2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
ASEE
Paper ID #40329

Engaging early-stage undergraduate students in research through a Science Communication Fellowship

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Abstract

Early engagement in undergraduate research opportunities promotes improved critical thinking and scientific reasoning, increased academic performance, enhanced retention both within STEM majors and in college overall, and improved satisfaction with college. It is therefore critical to create pathways for early-stage college students to engage in undergraduate research. Transdisciplinary Grand Challenges programs at large public universities provide an opportunity to engage undergraduates in research that is directly tied to their community's needs. The objective of this paper is to present the development and implementation of a science communication fellowship to engage early-stage undergraduate students in research. We created the Grand Challenge Water Science Communication Fellowship, in which students work with mentors (faculty, research scientists, graduate students) to create a communication project to educate the public on a water resources related issue that is currently being researched. The research used to produce the communication project can either be the student's own or the research of their mentor. Students select their own communications venues (e.g., paintings, podcasts, videos, infographics) and work individually with their mentor and together as a cohort to develop and refine their individual projects. The projects are presented at the end of the semester-long fellowship program at the University's Undergraduate Research Conference, which is open to the public. Participating students and mentors represent a wide variety of backgrounds, including biology, physics, environmental engineering, mechanical engineering, economics, environmental science, and geography. Several tangible benefits were seen for both students and mentors in the program's first year. Students formed an active multidisciplinary cohort that created a sense of belonging to the university; most of the students are now working in the research lab of their mentor; and students from the prior year's cohort and organizing and mentoring the next year's cohort. Research mentors have obtained broader visibility of their research by using the produced communications pieces in grant proposals, research papers, presentations, websites, and other public avenues for knowledge sharing. In the second year of the program, we now aim to use qualitative and quantitative surveys to understand if participation in the program increases students' self-efficacy and research identity. Survey questions ask students to evaluate aspects such as, how active their role was in planning the project, sense of responsibility for project progress, sense of belonging to a community of researchers, and intention to persist in a research experience. Results will be used to scale this opportunity and create similar communication fellowships for other Grand Challenges and disciplinary programs at the university.

1.0. Introduction and Background

1.1. Undergraduate Student Engagement in Research

Participation in transdisciplinary research enriches the undergraduate experience by taking educational content out of the classroom and materializing it in a real-world, professional setting. Early engagement in undergraduate research opportunities promotes improved critical

thinking and scientific reasoning, increased academic performance, enhanced retention both within STEM majors and in college overall, and improved satisfaction with college. [1]

However, there are several structural barriers to participation in research, including lack of information, time, and income. [2] Undergraduates may not participate due to lack of awareness about opportunities, uncertainty about the recruitment process, uneven access to faculty mentors, and personal responsibilities and living situations (e.g., living off campus). [3] First-year undergraduate students in particular may express interest in participating in undergraduate research experiences but may perceive a lack of readiness as a barrier to participation. [3]

Creating pathways for diverse and underrepresented undergraduate students to enter undergraduate research and continue to pursue graduate research is imperative to diversity the workforce. Underrepresented minority students often value collaboration and helping people as important factors in their educational objectives and careers. [4] They may have a misperception that science is an isolated field that does not engage in broader community interests. Involving students in community-engaged learning projects allows them to see the social and economic aspects of science problems, exposes them to the interdisciplinary and collaborative nature of science, and can result in improved recruitment and retention. Community engaged research projects have also been shown to strengthen institutional partnerships with surrounding communities through collaboration and action. [5]

The objective of this work is to share a Fellowship program that provides early-stage undergraduate students an opportunity to participate in community-engaged research in an informal, ad-hoc manner. Herein, we discuss goals, logistics, and outcomes of the first year of the fellowship program. Additionally, we introduce a survey instrument that will be utilized during the second year of the program to understand the impact of the fellowship on students' research identity and self-efficacy.

