Graduate Scholars Leadership, Engagement, and Development: Initial Design, Implementation, and Lessons Learned

By: Julie A. Coffield, Jasmine Choi, Ikseon Choi, Brandy B. Walker, Katherine Walters, Janette R. Hill, Sejin Kim, Janet E. Rechtman, K. Paige Carmichael, Ramana Pidaparti, and Meredith Welch-Devine

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Abstract:

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Keywords: graduate education | leadership | community engagement

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Abstract

The fast-paced advances in technology and scientific knowledge in the 21st century call for learners to possess professional skills that complement their technical skills to make meaningful contributions in communities. This article introduces a cross-disciplinary leadership training program, Graduate Scholars Leadership, Engagement, and Development (GS LEAD), that was designed and implemented to train students in professional skills including problem-solving, interdisciplinary teamwork, leadership, communication, and engagement. This training program provided learning opportunities for incoming graduate students to work beyond their laboratories, across disciplines, and into communities to identify real-world problems and design sustainable solutions. The design and implementation of the program, the findings of participating students' development in Program Year 1, and suggestions for future program design are discussed.

Keywords: graduate education, leadership, community engagement

Dynamic changes in global societies coupled with advances in technology and scientific knowledge call for a STEM workforce that is technically advanced in its disciplines and readily adaptable and responsive to evolving opportunities (Bidarra & Rusman, 2016; Crippen & Archambault, 2012). Traditional educational approaches primarily train students in foundational knowledge and technical skills, but emerging scientists and engineers need skills that reach beyond the laboratory, across disciplines, and into communities to identify issues and develop resilient and sustainable solutions.

Students need to develop professional skills that complement their disciplinary training and proficiency. This is particularly critical at the graduate level, as many students are pursuing advanced degrees that will enable them to move into a variety of professional roles after graduation. Although many experts recognize the importance of professional skills (Shuman et al., 2005), most academic programs do not specify professional skills training as an explicit goal for their students, nor as a formal aspect of their curriculum. Rather, programs rely on the time-honored traditions of mentoring and modeling as informal means to develop professional skills in their students (Bates et al., 2009; Benbassat, 2014). Given the importance of these skills, the traditional paradigm of informal training needs to be challenged by immersing professional skills development at the inception of graduate training. In addition to better preparing students to make contributions in their careers, early training may equip graduate students to make more creative and innovative contributions in their research labs, their dissertation projects, and their chosen fields of study. In this article, we present the Graduate Scholars Leadership, Engagement, and Development project (GS LEAD), a formal interdisciplinary train-

ing program developed at the University of Georgia (UGA) and implemented in the earliest stage of graduate education. We discuss the initial design, implementation, findings, and lessons learned thus far from the project to inform best practices for promoting graduate student leadership in the community.

Context

The University of Georgia

As a prominent public land- and sea-grant institution of higher education, UGA is committed to academic excellence. This commitment, as well as its institutional mission and core values, are reflected by its motto, "to teach, to serve, and to inquire into the nature of things" (University of Georgia, 2014). In recognition of the critical impact that rapid advances in science and technology have in our global society, UGA has made a strong commitment to the advancement of STEM education at all levels. In addition, education leaders at UGA value diversity, interdisciplinarity, and teamwork and embrace the need to prepare all students, both technically and professionally, for a 21st-century workforce that partners with communities locally and globally.

The GS LEAD Project

The University of Georgia initiated GS LEAD to address professional skills training in graduate education. This "project with promise" pilot program trains graduate students in problem solving, interdisciplinary teamwork, leadership, communication, and community engagement, critical professional skills that transcend disciplines and prepare graduate students with a focus on STEM for a broad range of career choices. Critical to the success of GS LEAD are strategic partnerships that (1) embrace the institutional pillars of teaching, research, and service; (2) reshape the 21st-century STEM graduate scholar to meet the needs of the communities they will serve; and (3) transform graduate education.

The GS LEAD project is a campus collaboration led by the UGA Graduate School and funded through a National Science Foundation Innovations in Graduate Education (NSF-IGE) grant awarded to the Graduate School. As the central unit responsible for supporting graduate education, the UGA Graduate School has brought together faculty leaders from across a broad span of academic and service units who possess the collective expertise to develop, coordinate, and implement the project goals.

The UGA Graduate School, in collaboration with the institution's Public Service and Outreach unit, partnered with the Colleges of Arts and Sciences, Education, Engineering, Journalism and Mass Communication, and Veterinary Medicine to carry out this project. The leadership team includes faculty in graduate education and public service and outreach, as well as STEM and STEM-related disciplines from across the UGA campus. The areas of expertise of the project implementation team range from interdisciplinary graduate education and program evaluation to communication, leadership, and community engagement. The rich variety and expertise of the leadership and implementation teams are reflected in the innovative design, development, and implementation of GS LEAD.

Project Details

Purpose of the Project

The GS LEAD approach focuses on newly matriculating doctoral students and infuses early doctoral education with experiential learning, beginning with facilitated instruction in professional skills that progresses to less-guided experiential learning, providing interdisciplinary collaborative opportunities and facilitating community-engaged opportunities. By aligning professional skill training with experiential learning, GS LEAD has piloted a novel approach in STEM graduate education. We hypothesize that a focused, student-centered learning model that pairs students with local communities to work on a problem of pressing importance will better prepare students to succeed in their graduate training, as well as in their chosen fields of work after graduation. GS LEAD uses a challenge-based learning model of professional skills training with three goals: (1) determining key considerations in transferring this pedagogical model from the health sciences domain in which it was established to the domain of STEM graduate education; (2) determining the impact of providing skills training at the beginning of a student's graduate career, both for the student and for the labs in which they may work; and (3) developing best practices for sustainably implementing the model, should it prove to be effective in

one or more of these contexts.

The results of this pilot study will significantly advance our understanding of the impact that early, immersive training in professional skills has on career placement and success and, just as importantly, on the contributions that students make to research during their graduate studies and beyond. In addition, the results will help assess whether pedagogies like challenge-based learning (Johnson & Adams, 2011) that have been successful in health sciences training (Harris & Brophy, 2005; Sable et al., 2001; Thistlethwaite et al. 2012) can be feasibly applied to STEM graduate education.

Project Site

GS LEAD was implemented at the main UGA campus in Athens, Georgia. Newly admitted doctoral students began GS LEAD in the summer before their first graduate semester at UGA (Summer Academy). The summer start also enabled students not familiar with the Athens area to get to know the campus as well as the surrounding community prior to the start of the academic year.

Participants

Newly admitted doctoral students in the agricultural and environmental sciences, biomedical and health sciences, engineering, public health, and social sciences were recruited to participate in GS LEAD during the spring term immediately preceding the start of the Summer Academy. Project participants received a stipend to partially offset living expenses during the summer program. The GS LEAD Year 1 cohort had 12 incoming doctoral students, Year 2 cohort included 15 incoming doctoral students, and Year 3 cohort included 14 students. The results presented in this article focus on the Year 1 cohort. In-depth analysis of the data from Cohorts 2 and 3 is ongoing and will be presented in future publications.

