningful STEM experience early in their academic career can serve as a strong recruitment and retention tool (Carlone & Johnson, 2007). More specifically, Haber (2012) notes that women’s understanding of leadership is more collaborative in nature. This understanding fits well with the team leadership learning outcome of service-learning projects in leadership courses (Sessa, Matos, & Hopkins, 2009). The area of STEM and service learning is an essential partnership because of the opportunity for students to experience how they can make a difference together through improvement of lives and communities (National Academy of Engineering [NAE], 2008).

In most recent years, service-learning research is increasing as the number of higher education institutions implementing new programs expands. One benefit of service-learning for students is the development of personal self-efficacy through community service (Reeb, Folger, Langsner, Ryan, & Crouse, 2010). Service-learning is significant as women in STEM majors reported lower levels of leader efficacy than women in non-STEM majors (Dugan et al., 2013). Other researchers argue additional gains include social justice, ethics, and civility (Britt, 2012; Harkavy & Hartley, 2010; Mayhew & Engberg, 2011). Emerging research on civic engagement and attitudes helps communicate a need to encourage social activism and civic responsibility at the undergraduate level (Britt, 2012; Manning-Ouellette, Friesen, & Parrott, 2016; Mayhew & Engberg, 2011). Once student’s leadership is situated within an exchange of individual and

group values, they can work towards reaching into an understanding of citizenship (Komives & Wagner, 2009). Students who apply their experiences and service work to larger social issues achieve more defined and comprehensive leadership identities (Manning-Ouellette et al., 2016), which is particularly important for women in STEM and their passion to “help society”.

### **Intentionality of Service-Learning and Leadership Project**

Service-learning and partnerships between leadership programs and STEM programs provide an outlet to enhance the experiences of women in STEM majors with a particular focus on faculty and peer interactions and the learning environment (Kuh & Hu, 2001; Schreiner, Kammer, Primrose, & Quick, 2011; Tinto, 1993). At the same time, service-learning and collaborative partnerships became a way to contribute to the experiences of women based on their collaborative view of the leadership process and the need for increased leader efficacy (Dugan et al., 2013; Haber, 2012). With opportunities to impact the learning environment of women and build leadership capacity and efficacy, women can prepare for leadership roles in American industry (Fischer, Overland, & Adams, 2010), and engage in the social change that draws many to a STEM major early in their college careers (Carlone & Johnson, 2007).

### **Institutional Context and Course Context**

For the past four years, the Program for Women in Science and Engineering (WiSE) and Leadership Studies Program have collaborated to develop a high-impact leadership experience for first-year women majoring in STEM fields at a large, Midwestern university. The WiSE program provides mentoring, academic tutoring, and education to over 5,000 undergraduate women pursuing STEM majors. This study centers research from a course that actively recruits first-year students, enrolling over 50 women in STEM. The introductory leadership course, incorporates a semester-long service-learning project while studying the Social Change Model of

Leadership (Komives, Wagner, & Associates, (2017). The service-learning project engages college students and community partnership offering services in the following areas: with children and adolescents from low-income backgrounds, senior assisted living, domestic and sexual violence support, support programs for at-risk youth, and volunteer coordination across rural counties.

### **Theoretical Framework**

This study centers the social change model of leadership as a conceptual framework for understanding students' experiences with service-learning and personal leadership identity development through the seven C's (Higher Education Research Institute [HERI], 1996). The social change model was developed by exploring student leadership, social change, and the interaction across individual (consciousness of self, congruence, and commitment), group (common purpose, collaboration, and controversy with civility), and societal (citizenship) values (HERI, 1996). The overall assumption is that leadership should be socially responsible and promote positive social change (Komives et al., 2009).

### **Methodology**

Our intent is to explore student reflection and outcomes of service-learning through qualitative methodology. We utilized narrative inquiry through large descriptive data sets (Denzin & Lincoln, 2018). Qualitative methods allowed us to review student narratives and understand reflective processes (Chase, 2018). The goal of this study was to examine student experiences and their reflection of material to better communicate outcomes and benefits of enrolling in a service-learning course.