1.2. The University of New Mexico Grand Challenges Program

Grand Challenges are problems of regional, national and global significance that require researchers to work together across disciplinary boundaries to develop and implement solutions. Grand Challenges address problems that, when solved, have a significant positive impact on people and society. These challenges are large in scale, ambitious in scope, and multi-disciplinary. They have carefully developed goals that enable multiple paths towards solutions, and that are relevant across varied disciplines and communities. The University of New Mexico has 13 Grand Challenges teams, focusing on topics such as Sustainable Water Resources, Successful Aging, and Substance Use Disorders. Different departments within the university have formed research teams who work collaboratively on interdisciplinary research to address these issues. [6]

The Sustainable Water Resources Grand Challenge focuses on water management in New Mexico. The challenges in the state include shortages and inequitable distribution of scarce water supply, increasing water demand, and a modern political and economic landscape that is influenced by water rights specified in the 1938 Rio Grande Compact. The Rio Grande is New

Mexico's largest natural hydrologic resource which supports communities, ecosystems, and economies across the state. Much of the research being done to ensure a future of sustainable water resources surrounds the preservation of the Rio Grande and surrounding ecosystem, which is threatened by wildfires, aquifer decline, climate change, forest dieback and other stresses. [7]

The goals of the Sustainable Water Resources Grand Challenge team are to conduct research necessary to help decision makers, communities, and individuals make better choices about how they manage water; collaborate with other institutions, stakeholders, and citizens throughout the state; and train the next generation of water managers and leaders needed to solve the state's water problems. The Grand Challenge Water Science Communication (GC WSC) Fellowship Program for Undergraduates was created to meet these objectives of workforce development and publicizing research being conducted at the university to external stakeholders.

2.0. The Grand Challenge Water Science Communication Fellowship for Undergraduates

2.1. Goals of the Fellowship

The GC WSC Fellowship aims to overcome barriers that limit or otherwise impede undergraduate involvement in research by pairing students with a mentor, connecting them with a research project that directly applies to the needs of their community, engaging them within a cohort of other scholars with whom they can connect and derive a support network, and providing a stipend to compensate for time spent working on their projects. Throughout the semester, students work with a mentor (faculty, research scientists, graduate students) to create a communication project to educate the public on a water resources issue that is currently being researched. The research used to produce the communication project can either be the student's own or that of their mentor. Students select their own communications venues (e.g., paintings, podcasts, videos, infographics) and work individually with their mentor and together as a cohort to develop and refine their individual projects. The projects are presented at the end of the semester-long fellowship program at the University's Undergraduate Research Conference, which is open to the public.

The Fellowship program has benefits for both the students and the mentors. Students become familiar with the process of conducting research through a unique avenue. They learn critical research skills such as identification a research question or challenge, independence and self-direction, problem solving, creativity, time management, communication with a mentor, and communication of research outcomes. They work within a multidisciplinary cohort, where they have an opportunity connect with leaders and students of various academic disciplines and see a myriad of perspectives on solving a grand challenge. Research mentors benefit from the program because it enables them to introduce an undergraduate to their research field and group without extensive training or time commitment. The mentors have obtained broader visibility of their research by using the produced communications pieces in grant proposals, research papers, presentations, websites, and other public avenues for knowledge sharing. The connections made between the students and their mentors are meant to last beyond the duration of the project and help the student further their academic careers. Most of the students from the first year's cohort are now working in the research lab of their mentor and/or organizing and mentoring the next year's cohort.

2.2. Logistics of Fellowship Program Operation

2.2.1. Fellowship Application and Selection Process

Program coordinators recruited mentors through email listservs and professional networks. Mentors included professors, graduate students, and working professionals who studied sustainable water resources. Water resources is a highly interdisciplinary and collaborative field. Mentor disciplinary backgrounds reflect the wide variety of skills and knowledge needed to solve this grand challenge, and include environmental and water resources engineering, biology, earth and planetary studies, law, journalism, economics, and geography. The majority of the mentors were affiliated with the University Grand Challenges program. Prospective mentors completed an online form that included name, department, a brief summary of research, and time commitment to mentorship (e.g., 1x/week, 2x/month, 1x/month).

Students were recruited via department and club email distribution lists, faculty presentations in classes, flyers posted around campus in buildings, dormitories, and other public spaces, and University social media pages. The advertisement included a brief description of the expectations of the fellowship, a link to the application, and indicated a $1000 participant stipend. Students completed an online application which asked for contact and bibliographical information including major/minor and academic classification, application track, a statement of interest, and how they heard about the program. Students could select from two tracks and write a statement of interest accordingly.

Track 1: A student new to research and interested in being paired with a mentor to learn and complete a communication project related to their work. The students were asked to look over the list of potential faculty mentors, provide a ranked list of their top 3 mentor choices, and write a 300-word statement about which people and/or projects were of interest to them and their ideas for a communication project.

