

Summative Report on NSF-Funded Graduate Traineeship in Rural Resource Resiliency: Program Description, Evaluation, and Insights

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Abstract

The NSF Research Traineeship (NRT) program at Kansas State University is dedicated to enhancing graduate STEM education through a convergence traineeship model that integrates hands-on curriculum, interdisciplinary research, professional skills development, and mentoring. In 2018, we received close to \$3 million funding from NSF to develop and launch a graduate traineeship in rural resource resiliency for food, energy and water (FEW) systems. Since 2018, the NRT at Kansas State University has trained 40 diverse, culturally competent STEM graduate students (doctoral and master's), to do interdisciplinary research, understand FEW stakeholders, communicate effectively to diverse audiences, and understand their potential vocational pathways, including government, academia, and industry.

The NRT program incorporated educational and experiential activities such as field experience, policy experience at the state capital, applied course work, interdisciplinary research projects, faculty and peer mentoring, professional development, and periodic assessment of these activities. The NRT developed and offered three courses: a one-credit-hour cross-listed course, Integrated FEW Systems, a two-credit-hour cross-listed NRT Capstone course, and a 0-credit NRT Seminar. The Integrated FEW Systems course introduced students to systems thinking, with specific application to the FEW nexus in Southwest Kansas. The NRT Capstone was a project-based course where students worked in interdisciplinary teams on FEW related research projects. The NRT Seminar consisted of training sessions related to team collaboration, career pathways, campus resources, professional development, science communication, and exposure to FEW research initiatives.

This paper details the graduate-level NRT activities with focus on educational activities including activities description, summative evaluation, and insights gained from four NRT student cohorts. Evaluation findings show the NRT is an inclusive, supportive, applied curriculum that enabled 40 graduate students to train as interdisciplinary researchers. This paper provides insights to current and future NRT programs, as well as other new interdisciplinary programs, to help them pursue elements of the NRT program that are most effective.

Introduction

As academic departments often work in silos, there are fewer opportunities for graduate students from different departments to interact and gain the skills needed for interdisciplinary research. Interdisciplinary teams have several benefits such as investigating complex research questions, addressing social problems, and having increased productivity [1] [2]. The National Science Foundation (NSF) has funded interdisciplinary training at the graduate student level through its NSF Research Traineeship (NRT) program since 2013 [3]. The NRT promotes training to engage STEM graduate students in cross-disciplinary teams and prepare them for different career pathways. As part of NSF's engagement in the Food, Energy, and Water (FEW) nexus and in recognition of the need for graduate students skilled in developing resilient FEW systems in rural communities, the NSF funded the NRT in the FEW nexus program at Kansas State University, Preparing Future Leaders: Rural Resource Resiliency.

Since 2018, the NRT at Kansas State University has trained 40 STEM graduate students, as shown in table 1. The NRT students have been master's and doctoral students from the College of Engineering, the College of Arts and Sciences, and the College of Agriculture. The NRT included educational and experiential activities [4] [5] [6]. This paper gives insights into the six years of the NRT activities with a focus on the educational activities including activities description, summative evaluation, and insights gained from four NRT cohorts.

Table 1: NRT Cohorts

NRT Cohort	# of students	Women	Members from historically excluded groups (e.g. Black, Hispanic, Native American)
2019-2020	16 (11 PhD, 5 MS)	8/16	1/16
2020-2021	7 (4 PhD, 3 MS)	4/7	4/7
2021-2022	8 (5 PhD, 3 MS)	3/8	3/8
2022-2023	9 (1 PhD, 8 MS)	3/9	3/9
Total	40	18/40 (45%)	11/40 (27.5%)

Positionality of the author team

The author team is an interdisciplinary team and includes faculty, administration, and staff from the Colleges of Engineering, Agriculture, and Arts and Sciences. The author team includes five people who identify as women. Two of these women are engineers, one is an educator, and two are social scientists. The author team also includes five people who identify as men. Three of these men are engineers, and two of these men are social scientists. As such, we have first-person experiences that allow us to relate to the experiences of women and men studying in STEM fields. Moreover, four of the authors hold dual citizenship and have first-person experiences that allow us to relate to being an outsider. The author team has been involved in the development, implementation, and evaluation of the NRT program and is committed to improving graduate student experiences. All team members have research and education experiences in the FEW nexus.