Program Design

Overall, GS LEAD was designed to provide students with the opportunity to engage in experiences that would develop leadership traits necessary to become STEM scholar leaders. To do this, a set of leadership competencies was first developed by the project evaluation team. Through literature reviews, discussions, and interviews with co-PIs and leadership experts to align leadership, interdisciplinary thinking, and community engagement, a list of leadership skills that students should possess was proposed. A semi-Delphi method was then employed to collect STEM experts' opinions on six key competencies and associated attributes across different disciplines. Potential attributes for these key competencies were collected from eight experts across different disciplines. An initial list was developed based on attribute frequency. The experts were then asked to identify their top five attributes for each of the competencies. This process resulted in identification of the top five attributes for each of the six competencies. These are referred to throughout the article as the GS LEAD leadership competencies and were used to guide the design of participants' experiences as well as program evaluation. Table 1 describes in detail the six competencies, attributes, and their definitions.

The GS LEAD program began with the 8-week Summer Leadership Academy. The purpose of this Summer Leadership Academy was for students to develop and hone transferable competencies in problem-solving, leadership, effective communication of scholarship, teamwork, and community engagement. A typical week in the summer academy included approximately three days of facilitated workshops, guest lectures, group exercises, one or two expert panel discussions, and dedicated time for self-reflection. Off-site visits with local or regional community programs were scheduled throughout the summer and provided students the opportunity to experience community issues firsthand. The workshops and lectures, usually delivered in a collaborative classroom setting, were organized by the course facilitators. Panel discussions included GS LEAD PIs/co-PIs, additional STEM scholar leaders from UGA, community engagement experts, and community leaders. Panelists and guest speakers were selected because they exemplified GS LEAD leadership competencies. Field experiences in the local community as well as surrounding areas were arranged and led by the facilitators and community partners. These opportunities for students to engage with a variety of people expanded their understanding of community issues. The overall theme for the first Summer Leadership Academy was food, including food technology, the politics of food, and then a growing emphasis on food access.

In the fall semester following completion

Table 1. Leadership Competencies, Definitions, and Attributes

Competency	Definition	Attributes
1. Self-awareness/lifelong learning	I understand my personal strengths and weaknesses and can reflect on and adapt to feedback and ideas for change.	1.1. I am open to feedback from others and to trying new ideas and methods based on this feedback. 1.2. I can adapt to changing conditions. 1.3. I have the courage to take risks. 1.4. I am eager to learn and grow. 1.5. I have a clear sense of how I am perceived by others and how this varies with context.
2. Community engagement/ public citizenship	Being aware of one's role(s) within different communities, understanding the different perspectives of different communities, and being respectful of the community.	2.1. I can organize and maintain smooth, effective working relationships. 2.2. I have a clear sense of how scientific research and practice relate to nonscientific disciplines and communities. 2.3. I recognize and reward the contributions of others. 2.4. I can assess and respond to contexts, including political, legal, commercial, ethical, disciplinary, and interpersonal. 2.5. I am sensitive to and responsive about the dilemmas and ambiguity that arise when STEM leaders work in community.
3. Paradigmatic knowledge	Understanding and appreciating the role of paradigms in one's work in community.	3.1. I have a broad understanding of my discipline, including context and content as well as technical knowledge of my field. 3.2. I understand the perspectives of various disciplines and functions and conditions that affect these perspectives. 3.3. I act in accordance with stated values and use ethical considerations to guide my decisions and actions. 3.4. I can integrate knowledge, perspectives, and entities that lead to new outcomes. 3.5. I understand how the social construction of knowledge can result in differences in perception dependent on context.*
4. Strategic problem-solving	Uses design thinking to engage others in setting goals, and definition and implementation of plans for achieving these goals.	4.1. I am mentally agile—I can see things from new angles and ask insightful questions. 4.2. I analyze diverse viewpoints to make planning decisions and solve problems. 4.3. I have a bias toward action, distinguishing between relevant and irrelevant information, making timely decisions that lead to helpful solutions. 4.4. I manage my time wisely, deal with interruptions appropriately, and avoid spreading myself too thin. 4.5. I use effective strategies to facilitate change initiatives and overcome resistance to change.
5. Effective communication/ storytelling	Clearly and succinctly shares ideas and information that engage others by creating and sustaining a sense of shared meaning about the work at hand.	5.1. I can encourage and maintain constructive dialogue among participants. 5.2. I can develop a credible and compelling vision and can secure commitment from stakeholders for achieving a shared vision. 5.3. I am warm and have a sense of humor. 5.4. I use web-based communications and social networking tools appropriately. 5.5. I am an effective advocate and spokesperson for the work I am advancing.
6. Multicultural/multidisciplinary fluency*	Skilled with norms of interaction that facilitate inclusive participation by people from diverse communities and disciplines.*	6.1. I can engage diverse partners (individuals and organizations) in collaborative networks and multidisciplinary partnerships. 6.2. I enjoy the challenge of working with and experiencing differences among people.* 6.3. I am aware of and respond positively to diversity in others, including disciplinary, class, gender, ethnic, and cultural differences. 6.4. I work effectively with people who differ in race, gender, culture, age, or background. 6.5. I facilitate individual and group self-expression, promoting the values of pluralism and diversity in society.

**Refined for Year 2.*

of the Summer Leadership Academy, the students advanced into a semester-long Grand Challenge Course with the overarching theme of connecting STEM disciplines to community needs. The purpose of the challenge course was for students to apply learned practices from the summer academy in a community setting, and to embrace these experiences in meaningful ways that could be carried forward into their dissertation research and professional careers. The end product of the fall course was a community-engaged project that the students defined and completed in small teams. The projects focused on working with communities to identify and codesign solutions to complex problems, such as access to healthy foods, experiential educational spaces, and community-engaged needs assessments.

Building community partnerships was crucial to the overall success of the program. However, gaining access to communities and building trust is a process that can take years. Fortunately, with service as a core pillar of its mission, UGA's Office of Vice President for Public Service and Outreach (PSO) has built partnerships across the state, with public service professionals deeply embedded in local communities throughout Georgia. The GS LEAD program collaborated with two PSO units, the J. W. Fanning Institute for Leadership Development and the Archway Partnership, to identify communities for students to partner with for their collaborative projects: The J. W. Fanning Institute for Leadership Development is "dedicated to strengthening communities, organizations, and individuals through leadership development, training, and education" (J. W. Fanning Institute, 2018), and the Archway Partnership addresses "self-identified community issues in geographically dispersed locations across the State" (*About Archway Partnership*, 2018). These units provided sites for field trips and identified local community leaders to act as guides for GS LEAD participants during these visits.

In addition to the experiences provided by the summer academy and fall course, students were encouraged throughout the program to engage in cohort-building activities to deepen their interpersonal relationships. For example, students had opportunities to continue engaging with their leadership coaches from the Summer Leadership Academy into the Fall Challenge Course. This multitiered approach has been reported by others to be effective for leadership development (Wendler et al., 2012).