Track 2: A student already working on water resources research and interested in building a communication project related to their own work. The students were asked to write a 300-word statement about what water resources research they were conducting, who their current faculty mentor was, why they were interested in applying for the fellowship, and their ideas for a communication project.

The application portal remained open for one month. Approximately 1/3 of the respondents indicated that they applied after having the Fellowship opportunity presented to them in one of their classes. The other 2/3 of the students applied after being told about the opportunity directly by a professor or peer.

In the first year of the GC WSC Fellowship, 12 applications were received, 12 offers were made, and 10 students accepted. In the first cohort, 8 students were from Track 1, and 2 students from Track 2. In the second year of the Fellowship, 19 applications were received, 15 offers were made, and 12 students accepted. In the second cohort, 11 students were from Track 1, and 1 student from Track 2. The students came from a wide variety of disciplines, including

civil and environmental engineering, mechanical engineering, environmental science, geography, biology, physics, statistics, computer science, economics, political science, psychology, communications and journalism. Most students chose mentors whose research field closely aligned with their majors or departments. The Fellowship coordinators attempted to prioritize matching students with mentors who shared similar interests, and disciplinary background was used as a secondary matching attribute. In some circumstances, for instance with a student who was interested in water resources concerns in Latin America, additional mentors who studied related research topics were recruited into the program. Students and mentors were notified of their selection into the program shortly after the application portal closed.

2.2.2. Semester-long Student Engagement

The GC WSC Fellowship program runs for one semester (approximately 12 weeks). Students attended an orientation at the first cohort meeting, where they were introduced to the program by the coordinators, participated in icebreaker, and reviewed semester schedule of events and deadlines. Table 1 shows the semester schedule for Spring 2023. Students did not meet individually with program coordinators. Students began meeting individually with their mentors following the first cohort meeting. In the first year of the program, the frequency and duration of individual meetings with mentors varied considerably by mentoring pairs. In the second year of the program, mentors and mentees were advised to meet weekly or biweekly, particularly in the front half of the program. Some mentors referred their mentees to additional experts to gather additional information or receive additional mentoring.

The student cohort met as a group weekly throughout the semester, usually for 30-60 minutes. During these meetings, students discussed with each other their progress, challenges and plans. Students drove the content of the meetings. Program coordinators attended some of the meetings, but most were conducted by students without supervision.

Students presented their finished or near-finished projects at a special Grand Challenges session of the University's Undergraduate Research Conference. Project presentations were 5-10 minutes long and featured students standing in front of an audience, showcasing their pieces, and giving an oral presentation about what they learned. Audience members included Fellowship student and mentors, key research personnel at the University (e.g., director of the Undergraduate Research, Arts and Design Network, Grand Challenges Operations Director, and peers, friends and family of the participants.

Table 1: Semester schedule of weekly activities for students to complete at cohort meetings

Week	**Activity**
1	First cohort meeting, introduce program, provide advice on how to set up first mentor meeting
2	Come to cohort meeting with a page of notes about what you learned from your mentor meeting, discuss what you learned about with your peers, determine follow-up questions that you need to ask your mentor
3	Introduction to science communication by program facilitators

4	Narrow down your notes to a specific project idea
5	First draft abstract for undergraduate conference, review and discussion
6	Second draft abstract, identify tasks needed to accomplish project, distill activities down into a 5-week schedule with milestones for each week
7	Submit abstract
8	Milestone 1, present update to cohort
9	Milestone 2, present update to cohort
10	Milestone 3, present update to cohort
11	Milestone 4, present update to cohort
12	Undergraduate Research Conference Complete project and present to cohort
13	End of semester celebration, invite all mentors

2.2.3. Resources and Personnel

Program coordination for the Fellowship requires time and effort from two faculty/staff and one student. Programmatic tasks include recruitment of mentors, advertisement and selection of student participants, setting weekly meetings for student cohorts, coordinating operations for the end-of-semester project showcase at the undergraduate research conference, and posting completed projects online for public viewing.