We instituted purposeful random sampling (Light, Singer, & Willett, 1990) to recruit college women in STEM, enrolled in a service-learning leadership course. Purposeful random sampling encompasses an intentional selection process to indicate a population associated with our overall research topic (Patton, 2001). Further, purposeful random sampling creates opportunities for more credibility in data collection and analysis (Light, Singer, & Willett, 1990).

### **Research Design and Participants**

We recruited 46 first-year women in STEM from a service-learning leadership course in Fall 2017 to participate in the study. The researchers recruited the women the last day of the course in December 2017. All 46 first-year women in STEM opted in the study by signing and agreeing to participate with an informed consent form approved through the institutional review board. Students ranged across STEM majors at the university (Appendix A) with the largest representations from general engineering (28%), aerospace engineering (7%), and chemical engineering (11%).

From the 46 participants, we analyzed three reflective journals each for a total of 138 student data sets. Student data consisted of course reflective journals due in weeks 10, 13, and 16 of the fall 2017 semester. The journals were submitted through the course learning management system and downloaded for analysis after the course commenced in December 2017.

### **Data Analysis**

We used a grounded theory thematic process to interpret the narrative data (Charmaz, 2009). This type of analysis is contingent on the types of coding skills and categories that surface from the narratives of participants (Denzin & Lincoln, 2018). The researchers applied three areas of the thematic process for data analysis: initial coding, line-by-line coding, and focused phased coding (Charmaz (2009). Initial coding involved quickly scanning the data and



openly examining prominent areas that that might be useful or irrelevant. Secondly, line-by-line coding assisted in pulling significant quotes associated with the initial themes depicted in the initial coding phase. Finally, we executed theoretical coding in the final phase to uncover themes, validating the main categories that emerged from initial coding (Charmaz, 2009). The preceding sections highlights the findings from our data analysis.

## **Findings**

We organize the findings from the study into three categories: community as a vehicle of persistence, exploring controversy to build resilience, and supporting future goals of social change. These categories provide insight into how first-year women in STEM enrolled in a service-learning leadership course, make meaning of the experience. The categories are organized into main themes from the student narrative data. We highlight specific quotes that illustrated each category in the data set to better demonstrate how students benefited from the course.

### **Community as a Vehicle of Persistence**

**Fostering Trust.** Over 80% of the participants indicated that fostering or developing trust in smaller groups was critical for social change and their collaboration across the semester. Trust was something that may have looked different across social identities given the identified privilege that the women held within the group or society. The women participants learned the power of personal story-telling and its alignment with trust. Many reflected on their process of building trust within the group to establish collaborative tones by learning each other's stories.

Sarah highlights,

I did not really trust that everyone would not judge me if I went against the status quo so I ended up agreeing on a project that I did not originally intend to do. However, as we continue to work on this project, I begin to trust my nest members more and know that they will not judge me for having a different opinion from them. I have also begun to see

why some of them are so passionate about our service project and have started developing a passion for it myself. Developing this trust between me and my other group members has made it easier to collaborate and for me to bring different ideas to the group.

Sarah expresses the process of group development and the critical nature of hearing the voices and narratives of her group members with the larger goal of social change and persistence. This aligns with previous research on women leaders engaging in collectivist approaches (Dugan et al., 2013; Haber, 2012).

**Navigating Personal and Group Core Values.** More than half of the women expressed the critical nature of knowing audiences or group members in order to enact change and build a foundational community. Students learned to navigate their personal values and what might be compromised or solidified when working toward positive social change and service. The women in the study also noted the importance of exploring others' core values as way of understanding their priorities and passions in the name of social responsibility. Nadine indicates,

I think the activity where we kept having to narrow our values down relates to the conflict of interest in groups, which ultimately leads to compromising trust. Because it's hard to trust someone who prioritizes other things before the group. The inevitable outcome of groups that don't know each other's ticks and don't trust each other are usually the ones that I see struggle when working together.

Nadine reflects on feeling confident in knowing your group members values and where they situate priorities in order for them to build a stronger community thus supporting previous research on women's sense of belonging and self-efficacy (Sax et al., 2017; Wilson et al., 2015).

Another STEM student, Mary, notes the significance of integrating values into priorities for group change as a benefit to all, "befriend the critics in your group, this way you know who the one person you need to ask first. When your biggest critic thinks your idea could work, this is when you know where to put in more work." She is reflecting on how individuals might navigate larger social change projects by understanding more critical perspectives as a way of

growth and persistence. Ultimately, these levels of community building shape how groups work toward social change. In the preceding section, our data sets indicate another level of learning through analysis of controversy within and outside of their community.