Measuring the Impact of GS LEAD

Assessment of the impact of GS LEAD (IRB Approval #00003534) focused on how the students' experiences in the program influenced their development of leadership, interdisciplinary, collaborative, and community engagement skills, as well as their personal development of self. Specific data collection instruments (see Table 2) were developed and employed to gather information on participants' experiences and were implemented according the schedule detailed in Table 2.

Findings to Date

GS LEAD Cohort 1 included 12 incoming doctoral students from STEM and STEM-related disciplines. Outcomes of participants' experiences of the program, including each data collection method, as well as the initial results, are provided below.

The outcomes of the project were assessed through five different data collection instruments. (1) The Leadership Inventory examined participants' understanding of leadership skills before and after the program. (2) The course satisfaction surveys measured participants' satisfaction and experiences on a weekly basis throughout the summer and during the fall. (3) Open-ended reflection questions enabled participants to reflect on their experiences throughout the summer. (4) Interviews were conducted in both summer and fall for participants to share experiences related to their individual growth through the program. (5) A simulation-based performance assessment assessed participants' growth by examining their leadership, teamwork, communication, and decision-making skills before and after the summer program.

GS LEAD Leadership Inventory

The GS LEAD Leadership Inventory (GSLLI; see Figure 1) includes six key competency definitions (e.g., community engagement/public citizenship) with five associated attribute statements (e.g., "I can organize and maintain smooth, effective working relationships.") for a total of 30 attribute statements. The GSLLI was developed to measure student understanding and engagement with the GS LEAD leadership competencies.

Table 2. Data Collection Instruments and Implementation Schedule

Data source/instrument	Description	Implementation schedule
Leadership Inventory	Twofold survey that assessed program competencies by ranking 30 leadership attributes students perceive they possess, and then ranking those they perceive as ideal for a STEM scholar leader.	• Beginning of Summer Leadership Academy • End of Fall Challenge Course
Course satisfaction survey	Online Likert scale survey to gauge students' satisfaction in their learning experiences.	• Weekly during Summer Leadership Academy • Midterm survey during Fall Challenge Course
Open-ended reflection questions	Online questions that prompt students to reflect on session activities and personal/learning experiences.	• Weekly during Summer Leadership Academy
Face-to-face interviews	Questions to elicit student feedback on the program experiences and effectiveness towards self-development.	• End of Summer Leadership Academy
Simulation-based performance assessment	Computer-mediated small group role-play activity to assess students' leadership, teamwork, communication, and decision-making skills.	• Beginning of Summer Leadership Academy • End of Summer Leadership Academy

The GSLLI was one way to measure the students' growth in leadership development as a result of their participation in GS LEAD. By having students express their views of current and ideal proficiencies in leadership throughout the program, changes in their understanding of leadership over the course of the program were measured.

Procedure

The GSLLI employed two activities for the students to complete using the leadership competency attribute statements. For the first activity, they were asked to rank these 30 attribute statements into five categories, in order of their current proficiency (from most to least proficient). The statements reflecting their best-realized attributes go in the first category and continue through a total of five categories until they classify all 30 attribute statements.

The second activity provided the students with the same list of attribute statements. However, this time they were asked to categorize the attribute statements they think will be most important to them in the future as STEM scholar leaders. Again, they grouped the attribute statements into five categories in order of importance.

The responses from the two activities were scored using a 5–1 scale (from most to least proficient/important). For example, the six attribute statements that were placed in the "most important" category received 5 points each. The six attribute statements that were placed in the "least important" category received 1 point each. Using this scale, a total of 90 points were assigned to 30 statements. Each competency consists of five statements, thus the value of each competency could vary from a total of 5 points to a total of 25 points, depending on the students' responses.

GSLLI Results

Students (N = 12) participated in pre- and posttraining surveys, once at the beginning of the program and once at the end of the program, to examine how their current and ideal competencies have changed throughout the Summer Leadership Academy and Grand Challenge Course (see Figure 1 and Figure 2).

Figure 2 illustrates students' current and ideal proficiencies at the beginning (presurvey) and at the end (postsurvey) of the program. If the importance of each competency is equally distributed, then the total score for each competency is 15 points; this was used as a reference point.

Name:

GS LEAD Leadership Inventory

1. Please look through the behavior cards provided and put each behavior card in the order of proficiency – How good I am in currently using these behaviors.