2.3. Fellowship Outcomes

In the first year of the Fellowship program, 10 science communication were produced. These include:

1. Painting: “Southwest Willow Flycatcher: How an Endangered Species can Help us Understand How to Conserve a Threatened Bosque Ecosystem” (Figure 1)
2. Charcoal sketches and timelapse video: “Drawing New Mexico’s Ecosystems” (Figure 2) [8]
3. Infographic: “Modeling the Santa Fe Watershed: not just water” (Figure 3) [9]
4. Photography: “The Nurturing of Paisaje del Agua” (Figure 4) [10]
5. Video: What is Terracing? [11]
6. Infographic: “Post-Wildfire Flooding in Ohkay Owingeh” [12]
7. Podcast: “Water Sustainability in Rivers” [13]
8. Podcast: “Nourishing our Riverlands” [14]
9. Video and poster: “Tó éí íiná át’é: Water is life”
10. ArcGIS Story Map: “Red River Mining Contamination” [15]

Four example projects are depicted in the figures below.

Figure 1: "Southwest Willow Flycatcher: How an Endangered Species can Help us Understand How to Conserve a Threatened Bosque Ecosystem." Painting and oral presentation by Kamryn Zachek on the mosaic patchwork conservation planning style for the Middle Bosque ecosystem. The bird depicted in the painting is a critically endangered species in the state of New Mexico which resides primarily in the Middle Bosque Ecosystem. The presentation discussed how conservation efforts are typically centered around endangered species, but the conservation style explored in this research regards this approach as a "quick fix" to a much larger issue. The research also states how lasting conservation of a species can only happen if their whole ecosystem is also conserved.

Figure 2: "Drawing New Mexico's Ecosystems." Charcoal sketches and timelapse videos by Will Crockett. The sketches and videos depict four of New Mexico's unique ecosystems, the organisms that live there, impacts of climate change, and the artist's experiences at the site. The sites include a mixed conifer forest that burned down after the Las Conchas fire (top left), a new mixed conifer site that was not burned down (top right), a piñon-juniper site that has been impacted by bark beetle infestation that could have occurred due to changing temperatures (bottom left), and a juniper savanna site where trees grow despite higher temperatures and lower precipitation rates (bottom right). [8] Links to YouTube videos [16], [17]: https://www.youtube.com/watch?v=OUaggTmiAhY and https://www.youtube.com/watch?v=VT49hzTKvGQ&t=7s