### **Exploring Controversy to Build Resilience**

The service-learning course lends itself to discussing one of the seven c's known as controversy with civility (Komives et al, 2017). More than 70% of the students in the study discussed how learning about power, privilege, and oppression influence their understanding of societal issues and how leaders should be able to discern how privilege impacts the process of leadership to promote positive social change. The most predominant themes in this category are analysis of power and privilege and learning how individuals might disenfranchise another individual.

**Analyzing societal power and privilege.** Ultimately, women sought to understand how privilege might hinder the work they aspired to do when helping society. While important, many of the women addressed the critical nature of analyzing their personal privileges and how these intersected with their leadership. Melaina expressed,

Another issue is that groups of people have pre-determined ideas of who is the “dominant” group in society and they tend to exercise that in public events. People often find bringing race into the conversation as an uncomfortable topic, but it needs to stop being uncomfortable and become more feasible for people to discuss so we can overcome it once and for all. As our professor says, “If it makes you uncomfortable, you’re learning something”. And that’s exactly what our society needs.

Melaina is able to discern the importance of embracing uncomfortable conversation for the sake of positive social change. She expressed the very need to engage in topics that people avoid in order to have transparent dialogue that promotes socially responsible behavior. These personal conversations helped to build resiliency in many of the women through controversial conversations.

**Navigating Disenfranchising Others.** As part of learning about controversy with civility, women learned the danger of disenfranchising others. While powerful, women found greater strength in developing their personal dialogues, analyzing their significance, using their experience for good, all the while noting that speaking for all could do harm across groups.

Constance discusses,

When addressing controversies, I must understand where my understanding of the topic comes from and where my experiences and biases might influence my perspective on the topic. This comprehension is especially important when trying to address problems that effect groups outside of our own personal identities or experiences. One of the most impactful notions discussed in our class was the idea of one's own empowerment disenfranchising others. Should I try to speak on behalf of that community, while I do identify as a part of it, I would not be doing a service to the cause, and I would likely be revoking the empowerment of another, more capable individual.

Some women found this concept freeing yet a burden in their quest for positive social change.

This navigation helps to build resiliency in their voices and how they might advocate for others in order to better society and in their own male-dominated campus spaces.

### **Support Future Goals of Social Change**

As a reflection of learning, many women placed the course in context with their personal and professional goals. Over 75% of the women reflected on their goal of “helping society” or working to create social movements in the hopes of promoting societal change. The women describe how the course supported their future goals to “change the world” through their major and through their career. Olivia boasts,

It is my hope that more people become activists in creating social movements and social change. These changes will require pre-existing leaders and also produce more leaders in the long run. When I graduate college, I plan to create a scholarship for women in STEM fields. This scholarship is just one little stepping stone that will be a piece of a much larger movement I plan to lead which will one day break the unfavorable norms for women in STEM majors.

Olivia helps communicate how we need to help current leaders shift to process-oriented leadership and continue to enhance future leaders in activism and positive social change. She clearly states her goals to make change within her major and field by using the leadership strategies she learned in the course. She wants to breakdown barrier for women in STEM since she has experienced obstacles and can draw from the course content to make a commitment to change.

### **Discussion**

Our study indicates that developing women's leadership in the first few years of college is critical in the development of women in STEM fields. We note that many women students have significant goals to help others in society in the future in our data sets, which aligns with previous research (Carlone & Johnson, 2007). This indicates that fostering citizenship and socially responsible leadership perspectives fulfills this need during college and promotes a connection to future leadership roles and professional goals. Assisting women in the development of positive social change could influence self-efficacy and confidence in their leadership skills, enhancing their overall collegiate career and building a foundation of leadership voice in their STEM career (Fischer, Overland, & Adams, 2010). Furthermore, the transferrable skills developed throughout the leadership course, aide in their persistence through male-dominated spaces.

College-specific administrators and faculty need to be aware of the climates within STEM classrooms and the reliance of understanding realities through male-dominated spaces. A strategy for combating isolation for women in STEM classrooms is to encourage and strengthen women's participation in leadership activities and find allyship and mentors within their academic programs or courses. Requiring universities to provide additional support for faculty

to adjust their classroom procedures and curricula to accommodate an inclusive environment for all students to thrive should be considered.