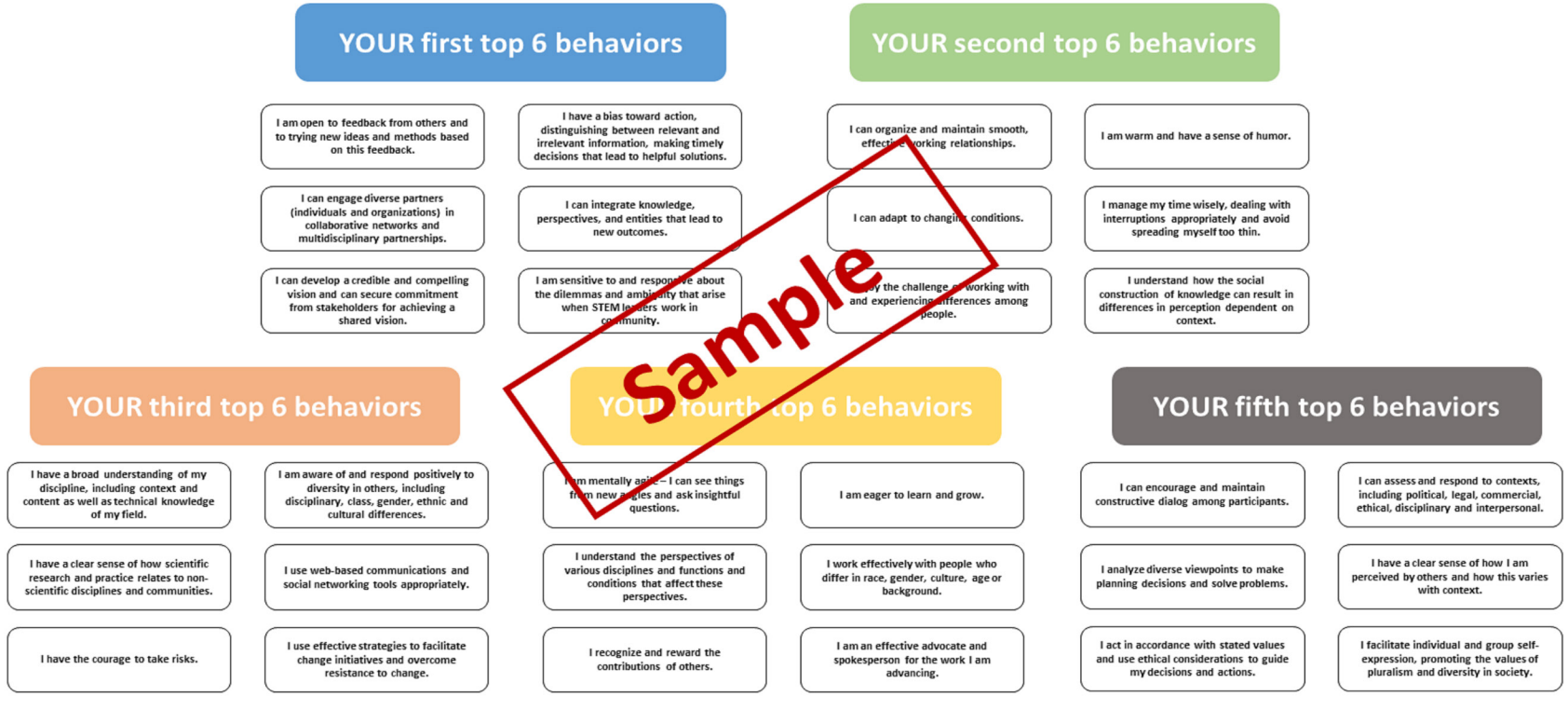

Figure 1. Sample GSLLI Inventory Survey

Comparison of current competencies between pre- and postsurvey results revealed that students awarded more points to self-awareness/lifelong learning, paradigmatic knowledge, and multicultural/multidisciplinary fluency over time. This may indicate that students perceived that their competencies became stronger in self-awareness/lifelong learning, paradigmatic knowledge, and multicultural/multidisciplinary fluency in comparison to others. The awarding of points in strategic problem-solving remained relatively stable over time. In contrast, students awarded fewer points to community engagement/public citizenship and effective communication/storytelling over time. Given that the awarding of a fixed number of total points requires that increases in some areas lead to decreases in others, this finding suggests that the students felt less strongly about their proficiencies in these two areas, or that their earlier perceptions of their abilities/knowledge were tempered by the real-life experiences they encountered during their training.

Figure 2 also shows changes over time in ideal proficiencies and suggests potential areas for enhancements in future training. Comparisons of ideal competency scores between pre- and postsurvey results revealed that students awarded more points to self-awareness/lifelong learning, paradigmatic knowledge, effective communication/storytelling, and multicultural/multidisciplinary fluency over time, with the latter two competencies seeing the strongest increases. These findings may indicate that students perceived that future training for scholar leaders should be focused further in areas of communication/storytelling and multicultural/multidisciplinary fluency. Corresponding decreases were noted in community engagement/public citizenship and strategic problem-solving over time, suggesting that the students gave less weight to proficiency in these areas. It should be noted that these interpretations may be limited by the lower number of participants in the postsurvey due to incomplete responses and/or low participation.

Course Satisfaction Surveys

Course satisfaction Likert scale surveys were used to gauge students' (N = 12) perceptions of the usefulness of the sessions by asking them to rate their satisfaction.

Procedure

The 5-point Likert scale surveys (5 = *high*, 1 = *low*) were implemented biweekly throughout the summer academy. A midterm course satisfaction survey using a 3-point Likert scale (3 = *high*, 1 = *low*) was administered in the challenge course to elicit recommendations for ongoing improvements of the course. All satisfaction surveys were distributed to the participants online using Qualtrics software.

Results

The participants' survey responses from the summer academy implied satisfaction, with an overall median score of 4.09 in terms of the design and implementation of the sessions (M = 4.02, SD = 0.51). The midterm evaluation of the challenge course indicated areas for improvement for the course design with an overall median score of 2.83 (M = 2.54, SD = 0.64). Table 3 presents overall Summer Leadership Academy course satisfaction survey results. Based on the satisfaction survey results, ideas for interweaving content for the Grand Challenge Course into the Summer Leadership Academy to improve transition were suggested and reflected in the overall revision of the curriculum for Year 2.

Weekly Open-Ended Reflection Questions for Summer Leadership Academy

Weekly open-ended reflection questions provided an opportunity for students to describe and reflect on their development and awareness of the competencies promoted through the learning experiences. The open-ended reflection questions also allowed the GS LEAD implementation team to gain a deeper understanding of the students' perceived experiences of the program. The reflection questions were posted from Weeks 1–6 on the program's private website discussion board; the students (N = 12) were also able to respond to the given questions through the secured website.

Procedure

The open-ended reflection questions were available to students starting at the end of Week 1 through the end of the Summer Leadership Academy. The reflection questions were formed based on the weekly themes and activities of the summer academy (see Table 4). The responses were analyzed and coded using the five attri-