Description of the NRT program at our university

The NRT applied coursework included a one-credit-hour Integrated FEW Systems course and a two-credit-hour NRT Capstone course. Both courses were cross-listed and co-taught by faculty

from the Colleges of Engineering, Agriculture, and Arts and Sciences. The Integrated FEW Systems course was offered every fall semester from 2019 to 2022. In this course, students were introduced to systems-level thinking with specific application to the FEW nexus in Southwest Kansas through class discussion, lectures, guest speakers, readings and assignments [6]. The systems framework was introduced through the book, *The Macroscopic* [7], and students used LOOPY [8], an interactive tool for thinking in systems, to build simulations of engineering and social aspects of FEW systems in Southwest Kansas. Course materials integrated engineering, economics, and social sciences, with a focus on the challenges for management, governance, communication, and policy in rural agricultural contexts.

The two-credit-hour NRT Capstone was offered in spring 2021 and spring 2023. In the NRT Capstone course, students built upon the systems thinking framework taught in the Integrated FEW Systems course. The NRT Capstone integrated theory and practice and students worked in interdisciplinary teams on FEW related research projects [5]. For a final capstone product, students completed an original interdisciplinary research paper in one of the NRT research themes: innovations for soil in the face of drought; hydrologic science and water conservation systems for efficient food production; and anaerobic bioreactors to transform animal waste into usable energy, water, and/or fertilizer.

For students' professional development, the NRT offered a 0-credit-hour seminar series on a Credit/No Credit basis in the fall and spring semesters (10 semesters total), which included eight sessions (twice a month) each semester. Students completed up to four semesters of NRT Seminar. The NRT Seminar consisted of training sessions related to inclusion, career pathways, campus resources, science communication, and exposure to FEW research initiatives. Internal and external guest speakers led the seminars. Students completed a reflection activity after each seminar session. To receive credit for the NRT Seminar, students completed six, out of eight, reflection activities and a required science communication activity.

To understand the interdisciplinary nature of FEW resource challenges in rural communities, and to learn how to communicate effectively with FEW stakeholders, students spent time in the summer with FEW stakeholders. In summer 2020, NRT trainees engaged with FEW stakeholders from Kansas and FEW scholars via Zoom. In summer 2021, NRT students visited a research farm and an irrigation district in Northeast Kansas, where they met with the farm manager and the irrigation district manager. In summer 2022, NRT trainees traveled to Southwest Kansas, where they met with FEW stakeholders and visited a livestock farm, a dairy farm, and a wastewater treatment plant that uses anaerobic digester to convert wastewater to biogas. The field experiences were organized in the summer to avoid conflicts with students' course schedules, academic breaks and producers harvesting or planting times. Transportation to the field sites and back was provided from the Kansas State University campus.

To explore different career pathways, the NRT leadership team established a team-based faculty and peer mentoring model to provide vocational counseling and career planning for NRT students to pursue industry, government, and academia positions [9]. The interdisciplinary team-based faculty mentoring included development of Individual Development Plans (IDPs) with NRT students [10]. Each mentoring group had three faculty members from at least two disciplines. The IDP included skills assessments, short-term and long-term career goals. As part

of their IDP, students and faculty identified critical skills to be developed, activities that could develop those skills, and target dates to achieve those skills. In addition, NRT students participated in monthly peer mentoring groups to respond to a monthly prompt to develop leadership skills, team building, and their academic and professional goals.

Evaluation: Identifying and Measuring Intended Outcomes of the NRT Program

An external evaluator worked collaboratively with the NRT leadership team to support continuous program improvement. Data collection activities were designed to provide insight into how NRT student experiences compared with intended outcomes identified by NRT leaders when they designed the program. Regular, formative evaluation feedback helped NRT leaders shape the program so that it more effectively trained current and incoming graduate students.

An annual NRT trainee survey elicited students' feedback about their experiences with the NRT program and the different NRT activities. Students from all four cohorts, between 2019 and 2022, completed the survey after their fall semester courses. Most students from each cohort responded to the annual NRT trainee survey with a response rate as shown in Table 2 of 69% in 2019-2020, first cohort, 75% in 2020-2021 and 2021-2022, second and third cohorts, and 85% in 2022-2023, fourth cohort. To elicit student feedback about their experiences with the NRT Capstone course, the external evaluator administered a survey to students at the end of the course when it was offered in spring 2021 and 2023 with response rates as shown in Table 2 of 88% and 85% respectively.