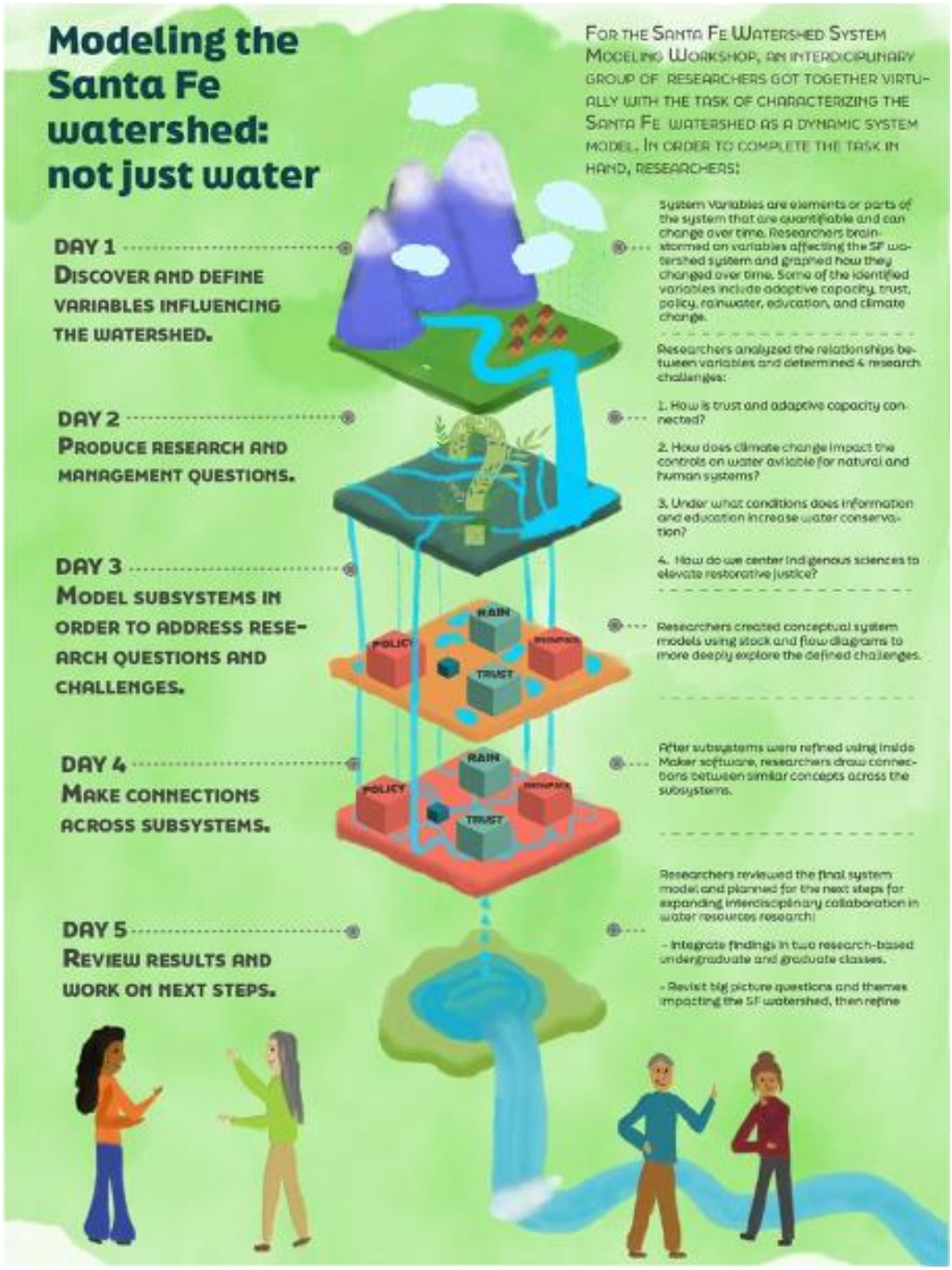

Figure 3: "Modeling the Santa Fe Watershed: not just water." Infographic and oral presentation by Constanza Kremer. The infographic illustrates the progression of the Santa Fe Watershed System Modeling Workshop hosted by the Sustainable Water Resources Grand Challenge and the Intermountain West Transformation Network, in which experts of diverse disciplines characterized the Santa Fe watershed system over five days. This piece was created to communicate the process and importance of implementing interdisciplinary work in water resources systems. [9]

Figure 4: "The Nurturing of Paisaje del Agua." Photography and Photoshop by Sa'angna Mi'ila Gollette. The photos show the effects on the role climate change has on traditional acequia systems in New Mexico. Acequias are a system of ditches or canals that are generally community-operated to carry water to irrigate distant fields and have been used to control and allocate water in drought-prone regions of New Mexico for centuries. The top left photo is of the Upper Rio Hondo Water Shed in Taos Ski Valley, New Mexico, showing an original view of a healthy flowing stream as it surrounded by snowfall. The top right photo shows the artist's hypothesized rendering of the beginning effects of soil erosion leading to destruction of sediment that will cause both an abnormal flow of water and a change of habitat for microorganisms living in the watershed. The bottom left photo is of the Lower Rio Hondo Watershed in Arroyo Hondo, New Mexico, showing a healthy flow of water with a diverse amount of vegetation cover. The bottom right photo shows the artist's hypothesized rendering of loss of stream power flow, shrinkage of flow zone, and beginning stages of sedimentation. [10]

Students presented their communications pieces at the end of the semester during a special Grand Challenges session of the University's Undergraduate Research Conference. A news article on the fellowship and conference session was shared on the front page of the University's virtual newsroom and has been viewed over 300 times between April 2022 and February 2023. [18] Student projects were shared and archived in two online spaces- the Southwest Environmental Finance Center website and the Undergraduate Research Arts and Design Network website. [19], [20]

Student participants in the program have gone on to apply to graduate school (n=2), participate in the McNair Scholars Program (n=1), or continued working with their research mentor (n=3). Quotes from select participants in the fellowship program are included below:

"*I'm so glad I did the grand challenges in sustainable water resources. I had a lot of fun with my cohort and I learned a ton about riparian restoration from the interviews I did for my podcast. In doing my project, I got the opportunity to interview [name redacted], a professor in water resources who I highly respect and wished I could work with. As a result, he emailed me over the summer out of the blue and offered me a job making podcasts for his multi-million dollar project building water sustainability in the western United States! I can now say that, thanks to the Grand Challenges, I am paid to make a weekly podcast called the Transformation Network Podcast."*

"When I was considering applying for Grand Challenges, I figured it would look good on a resume and serve as a relatively easy way to make some extra cash. What I got out of this program was so much more than I ever expected. The coordinators really cared about my peers and I and wanted us to succeed, it was obvious from how hands-on and supportive they were from beginning to end. I have always wanted to become a lawyer, and because of Grand Challenges I was able to make lasting connections with prominent figures at the local law school who continue to advise me on my academic journey to this day. Also, the painting I did based on my mentor's research last year now hangs in the University's law school! Since the conclusion of last year's project, I have continued to stay involved with the Fellowship now acting as Student Lead to this year's cohort."