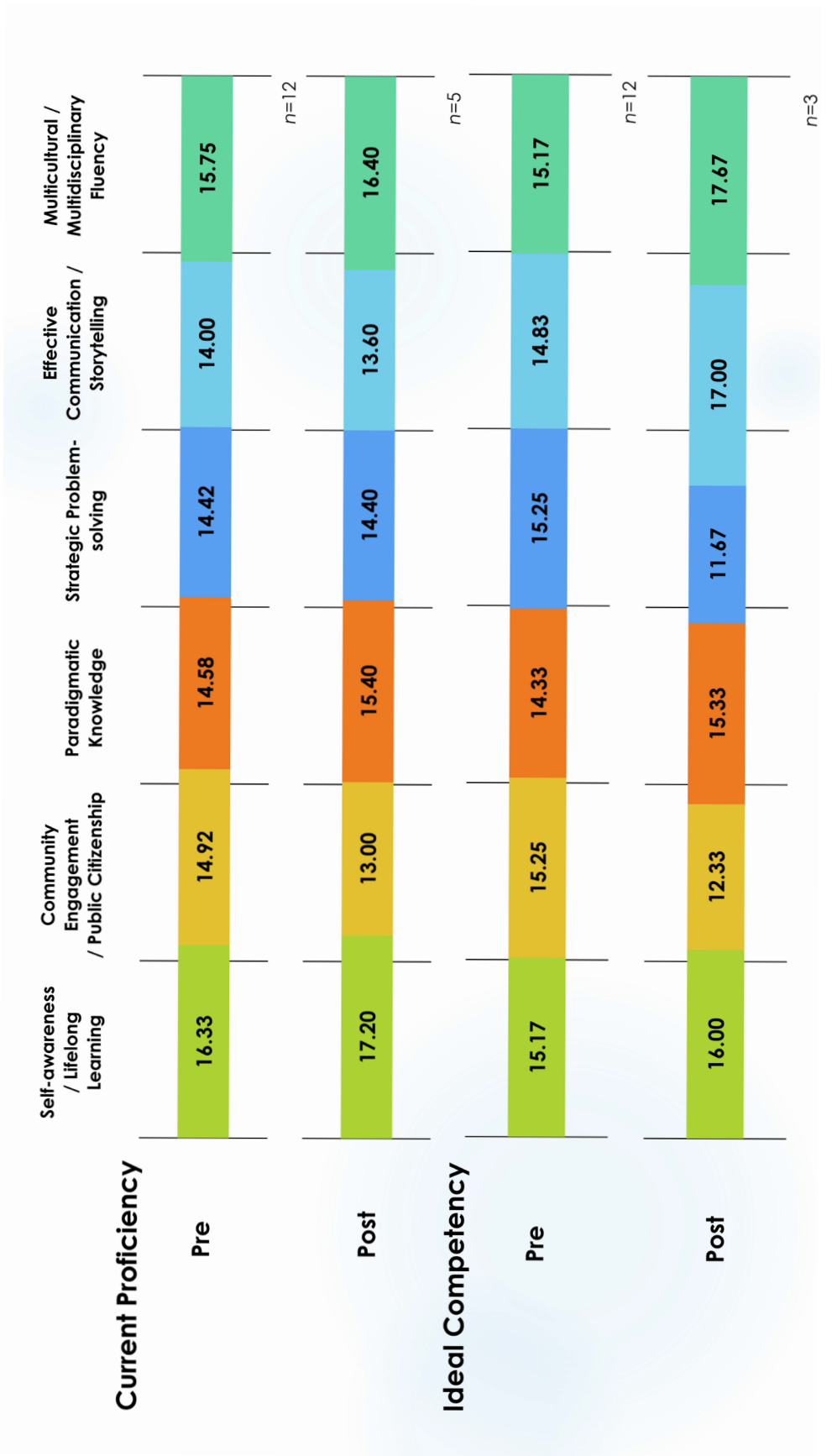

Figure 2. Students' Current and Ideal Proficiencies From Pre- and Postsurvey Data. Note. The number of respondents varies depending on the response rates.

Table 3. Course Satisfaction Survey

Session	Mean (SD)	Median	n
Summer course evaluation question: *This session had a positive impact on my development as a STEM scholar leader.*			
Opening Retreat: Welcome to the Summer Leadership Academy			
Panel on leadership	4.64 (0.64)	5.00	11
Cohort introductions via pecha kucha	3.91 (0.79)	4.00	11
Leadership perspectives sorting exercise	4.00 (0.60)	4.00	11
Team-building activities	4.36 (0.77)	5.00	11
Cohort activity/Watching and discussing the movie "The Martian"	3.91 (0.67)	4.00	11
Week 1: Food for thought, leadership, and your new role as a PhD student			
Simulation: Climb Mt. Everest	4.27 (0.86)	4.00	11
How people learn about leadership (KOLB & ORID)	3.73 (0.86)	4.00	11
Leadership practice inventory (LPI)	4.18 (0.72)	4.00	11
Guest speaker: STEM salaries	3.73 (0.86)	4.00	11
Marshmallow challenge	3.91 (0.79)	4.00	11
Science communication: Holistic vision of the lived experience of a STEM graduate student	3.73 (0.62)	4.00	11
Panel: Leadership & Food	4.64 (0.48)	5.00	11
Mindfulness sessions	4.18 (1.03)	5.00	11
Cohort activity/Campus tour & scavenger hunt	3.09 (0.79)	3.00	11
Field trip/Field trip to technical college	4.64 (0.48)	5.00	11
Homework/Observation assignment	3.09 (0.90)	3.00	11
Homework/Epistemology instruments	3.90 (0.83)	4.00	10
Week 2: We are what we eat, and community is about who you eat with			
EMERGENETICS	4.82 (0.57)	5.00	11
Panel: Storytelling, implicit & embedded narratives	4.73 (0.45)	5.00	11
Guest speaker: Culturally sensitive approaches to community	4.00 (0.95)	4.00	11
Cohort activity/Lab visit	4.18 (1.03)	5.00	11
Homework/Prioritizing competencies	4.09 (0.67)	4.00	11
Week 3: Slow food, fast food: Polarities as a STEM scholar/practitioner			
Politics of science	4.58 (0.49)	5.00	12
Panel with the regional commission	4.08 (0.76)	4.00	12
Discussion of Thomas Kuhn's *Structure of Scientific Revolutions*—Normal science and paradigm shifts	3.00 (1.15)	3.00	12
Communication and conflict (Ladder of inference, implicit bias)	4.25 (0.72)	4.00	12
Difficult conversations and dialogue	4.36 (0.48)	4.00	11
Epistemology discussion	2.92 (1.11)	2.50	12
Design thinking	3.17 (1.14)	3.00	12
Field trip/Food Well Alliance partners—Harvest; food bank; West community garden	4.83 (0.39)	5.00	12

Table continued on next page.

Table 3. Course Satisfaction Survey (cont'd)

Session	Mean (SD)	Median	n
Week 4: Indigestion, innovation, and inspiration			
The scientist discussion	4.33 (0.62)	4.00	12
Panel with LSAMP director; director of Regenerative Bioscience Center	3.83 (1.28)	4.50	12
Mangle of parsimony—Community engagement plan	3.00 (1.08)	3.00	12
Risk workshop	3.33 (1.37)	3.00	12
Innovation workshop	3.50 (1.12)	4.00	12
Culture, diversity, and personal/community narratives	4.00 (1.22)	4.50	12
Field trip/County partners—Westside Middle School; Oak Grove Landfill; Wimberly Community Center; Elementary Farm to School Project; Lazy B Farm	4.25 (0.62)	4.00	12
Mindfulness sessions	4.50 (0.67)	5.00	12
Week 5: Close-up on community/university partnerships			
Field trip—"Extended" campus Food PIC	3.57 (0.98)	4.00	7
Field trip—"County-community" partnership visit	4.57 (0.53)	5.00	7
Week 6: Iron chef: Technical and adaptive leadership			
Panel on ethics, sustainability, and safety	3.71 (1.60)	5.00	7
Ideation session	3.71 (1.11)	4.00	7
Week 7: Local flavor and community context			
Visioning session with project partners using Visual Explorer pictures	3.29 (0.95)	3.00	7
Think tank with project partners	4.29 (1.11)	5.00	7
Week 8: Soup's on! Bench to bedside			
Case study write-up, work-through, and skit	4.00 (0.58)	4.00	7
Peer consulting triad	4.71 (0.49)	5.00	7
Week 9: Celebrate and on to the Challenge Course			
Simulation game—Climb Mt. Everest	4.50 (0.55)	4.50	6
Final presentation—Personal leadership plan snapshot	4.17 (0.75)	4.00	6
Final presentation—Philosophy of community engagement snapshot	4.17 (0.75)	4.00	6
Final presentation—Project presentations	4.50 (0.55)	4.50	6
Self-graduation	4.33 (0.82)	4.50	6
Celebration reception	4.17 (0.98)	4.50	6
Fall course evaluation question: Rate the following activities for the program . . .			
Bring your own faculty (BYOF)	3.00 (1.79)	3.00	6
Lectures	1.40 (0.89)	1.00	5
Team clinics	3.00 (1.26)	3.00	6
Team sharing/Presentations in class	2.20 (1.10)	3.00	5
Design Review #1 (presentation)	2.67 (1.97)	2.00	6
Special session: Dean "Dan"	3.00 (1.79)	3.00	6

Note. Each session was ranked on a 5-point Likert scale.