Table 2: Surveys' Response Rate

Data Collection Instrument	Eliciting Feedback about Student Experience	Response Rate
Annual NRT Student Survey	Fall 2019 NRT program	69%
	Fall 2020 NRT program	75%
	Fall 2021 NRT program	75%
	Fall 2022 NRT program	85%
Capstone Post-Course Survey	Spring 2021 course experience	88%
	Spring 2023 course experience	85%

At the closing of each survey, the evaluator downloaded response data from Qualtrics survey software to Microsoft Excel and analyzed them. Average rating scores and bar charts were created to support discussions with the NRT leadership team. These co-interpretation sessions were held to improve validity of the analysis by adding context about what was happening in the classroom and in the field [11]. Co-interpretation also supported NRT program planning and decision-making to improve student experiences. For this paper, tables for the NRT Integrated FEW Systems course (Table 3), the NRT Capstone (Table 4), and the NRT Seminar (Table 5), summarize data about skills development from each of the four cohorts. To examine if changes in abilities were significant from before to after NRT interventions, a *t*-test, *p* (cohort), for each of the four cohorts and *p* (all cohorts) were performed for a summative significance. Bar graphs (Figures 1-4) show ratings from students in the four cohorts for the whole NRT program and for the usefulness of various course activities in the NRT program for preparing them to carry out

interdisciplinary research, communicating with diverse audiences, and exploring different career paths.

How well did the NRT program support trainees' interdisciplinary research skills development?

Evaluation results, described in this section, offer evidence that KSU NRT provided students with the support they needed to develop interdisciplinary research skills. This evidence came from students' overall rating of the program, described below. Following this is a report of students' self-ratings of their gains in interdisciplinary research skills through all three NRT courses.

We asked NRT students to give the whole NRT program a grade for supporting their development of five skills, where a grade of 'F' is 1 point, and a grade of 'A' is 5 points. The five different skills are 1. Communication with audiences from different academic disciplines and the public 2. Understanding FEW stakeholders 3. Identify potential research partnerships 4. Interdisciplinary teamwork, and 5. Understand potential career pathways: government, academia, industry. Then we calculated the mean student rating for each skill. Figure 1 offers a summative depiction of student ratings for how well the NRT program supported development of the five skills. All cohorts rated the NRT program similarly for each skill, with a grade at or near 4.0, which is a 'B'. These results indicate that the NRT program provided support for students' skills development to carry out high quality interdisciplinary research, communicating with diverse audiences, understanding FEW stakeholders and understanding potential career pathways.

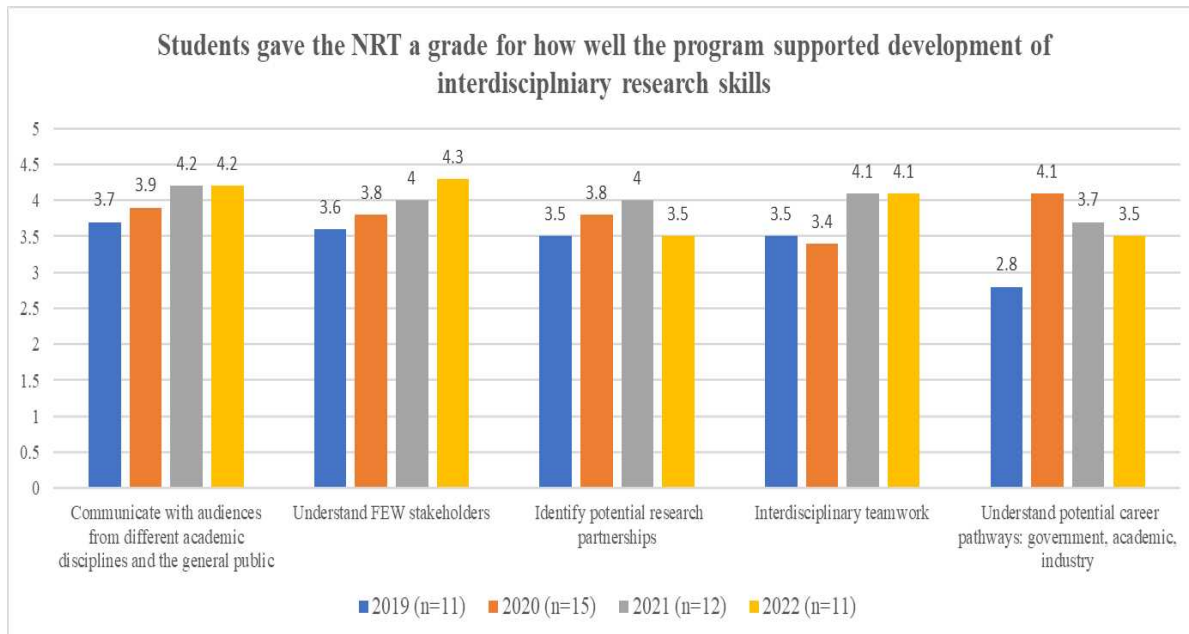


Figure 1: Student NRT grades for evaluation of the NRT program in support of trainees' development as interdisciplinary scholars

For the Integrated FEW Systems course, the NRT Seminar and the NRT Capstone, we asked students to rate their ability to perform a short list of skills before and after participating in the activity. Survey respondents selected ratings from a five-point scale: 1=not at all able, 2=a bit able, 3=somewhat able, 4=very able, 5=extremely able. To identify significant advancement in skills we calculated averages from before and after skill ratings and then calculated change. Standard deviations were at or less than 1.3 rating point, indicating that response variations were low.