"Grand Challenges helped me to connect and explore my artistic side. As a student in STEM, I tend to forget art as a part of my life or as a part of science, but Grand Challenges made me realize that it doesn't have to be that way. Art is a great way to communicate a message and transmit emotion, and I think that using art as a tool for science communication is an excellent way to bring science to a broader audience. We often think the two fields are completely separate and unrelated, but they are not. Art is able to take a complex topic and create something appealing, while making people reflect in scientific topics that are usually hard to explain in simple words. With Grand Challenges, I had the opportunity to also learn about some of UNM's faculty research. During the workshop led by [name redacted]and [name redacted], I got to see how interdisciplinary and collaborative work looks like, and to participate in interesting discussions about water and water resources systems. As a result, I have applied some of the experience I gained, to help organize an interdisciplinary workshop as part of my work with [name redacted]in Atmospheric Water Harvesting. Ultimately, Grand Challenges opened doors for me with experiences I haven't explored before."

2.4. Work in Progress: Fellowship Year 2

The GC WSC Fellowship Program is currently in its second year with a new cohort of students. The organizers aimed to create a more formalized method to evaluate the program's impact on student participants. A survey was created to measure students' research identity and self-efficacy pre- and post- program involvement. (Appendix I) This assessment tool was developed from the University's Expanding Course-Based Undergraduate Research Experiences (ECURE) Impact Assessment and adapted to fit the needs of this program. [21] Questions aim to explore 1) participants' previous research and research communication experiences, 2) their identity as a researcher, 3) their research self-efficacy, 4) their perception of water research interdisciplinarity, and 5) their intent to persist in research. Construct questions were adapted for our interdisciplinary context from published survey methods on research identity, research self-efficacy, and intent to persist in research. [22]–[27]

For the purpose of the survey, we defined research as investigating a question or problem where no one (including your instructor or other researchers) is certain what the answer will be or should be. Participation with research can be individual (where you independently investigate the question or problem), or social (where you collaborate with others, possibly including instructors and peers within your school or major).

The pre-survey was administered to all fellows on an online platform through Qualtrics at the start of the semester. The survey is under review by the University's Institutional Review Board. Fellows will take the same survey at the end of the semester, after they have presented their projects to the public at UROC. We will be able to connect pre- and post- program surveys to evaluate the program's impact on student's research identity and self-efficacy. The 2022-2023 cohort is completing their water science communication projects, and therefore we will not have post-program survey data until May 2023.

3.0. Communication Fellowship Program Scalability

In a recent Sustainable Water Resources Grand Challenge internal impact survey of 17 respondents who participated in the program as either faculty mentors or students, a majority indicated that participation furthered goals of the Grand Challenges program such as extending research and strengthening the reputation of the University's research and undergraduate programs. Most respondents also indicated that the program increased interdisciplinarity, created new or stronger collaborations, and strengthened relationships with non-academic stakeholders.

The GC WSC Fellowship Program can be replicated and scaled to other multi- and trans-disciplinary research programs to involve early-stage undergraduate students in research and highlight research outcomes to key stakeholders and the general public. Future programs can incorporate community partners to form triads of students-researchers-stakeholders. This will enable students and mentors to integrate and highlight perspectives of stakeholders within their communications pieces and empower community knowledge keepers with tools to facilitate discussion with their community members.

Funding for communications fellowships programs may be obtained from within the University through multi-disciplinary collaboration initiatives such as Grand Challenges Programs, as well as externally from state or national arts endowments. The program has a relatively low operating cost ($1000 per participant; $10,000 for a cohort of 10 students) and leads to outsized outcomes beyond the university scale. The impact and reach of such a program can lead to new interdisciplinary collaborations, avenues for students to connect the arts and science in their degree programs, connections with local artists and community members, and connections with local, state and federal legislatures.

Acknowledgements

Funding for this work was provided by the University of New Mexico Grand Challenge on Sustainable Water Resources.