This study provides groundwork for a conversation on strategies to develop socially responsible leadership in women and perhaps to change the climates they experience on a daily basis. These experiences, both positive and negative, influence women's persistence in college as well as contribute to the environments they seek to work in during their career. This study is significant because it provides insight into enhancing and improving programs and leadership opportunities for women in STEM.

### **Recommendations and Implications for Practice**

The WiSE program and the women in STEM-specific leadership course builds platforms based on the philosophy that it is critical for girls and women to connect with other women involved with STEM and to strive to address larger societal issues in the name of STEM fields. This socially responsible leadership strategy allows women in STEM to 'visualize' their ability to pursue and succeed in STEM while changing the world for the better. This social change leadership course serves as a way for participants to make a connection between people and STEM and how to enact congruence with positive social change. Large STEM focused institutions of higher learning should consider enhancing or redesigning current programs to incorporate socially responsible leadership courses and/or projects to foster their students' dreams and showcase a climate of persistence and support.

Another outcome of advancement for institutional programs is the continued and increased collaboration between several departments on campus. The service-learning course utilizes several campus units such as the College of Liberal Arts and Sciences, the College of Engineering, the Center for Women and Politics, the Leadership Studies Program, the Student

Activities unit of student affairs, mentoring programs, and community agencies. These partnerships centralize conversations and development for campus students. The students benefit from several perspectives and pedagogies of learning, increased evidence-based practices, and alignment of institutional, college, and student affairs purpose. Further, we recommend that institutions continue to work on building, valuing, and fostering these partnerships to enhance student retention and persistence.

Overall, the service-learning leadership course continues to be a highlight of the women in STEM's undergraduate experience, especially in the first-year. After the initial project, students actively worked to create a plan for continued service and activism in the future. Many of the students reported a greater sense of community with their small women in STEM groups during the course. Students reported that they felt a connection to the local area, the university, and to women in STEM from taking the course. Several women disclosed that the small group interaction and work with other women propelled them for success in the course and in their major courses. Furthermore, almost all the students of color expressed that the course helped with feelings of isolation on a predominantly White campus and in the male-dominated majors they inhabit. This course served as a catalyst of discovery and a vehicle for bonding with others that experience the same seclusion in their undergraduate career. STEM programs should consider the intersectionality of their women participants and how to foster their voices of positive change through analysis of disenfranchised experiences at the university and within society.

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## Appendix A

	<b>NAME</b>	<b>MAJOR</b>		<b>NAME</b>	<b>MAJOR</b>
1	Mariah	Communication Studies	24	Macy	Biosystems Engineering
2	Jordan	Mechanical Engineering	25	Nicky	Aerospace Engineering
3	Bree	Engineering	26	Lindsay	Aerospace Engineering
4	Constance	Engineering	27	Mary	Chemical Engineering
5	Emily	Electrical Engineering	28	Kate	Engineering
6	Raquel	Open option	29	Bianca	Pre-Med
7	Karrie	Mechanical Engineering	30	Tasha	Aerospace Engineering
8	Melissa	Chemical Engineering	31	Miranda	Engineering
9	Myra	Engineering	32	Erika	Engineering
10	Sarah	Engineering	33	Amanda	Pre-Med
11	Nancy	Animal Science	34	Pam	Software Engineering
12	Isabel	Chemical Engineering	35	Justice	Chemical Engineering
13	Emily	Open Option	36	Amanda	Agricultural Engineering
14	Sandy	Aerospace Engineering	37	Logan	Animal Science
15	Keera	Aerospace Engineering	38	Chastity	Chemistry
16	Brinley	Engineering	39	Star	Animal Science
17	Nissa	Chemistry	40	Olivia	Engineering
18	Nadine	Engineering	41	Lanie	Industrial Engineering
19	Tammy	Open option	42	Ashley	animal Science
20	Courtney	Engineering	43	Rachel	Materials Engineering
21	Willow	Engineering	44	Patty	Chemical Engineering
22	Becky	Open option	45	Quiana	Aerospace Engineering
23	Melaina	Engineering	46	Helena	Aerospace Engineering