For the Integrated FEW Systems (Table 3), students rated their ability to perform seven key tasks: 1. Collaborate on interdisciplinary teams 2. Communicate scientific, disciplinary knowledge to diverse audiences 3. Communicate across disciplinary boundaries 4. Be aware of diverse perspectives of FEW stakeholders 5. Conceptualize key FEW systems' elements, links, processes, and dynamics 6. Use narrative and visual tools to interpret FEW systems, and 7. Collaborative diagnose FEW systems challenges. For the NRT seminar (Table 4), students rated their ability to perform six key tasks: 1. Identify potential research partnerships 2. Communicate research in a succinct manner 3. Articulate how research can become interdisciplinary 4. Cooperate on an interdisciplinary team 5. Present research to a diverse audience, including stakeholders and other scholars, and 6. Identify possible career paths before and after participating in the NRT Seminar series. For the NRT Capstone (Table 5), we asked students to assess their ability to perform a short list of three key tasks: 1. Write a literature review 2. Produce research products, and 3. Work in interdisciplinary teams. They rated their abilities using a scale of 1=not at all able, 2=a bit able, 3=somewhat able, 4=very able, 5=extremely able.

Table 3: Students' perceived gains in seven abilities to carry out interdisciplinary systems tasks improved from before to after participating in the NRT Integrated FEW Systems course (self-report from four NRT trainee cohorts, 2019 to 2022)

Skill	Cohort	M before	M after	p(cohort)	p(all cohorts)
Collaboratively diagnose FEW system challenges	2019 (n=11)	2.6	3.6	0.00	0.00
	2020 (n=6)	2.2	3.8	0.00	
	2021 (n=7)	2.4	3.7	0.00	
	2022 (n=6)	1.8	4.0	0.00	
Communicate across disciplinary boundaries	2019 (n=11)	2.9	3.7	0.02	0.00
	2020 (n=6)	2.7	3.7	0.01	
	2021 (n=6)	3.0	4.0	0.04	
	2022 (n=6)	2.7	3.8	0.08	
Be aware of the diverse perspectives of FEW stakeholders	2019 (n=11)	2.8	3.6	0.03	0.00
	2020 (n=6)	2.0	3.5	0.02	
	2021 (n=7)	2.7	3.9	0.00	
	2022 (n=6)	2.0	3.7	0.05	

Use narrative and visual tools to interpret systems from multiple perspectives	2019 (n=11)	2.6	3.5	0.03	0.00
	2020 (n=6)	2.3	3.3	0.01	
	2021 (n=7)	2.7	3.7	0.00	
	2022 (n=6)	2.5	4.0	0.04	
Conceptualize key FEW system elements, links, processes, and dynamics	2019 (n=11)	2.7	3.6	0.00	0.00
	2020 (n=6)	2.5	3.7	0.03	
	2021 (n=7)	2.9	4.1	0.00	
	2022 (n=6)	2.3	4.0	0.00	
Communicate scientific, disciplinary knowledge to diverse audiences	2019 (n=11)	2.9	3.5	0.02	0.00
	2020 (n=6)	3.0	3.7	0.10	
	2021 (n=7)	3.0	4.1	0.03	
	2022 (n=6)	2.0	3.7	0.05	
Collaborate on interdisciplinary teams	2019 (n=11)	3.2	3.8	0.05	0.00
	2020 (n=6)	2.2	3.8	0.00	
	2021 (n=6)	2.8	3.8	0.04	
	2022 (n=6)	3.5	4.3	0.22	

Table 4: Students' perceived gains in six abilities to carry out interdisciplinary work and science communication tasks improved from before to after participating in the NRT Seminar (self-report from four NRT trainee cohorts, 2019 to 2022)

Skill	Cohort	M before	M after	p(cohort)	p(all cohorts)
Identify potential research partnerships	2019 (n=11)	2.5	3.6	0.00	0.00
	2020 (n=15)	2.7	3.6	0.00	
	2021 (n=11)	2.5	3.4	0.00	
	2022 (n=11)	2.5	3.2	0.04	
Communicate your research in a succinct manner	2019 (n=11)	2.9	3.6	0.02	0.00
	2020 (n=15)	3.4	4.1	0.00	
	2021 (n=11)	3.2	3.9	0.00	
	2022 (n=11)	2.7	3.7	0.01	
Articulate how your research can become interdisciplinary	2019 (n=11)	3.2	3.8	0.01	0.00
	2020 (n=15)	2.6	3.7	0.00	