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Appendix I: Survey Instrument

Welcome to the Grand Challenge Water Science Communication Fellowship! We are excited to be a part of the beginning of your research journey. You are being asked to take a survey at the start and end of the program so that we can better understand the program's impact on your research identity and self-efficacy.

We understand that it is likely you do not have any previous research experience. Please know that will not impact your success in this program, and we are excited to have you!

For this purpose, research means investigating a question or problem where no one (including your instructor or other researchers) is certain what the answer will be or should be. Participation with research can be individual (where you independently investigate the question or problem), or social (where you collaborate with others, possibly including instructors and peers within your school or major)

To connect your survey responses before and after you participate in the program, we ask that you create a self-identification code. Please provide the last 5 digits of your UNM ID.

Section 1: Your Past Experiences Conducting Research

We would like to hear about any of your past experiences conducting research. Do not worry if you do not have previous experience.

1. Describe a prior experience you have had CONDUCTING research prior to this semester, either in college or high school. What was the goal of the research? What did you do? What course was this in? If you have had no such experiences, please write NONE in the box, and skip to the next page.

2. How important or unimportant was the research that you described...

	Very unimportant	Unimportant	Somewhat unimportant	Neither unimportant nor important	Somewhat important	Important	Very important
…to other researchers	○	○	○	○	○	○	○
…to solving problems that matter to you?	○	○	○	○	○	○	○

3. How responsible or not responsible did you feel…

	Not responsible at all	Not responsible	Somewhat not responsible	Neither responsible nor not responsible	Somewhat responsible	Responsible	Very responsible
…for the outcomes of the research that you described?	○	○	○	○	○	○	○
…for coming up with your own ways to make progress on the research that you described?	○	○	○	○	○	○	○

Section 2: Your Research Communication Experience

We are interested in hearing about your previous research communication experience. Do not worry if you do not have previous experience.

4. Describe a prior experience you have had COMMUNICATING research to your peers, your family or your communities. The research you communicated could be yours or that of another researcher. If you have had no such experiences, please write NONE in the box, and skip to the next page.

5. In the experience you described, how active or passive was your role in planning/directing the communications and selecting the medium (i.e., essay, podcast, video, poster), where very passive means carrying out instructions given to you by someone else? Leave blank if you have not had such an experience.

Very passive	Passive	Somewhat passive	Neither passive nor active	Somewhat active	Active	Very active
○	○	○	○	○	○	○

6. How important or unimportant was the research communication project that you described...

	Very unimportant	Unimportant	Somewhat unimportant	Neither unimportant nor important	Somewhat important	Important	Very important
to other researchers	○	○	○	○	○	○	○
to solving problems that matter to you?	○	○	○	○	○	○	○

7. How responsible or not responsible did you feel…

	Not responsible at all	Not responsible	Somewhat not responsible	Neither responsible nor not responsible	Somewhat responsible	Responsible	Very responsible
for the outcomes of the research communication project that you described?	○	○	○	○	○	○	○
for coming up with your own ways to make progress on the research communication project that you described?	○	○	○	○	○	○	○

Section 3: Your Identity as a Researcher

We are interested in learning more about your identity as a researcher.

8. How important or unimportant is…

	Very unimportant	Unimportant	Somewhat unimportant	Neither unimportant nor important	Somewhat important	Important	Very important
being a researcher to your self image?	○	○	○	○	○	○	○

9. How strong or weak is your…

	Very weak	Weak	Somewhat weak	Neither weak nor strong	Somewhat strong	Strong	Very strong
sense of belonging to a community of researchers?	○	○	○	○	○	○	○

10. How much or little do you perceive yourself as…

	Very little	Little	Somewhat little	Neither little nor some	Somewhat much	Much	Very much
a researcher right now?	○	○	○	○	○	○	○
being integral to the research process?	○	○	○	○	○	○	○
being a future researcher?	○	○	○	○	○	○	○

11. How confident or unconfident are you that you can…

	Very unconfident	Unconfident	Somewhat unconfident	Neither unconfident nor confident	Somewhat confident	Confident	Very confident
effectively communicate research to the general public?	○	○	○	○	○	○	○
use technical skills (use of tools, instruments, and/or techniques of your field of study) to do research?	○	○	○	○	○	○	○
generate a research question to answer?	○	○	○	○	○	○	○
figure out which data/ observations to collect and how to collect them?	○	○	○	○	○	○	○
explain the analysis results?	○	○	○	○	○	○	○
use academic literature to guide your research?	○	○	○	○	○	○	○
speak publicly to a broad audience?	○	○	○	○	○	○	○
communicate with professors/ faculty researchers?	○	○	○	○	○	○	○
Communicate with professionals in their field e.g., water managers, scientists, lawyers, etc.?	○	○	○	○	○	○	○
communicate with your research peers and fellow students?	○	○	○	○	○	○	○

Section 4: Your Perception of Water Research

We would like to hear about your perception of water research.