Table 4. Weekly Themes and Activities

Week	Topic	Activities
1	Food for Thought . . . Leadership and your new role as a PhD student	Forum: STEM community and you Cohort activity: Campus tour and scavenger hunt Field trip: Learn-It Farm at regional technical college
2	We are what we eat & community is about who you eat with	Workshop: Community Engagement Dilemmas Cohort activity: Cook a meal together as a cohort Field trip: Visit labs across campus
3	Slow Food, Fast Food: Polarities as a STEM Scholar/Practitioner	Panel: Politics of Science Lecture: Introduction to Design Thinking Workshop: How to Have Difficult Conversations Cohort activity: Work with partners to interview STEM faculty across campus Field trip: Food Well Alliance and International Farmer's Market
4	Indigestion, Innovation, and Inspiration	Panel: Role of the "Scientist" Lecture: Role of Innovation and Risk in STEM Workshop: Culture, Diversity, and Community/Personal Narratives Cohort activity: Explore project ideas with team members Field trip: County school/Community field trip
5	Close-Up on Community/ University Partnerships	Cohort activity: Explore project ideas with team members Field trip: "County-Community" Partnership and the Food Product Innovation and Commercialization Center (Food PIC)
6	Iron Chef: Technical and Adaptive Leadership	Panel: On the Challenges of Modernity: STEM Safety, Ethics, Sustainability Workshop: Ideation Session Cohort activity: Work on community project plan with your team

butes from each of the leadership competencies: self-awareness/lifelong learning, community engagement/public citizenship, paradigmatic knowledge, strategic problem-solving, effective communication/storytelling, and multicultural/multidisciplinary fluency.

Results

Based on a course content analysis, the six leadership competencies were distributed across the content (see Table 4) of the Summer Leadership Academy. Given that these competencies were the major learning objectives of the program, we believe that the content of the Summer Leadership Academy is aligned with the purpose of GS LEAD.

Students' reflection responses were analyzed using the leadership competencies as the initial codes (see samples of student quotes in Table 5). The numerical values in Table 6 represent the frequency of the competencies described by the students in their reflection responses. This process allowed the frequency of each individual competency to be compiled across each session week of the summer academy. Results indicate that students' overall experiences with the competencies were well-distributed across the Summer Leadership Academy. In particular, students' reflections indicated an emphasis around three competencies: (1) self-awareness/lifelong learning, (2) community engagement/public citizenship, and (3) effective communication/storytelling.

Interviews

The goals of the interviews were to collect constructive feedback on the experiences and effectiveness of GS LEAD, understand students' learning experiences and learning processes, and check what, if any, leadership competencies were personally developed and how such development occurred. Individual or small group (n = 2–3) interviews with participants (N = 12) took place at the end of the Summer Leadership Academy.

Table 5. Sample Quotes From Weekly Open-Ended Reflection Questions

Competency	Quotes
Self-awareness/lifelong learning	I thought that the hunger simulation was a great way to dismantle the privileged perspective that I have when it comes to food security.
Community engagement/public citizenship	I do want my research to make a difference and have a direct impact on the lives of others. Heeding his advice about establishing partnerships with groups and organizations before collecting data will go a long way towards making my research more meaningful.
Paradigmatic knowledge	The act of service has always been an integral part of my personal and professional life. I believe in service you find what you are most passionate about. I think when passion and service intersect is when we can really make a difference in communities.
Strategic problem-solving	One of the things that I liked the most about it was the fact that it combined a for-profit model with trying to do better in the community and create economic development.
Effective communication/storytelling	I think most PhDs want their research to have a significant impact on society and would love an opportunity to discuss their research to the public.
Multicultural/multidisciplinary fluency	It's nice to see how people from different backgrounds (Aerospace engineering, Ag engineering and even some of them with no academic degrees) come together to bridge the gap between consumers and local food producers. I think it's a great way to serve the community.

Table 6. Competency Alignment (Overall)

Competency	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Total
Self-awareness/lifelong learning	12	1	23	14	-	-	**50**
Community engagement/public citizenship	9	3	24	17	9	1	**63**
Paradigmatic knowledge	6	2	13	5	1		**27**
Strategic problem-solving	2	-	11	20	5	1	**39**
Effective communication/ storytelling	4	-	26	14	-	-	**44**
Multicultural/multidisciplinary fluency	2	-	15	13	-	-	**30**
Total	**35**	**6**	**112**	**83**	**15**	**2**	

Procedure

Students were asked to participate in 1-hour interviews starting at the end of summer, which also included the first few weeks of the fall semester. The interviews were audio-recorded, then transcribed verbatim and coded using keywords from the list of leadership competencies. Additional themes and subthemes were generated in the analysis.

Results

The themes emerging from the analysis of students' responses during the interviews, along with the associated competencies and sample quotes, are listed in Table 7. Overall, students expressed greater awareness of interdisciplinary mind-sets and community engagement as a result of their experiences. Moreover, students began understanding what it meant to them to be a STEM scholar leader, and how their professional identities should be reflected.

Simulation-Based Team Performance Assessment

Working and learning together throughout the Summer Leadership Academy was a major component of the curriculum. Team performance was evaluated through the Mt. Everest simulation game developed by Michael A. Roberto and Amy C. Edmondson (Harvard Business School Publishing, 2011). As indicated on the website:

> The simulation uses the dramatic context of a Mount Everest expedition to reinforce student learning in group dynamics and leadership. Students play one of 5 roles on a team of hikers [e.g., leader, physician, environmentalist, marathoner, and photographer] attempting to summit the mountain. Team members analyze information on weather, health conditions, supplies, goals, or hiking speed, and determine how much of that information to communicate to their teammates. Failure to accurately communicate and analyze information as a team has negative consequences on team performance. (Roberto & Edmondson, 2011)

The simulation was selected and implemented as an assessment to understand the students' capabilities in communication and problem-solving while engaged in collaboration. To measure any changes in students' capabilities, the simulation was implemented before and after the Summer Leadership Academy.

Procedure

The pretest simulation was implemented in the first week of the Summer Leadership Academy; the posttest occurred at the completion of the Summer Leadership Academy. For the pretest, students (N = 12) were randomly divided into two groups (Team 1 and Team 2) with six members each. Each member's role in the group was randomly generated and assigned by the simulation program. For the posttest, the groups stayed the same, but students received different role assignments that were randomly distributed by the evaluation team. We used the following process to assign posttest roles for each member: (1) Depending on the type of role, the member who was the least active in the pretest was assigned the leader role. (2) Leaders from the pretest became observers. (3) Other members were assigned through a random drawing to ensure that different roles were assigned in the posttest.

Students also completed an anonymous survey at two points during the simulation: (1) halfway through and (2) upon completion. Both the pre- and posttests were observed and video recorded by program evaluators. The survey results were collected from the simulation program.

Results

During analysis of pretest observations, conflict among group members and their decision-making processes emerged as two important themes influencing their group dynamics. Therefore, the posttest analysis focused on these two themes. Each theme was analyzed in multiple ways: in groups and as individuals, as well as team/pair dynamics. Through comparison of the pre- and posttest simulation results, the groups' ability to negotiate and communicate with each other throughout the simulation was assessed.

The overall observations and video analyses identified several findings from the pre- and posttest simulations. Analyses of these data indicated that as the students worked and learned together in the Summer Leadership Academy, they developed an un-

Table 7. Sample Quotes From Interviews

Competency	Themes	Quotes
Self-awareness/ lifelong learning	Confidence	Interactions with other students in courses can only be benefited by the Summer Academy. Even in something like a journal club and making a presentation, I just feel a little more confident.
Community engagement/public citizenship	Empathy	Like I feel more respect for the community and I feel more like an advocate for the community because I just know that a lot of people don't see that communities as actual human beings—and it's hard for people to connect that when they're doing research and I've been just able to see that and I just don't want to ever be the person to do that.
Paradigmatic knowledge	Scope of discipline	I think as scientists we're trained to look smaller and smaller and smaller and sometimes the idea of having a big picture kind of gets weeded out. You don't want to be the head in the clouds person, you have to have this very detail-oriented kind of person. You're studying microbiology, the process inside of a single cell. It's crazy to think that we also have to think like as big as space.
Strategic problem-solving	Changing mind, new perspective	It [interaction with other people] was really beneficial I think to have that experiences to work with people from different disciplines and it showed me how we really do think in a different manner, may approach problems from different directions and being able to do that can help you see around the corner and come up with a better solution. . . .
Effective communication/ storytelling	STEM scholar	Open-minded, driven, logical, and collaborative person. I feel like you need all those things. You can't just be really smart. You can't just be really good at doing research. You have to be able to work with others. You have to be able to communicate your research. Because if you're doing the coolest research in the world but you can't explain it to people outside your discipline, it's useless. And you have to be open-minded to change because that's the fun and hard thing about science. What we accept as fact is always changing.
Multicultural/ multidisciplinary fluency	Interdisciplinary, collaboration	Because the Summer Academy really I guess, reassured that interdisciplinary approach and how that's really important. And of course, I always thought that was important, but over the summer I was really able to see how people with different disciplines could come together and make something better than when you just have a team with one discipline. So I think that I would want to have a more interdisciplinary approach to my research and dissertation in the future.

derstanding of each other as both individuals and team members (see Table 8). For example, during the simulation, students checked in more frequently with each other during the pretest, whereas posttest data indicated they were not checking in with each other as frequently, most likely because they had become more familiar with each other. Likewise, assigned roles were more important in the pretest than in the posttest, because students did not have as much awareness of each other at the beginning of the program and, possibly, were less likely to express individuality. It should be noted that for Team 2, students' behaviors based on the given roles were less evident; students' personalities rather than the assigned roles were perceived to determine their behavior. Finally, over time student participation increased and problem-solving strategies became refined.

Survey Results

Aside from the observations, the Mt. Everest simulation also conducted a survey twice within each simulation: (1) halfway through the simulation and (2) upon completion of the simulation. Each survey included 11 statements and asked the participant to rate their level of agreement with the statement on a 1 to 5 scale, where 1 represents *strongly disagree* and 5 represents *strongly agree*. The statements focused on the group performance, individual comfort with and trust in their group, and the performance of the person in the leader role. For example, statements included "I would prefer to work with some other group of people, rather than this particular team, if I actually had to make important real-life decisions" and "We engaged in vigorous debate about alternative courses of action during the decision-making process."

Overall posttest survey results indicated different results for the two groups. Team 1 (n = 6) scored high on taking team opinions and efforts into consideration, with evidence of analyzing each member's situation, whole-group discussions for decision-making, and collaboration. In Team 1, students participated in the simulation based on their assigned roles, and the level of students' participation increased in the posttest. Team 2 (n = 6) reflected similar decision-making processes in both the pretest and posttest. A small group of students (n = 2) on the team were perceived to have more weight in the decision-making process, as these students participated more actively in the pretest and were also more active in the posttest.

Next Steps

Recommendations for Future Cohorts

After completion of the first GS LEAD Summer Leadership Academy and Fall Grand Challenge Course, a preliminary evaluation report (January) and an interim report (April) were presented to the key stakeholders of this project. Based on the preliminary data analysis from this first cohort, recommendations for changes to the curriculum, as well as in the evaluation strategies, were made and have been implemented for future cohorts. These changes were suggested to provide students with learning opportuni-

Table 8. Findings From the Simulation

Concept/element of observation	Key findings from pretest	Key findings from posttest
Group dynamic	Students checking in with each other frequently	Students checking in with each other less frequently
Student personality	Not evident in pretest	Assigned roles were less important to contribution style than student personality
Student participation	Many members in Team 1 stayed quiet; not all members in either group participated equally	Team 1 engaged more actively
Problem-solving strategies	Students created goals and made decision points clear	Students created goals and made decision points clear; students referred back to pretest experience to avoid mistakes

Table 9. Refined Leadership Competencies

	Competency	Definition	Attributes
Year 1	6. Multicultural/ multidisciplinary fluency	Skilled with norms of interaction that facilitate inclusive participation by people from diverse communities and disciplines.	6.2. I enjoy the challenge of working with and experiencing differences among people.
	3. Paradigmatic knowledge	Understanding and appreciating the role of paradigms in one's work in community.	3.5. I understand how collaboration amongst peers and communities can result in differences in perceptions dependent on context.
Year 2	6. Interpersonal collaboration/ multiculturalism	Skilled with facilitating inclusive participation by people from diverse communities, backgrounds, and disciplines.	6.2. I acknowledge and respect differences among people.
	3. Paradigmatic knowledge	Understanding and appreciating the role of paradigms in one's work in community.	3.5. I understand how collaboration among peers and communities can result in differences in perceptions dependent on context.

ties that better align with curricular goals, and to enhance leadership, community engagement, and strategic problem-solving skills that support students in their community project design and development.

Revisions to Data Collection Instruments for Year 2

GSLLI

The six leadership competencies were developed through STEM faculty input and used to guide the collection and evaluation of qualitative data (interviews, discussion posts, weekly evaluations, and performance simulation activity) in Year 1. Throughout the analysis of the results, interpersonal communication and collaboration emerged as important aspects for participants' leadership development. The emergence of these themes led to modifications of the GS LEAD competency framework. As a result, the evaluation team recommended changing the name of Competency Number 6 from multicultural/multidisciplinary fluency to interpersonal collaboration/multiculturalism to better reflect the students' learning experiences. Further, two attribute statements in paradigmatic knowledge and interpersonal collaboration/multiculturalism were revised for clarification based on students' feedback. These recommendations were accepted and implemented by the GS LEAD project leaders. The refined leadership inventories were applied to the Year 2 cohort (see Table 9 for more details).

Revisions to Curriculum for Year 2

The formative evaluation reports supported data-driven decisions for curriculum revisions across both the Summer Leadership Academy and Grand Challenge Course. Tables 10 and 11 summarize the key curriculum changes recommended by the evaluation team, key curriculum changes made by the curriculum team, and preliminary data reflecting the results of the changes.

Data analysis has continued into the fall of Year 3 to include cross-year analyses of surveys conducted along with data from the Summer Leadership Academy, discussions, weekly personal reflections, and video analysis of students' performances, discussions, and engagement. The cross-year analyses will result in better understanding of the overall development of students' perceptions and personal positions on what it means to be a STEM scholar leader in the 21st century.