12. How much or little do you see these fields have a role in water resources research?

	Very little	Little	Somewhat little	Neither little nor some	Somewhat much	Much	Very much
Biology	○	○	○	○	○	○	○
Chemistry							
Communications							
Community, Regional and Urban Planning							
Economics							
Education							
Engineering							
Environmental sciences							
Geography							
Law and policy							
Mathematics							
Physics							
Political science							
Public health							

Section 5: Your Future Plans

We would like to hear about your future plans.

13. What is your current or intended major?

14. Do you have a minor, specialization, or concentration? If so, please enter it below.

15. At this moment in time, how certain or uncertain are you that…

	Very uncertain	Uncertain	Somewhat uncertain	Neither uncertain nor certain	Somewhat certain	Certain	Very certain
you will earn a degree in your current or intended major?	○	○	○	○	○	○	○

16. How strong or weak is your intention to persist in…

	Very weak	Weak	Somewhat weak	Neither weak nor strong	Somewhat strong	Strong	Very strong
your pursuit of your current or intended degree?	○	○	○	○	○	○	○
courses that include research experiences?							
a research experience, such as a summer program or working in a faculty or national lab?							

17. Do you think participating in a research experience is beneficial to you? Why or why not?

Section 6: Your Approach to Research

We would like to hear about your approach to research.

18. Imagine that you collected data based on your research question and conducted analysis. However, your results don't make sense. A professor whose research is related looks over your work and provides very critical feedback, including reference to your "lack of understanding" and "poorly described procedure," but also provides suggestions. You want to have an excellent research experience because you have clear career goals and you don't want to disappoint your family. Based on the scenario above, how likely or unlikely would you be to...

	Very unlikely	Unlikely	Somewhat unlikely	Neither likely nor unlikely	Somewhat likely	Likely	Very likely
work harder?	○	○	○	○	○	○	○
keep trying?	○	○	○	○	○	○	○
use the feedback to improve your work?	○	○	○	○	○	○	○
just give up?	○	○	○	○	○	○	○
think more about your strengths and weaknesses to help you work better?	○	○	○	○	○	○	○
give yourself encouragement?	○	○	○	○	○	○	○

seek encouragement from your family and friends?	○	○	○	○	○	○	○
try different ways to solve the problem?	○	○	○	○	○	○	○
feel everything was ruined and was going wrong?	○	○	○	○	○	○	○
begin to think your chances of success doing research were poor?	○	○	○	○	○	○	○
get depressed?	○	○	○	○	○	○	○
be disappointed?	○	○	○	○	○	○	○

19. Imagine that you presented a poster or talk on your research at a public undergraduate conference. The audience asked you insightful questions after your presentation and gave you feedback on future research you could explore. At the end of the conference, the Director of undergraduate research came up to you and personally congratulated you on your achievement. They asked if you were interested in continuing research and applying for a future graduate fellowship. Based on the scenario above, how likely or unlikely would you be to...

	Very unlikely	Unlikely	Somewhat unlikely	Neither likely nor unlikely	Somewhat likely	Likely	Very likely
work harder?	○	○	○	○	○	○	○
keep trying?	○	○	○	○	○	○	○
use the feedback to improve your work?	○	○	○	○	○	○	○
just give up?	○	○	○	○	○	○	○
think more about your strengths and weaknesses to help you work better?	○	○	○	○	○	○	○
give yourself encouragement?	○	○	○	○	○	○	○
seek encouragement from your family and friends?	○	○	○	○	○	○	○
try different ways to solve the problem?	○	○	○	○	○	○	○

feel everything was ruined and was going wrong?	○	○	○	○	○	○	○
begin to think your chances of success doing research were poor?	○	○	○	○	○	○	○
get depressed?	○	○	○	○	○	○	○
be disappointed?	○	○	○	○	○	○	○

20. Is there anything else you would likely to share before submitting your survey?