Outcomes and Implications

Development of Leadership Inventory (GSLLI) for Higher Education

Table 10. Curriculum Revision Matrix (Recommendation 1)

Recommendation 1: Integrate summer and fall curriculum and experiences

Change recommended based on data	Change made in summer Year 2	Preliminary results of change*
1.1. In order to seamlessly integrate leadership experiences and training in the Summer Leadership Academy with design thinking activities and community engagement in the Challenge Course, suggestions were made to combine (and partially flip) the Summer Leadership Academy and Challenge Course curricula.	The first week of the Summer Leadership Academy was revamped to focus more on community building with the cohort. Additionally, there was more of a focus on being a leader rather than doing leadership as demonstrated through a project. Curriculum focused a week on cohort community building.	Greater opportunity to focus on leadership, broadly as well as on a personal level. [Interview]
1.2. Leadership training and experiences, mainly introduced in the Summer Leadership Academy, should also be included in the fall so students can apply their leadership skills in the community-engaged projects.	Added two community events in the summer that were designed, developed, and implemented by the students so they could practice the leadership skills learned to date. Added a retreat that allowed students time to reflect on the leadership skills they learned, which was helpful as they engaged with communities. Moved the community project development to fall to allow students to apply their individual leadership and collaboration skills to identify issues, develop potential solutions, and implement plans with community partners.	Students perceived the community events as having high value for developing their leadership skills. [Week 4 course satisfaction survey and open-ended responses] Moving project development to the fall contributed to the ability to reduce the time in the summer, thus better meeting the needs of the participants. [Interview]
1.3. Design thinking, a focal point of the Challenge Course in Year 1, should be introduced in the Summer Leadership Academy at an earlier stage.	Introduction to Design Thinking was moved to Week 1 of the Summer Leadership Academy instead of Week 4.	Earlier exposure to the concept of design thinking allowed the participants more time to integrate this into concepts related to leadership. It also enabled more engagement early on from faculty who work with the students in the fall, thus bringing in more seamless integration in the summer/fall. [Interview] Increased satisfaction of students' learning experiences. [Week 4 course satisfaction survey and open-ended responses]
1.4. Challenge Course needs to provide opportunities to use leadership training and experiences. More focus should be given in the fall to combining community engagement (summer) and design thinking (fall).	The community engagement project was integrated into the summer, enabling the participants to apply leadership skills and community engagement ideas in more seamless manners.	Integrating leadership concepts/practices in the fall promises to result in more seamless integration between the summer and fall (curricula). [Interview]

**Data for results are from facilitators interview and course satisfaction survey data.*

Table 11. Curriculum Revision Matrix (Recommendation 2)

Recommendation 2. Streamline summer experiences to enhance leadership development

Change recommended based on data	Change made in summer Year 2	Preliminary results of change*
2.1. The Interim Evaluation Report, which analyzed students' experiences of the program (through student interviews, weekly reflections, course satisfactions, Leadership Inventory, Mt. Everest, and Epistemic Belief Inventory), overall suggested a review of the experiences in the summer to enable a more streamlined focus on leadership experiences and activities.		
2.2. Summer Leadership Academy period could be shorter and closer to the fall semester.	Reduced the number of weeks from 8 (two classes a week) to 5 (three classes a week) and ended close to the fall.	Better meeting the needs of the participants as incoming doctoral students. [Interview]
2.3. Panelist questions too repetitive and the information gained not as valuable as it could be for enhancing leadership practices.	Reduced the number of panels and panel discussions better aligned with learning objectives.	Reducing the number of panels and field trips enabled the participants to focus more on leadership concepts and understandings, broadly as well as for themselves. [Interview] Increased satisfaction of students' learning experiences. [Week 4 course satisfaction survey and open-ended responses]
2.4. Some guest speakers are not relevant to the program.	Reduced guest speakers; selective based on the last year's data.	Increased satisfaction of students' learning experiences. [Week 4 course satisfaction survey and open-ended responses]
2.5. Field trips are too numerous and time-consuming. Field trips should be chosen strategically by their relevance and convenience.	Reduced the number and sites of the field trips.	Reducing the field trips and having one in town and only one out of town enabled more time to be devoted to deepening understandings of leadership. [Interview]

**Data for results are from facilitators interview and course satisfaction survey data.*

Through the development of a community-engaged leadership program for graduate students, the GS LEAD team designed a leadership inventory survey tool for use in higher education. Although validation of the GS LEAD Leadership Inventory is in its early stages, the identified competencies and attributes are grounded in data gathering and analysis and serve as a framework for both the program curricular/instructional design process and strategies going forward.

Timing of Program Implementation

GS LEAD was designed as an introductory training program for incoming graduate students. The initial impact of the program on participants has met the program objectives of promoting STEM scholar leader competencies early in graduate training. As the program is in early stages of development/implementation, the program's impact on graduate scholars' research and career development will be determined as the students become further engaged in their dissertation research and develop themselves as early career professionals. Nonetheless, preliminary results from the GS LEAD program reveal that the experiences had positive effects as the incoming students expressed greater awareness of engaging with communities and stronger interests in formulating research ideas to create meaningful connections between their research and communities.

Limitations

A couple of limitations of the program evaluation are as follows. First, most of the results presented are from self-reports, which include variations that may have affected the outcomes. For instance, the participants' shared experiences in the program, development of their leadership and community engagement skills, and so on, may have been influenced by their prior experiences and/or expectations of the program. For this reason, in-depth interviews were implemented to triangulate the findings to better inform program experiences. Second, due to the intensive, student-centered nature of this pilot program, the number of participants in each cohort (N = 12–16) was kept intentionally low; this, coupled with the decreased participation in the voluntary evaluation activities toward the end of the program, impacted the ability to achieve statistical significance. Increasing the overall number of participants and the response rates of the evaluation activities through additional cohorts will better inform statistically significant results related to the participants' leadership development and program experiences.

About the Authors

Julie A. Coffield *is associate professor in the Department of Physiology and Pharmacology in the College of Veterinary Medicine at the University of Georgia.*

Jasmine Choi *is a postdoctoral associate in the Mary Frances Early College of Education at the University of Georgia.*

Ikseon Choi *is a professor in the Mary Frances Early College of Education at the University of Georgia.*

Brandy B. Walker *is a public service faculty member in the J. W. Fanning Institute for Leadership Development, Public Service and Outreach at the University of Georgia.*

Katherine Walters *is a doctoral candidate in the Mary Frances Early College of Education at the University of Georgia.*

Janette R. Hill *is a professor in the Mary Frances Early College of Education at the University of Georgia.*

Sejin Kim *is an assistant professor in the Department of Medical Education at Kosin University College of Medicine.*

Janet E. Rechtman *retired from the J. W. Fanning Institute for Leadership Development at the University of Georgia.*

K. Paige Carmichael *is a professor in the Department of Pathology in the College of Veterinary Medicine at the University of Georgia.*

Ramana Pidaparti *is a professor in the College of Engineering at the University of Georgia.*

Meredith Welch-Devine *is associate dean of the Graduate School at the University of Georgia.*

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