	2021 (n=11)	2.9	3.7	0.02	
	2022 (n=11)	2.9	3.7	0.03	
Cooperate on an interdisciplinary team	2019 (n=11)	3.0	3.7	0.04	0.00
	2020 (n=15)	3.2	3.8	0.02	
	2021 (n=11)	3.2	3.8	0.03	
	2022 (n=11)	3.4	3.7	0.31	
Presenting research to a diverse audience, including stakeholders and other scholars	2019 (n=11)	2.9	3.6	0.04	0.00
	2020 (n=15)	3.2	3.9	0.00	
	2021 (n=11)	3.2	3.9	0.00	
	2022 (n=11)	3.4	3.7	0.00	
Identify possible career paths	2019 (n=0)	NA	NA	NA	0.00
	2020 (n=15)	3.3	3.8	0.00	
	2021 (n=10)	3.8	4.0	0.34	
	2022 (n=11)	3.5	4.2	0.03	
NA=no data was collected in 2019 for this factor.					

Table 5: Students' perceived gains in three abilities to carry out interdisciplinary research tasks improved from before to after participating in the NRT Capstone course (self-report from spring 2021 and spring 2023)

Skill	Cohort	M before	M after	p _(cohort)	p _(all cohorts)
Write a literature review	2021 (n=14)	3.6	4.0	0.01	0.00
	2023(n=12)	3.6	4.3	0.01	
Produce research products	2021 (n=14)	3.3	3.9	0.01	0.00
	2023 (n=12)	3.4	4.0	0.05	
Work in interdisciplinary teams	2021 (n=14)	2.9	4.0	0.00	0.00
	2023 (n=12)	3.7	4.2	0.08	

Survey results that are shown in Tables 3, 4, and 5 above indicate that NRT students across the four cohorts advanced in their ability to do interdisciplinary work, communicate with diverse audiences, understand FEW stakeholders, and understand potential career pathways from before (retrospectively [12]) to after participating in NRT activities with a few exceptions shown in gray-highlighted area, these gains were statistically significant, p (cohort). Moreover, the summary statistics and p (all cohorts) show significance for each skill, suggesting little variation among cohorts for this skill building.

The usefulness of NRT program activities

Evaluation results also showed that NRT students thought the activities in the NRT program were useful for preparing them to carry out interdisciplinary work, understanding FEW stakeholders, communicating effectively to diverse audiences, and understanding their potential vocational pathways. To this end, we asked students about the usefulness of activities in the Integrated FEW Systems course, the NRT Seminar, and the NRT Capstone.

For the NRT Integrated FEW Systems course, the NRT Seminar, and the NRT Capstone, students rated a list of course activities on a scale of 1=not at all useful, 2=a bit useful, 3=somewhat useful, 4=very useful, 5=extremely useful.

The most useful activities from the Integrated FEW Systems course had to do with the Systems map, class discussion, guest speakers, faculty lectures, and trainee presentations (Figure 2). It is worth noting that not all four cohorts experienced all course activities. That is, the fourth cohort did not experience trainee presentations, as all trainees were master's students in their first semester, more time was allocated to class activities.

Activities from the NRT Seminar that students found most useful had to do with presentations (Figure 3). More than 60% of survey respondents indicated that the science communication presentation and practice was 'very' or 'extremely' useful. Similarly, more than 50% indicated that presentations about careers and other guest presentations were 'very' or 'extremely' useful. As before, not all four cohorts experienced the same activities. Students in the first cohort were involved in seminar planning by suggesting seminar topics and scheduling guest speakers. From the annual survey results, we learned that students liked to provide input about seminar topics but did not want to take part in scheduling guest speakers. As a result, since then, the NRT Coordinator and/or NRT faculty scheduled the guest speakers with trainee input on seminar topics. Another change was the elimination of the 3-minute thesis challenge activity from this early semester in students' studies, because they do not have sufficient research results to share [13]. In addition, the fourth cohort of NRT trainees participated in podcasting training after NRT leadership learned, through seminar reflection activity, there was an interest in podcasting.

Moreover, students thought that most NRT Capstone course activities were quite useful (Figure 4). More than 80% of survey respondents indicated that working in interdisciplinary teams was 'very' or 'extremely' useful. At least 40% rated almost all other activities as 'very' or 'extremely' useful.

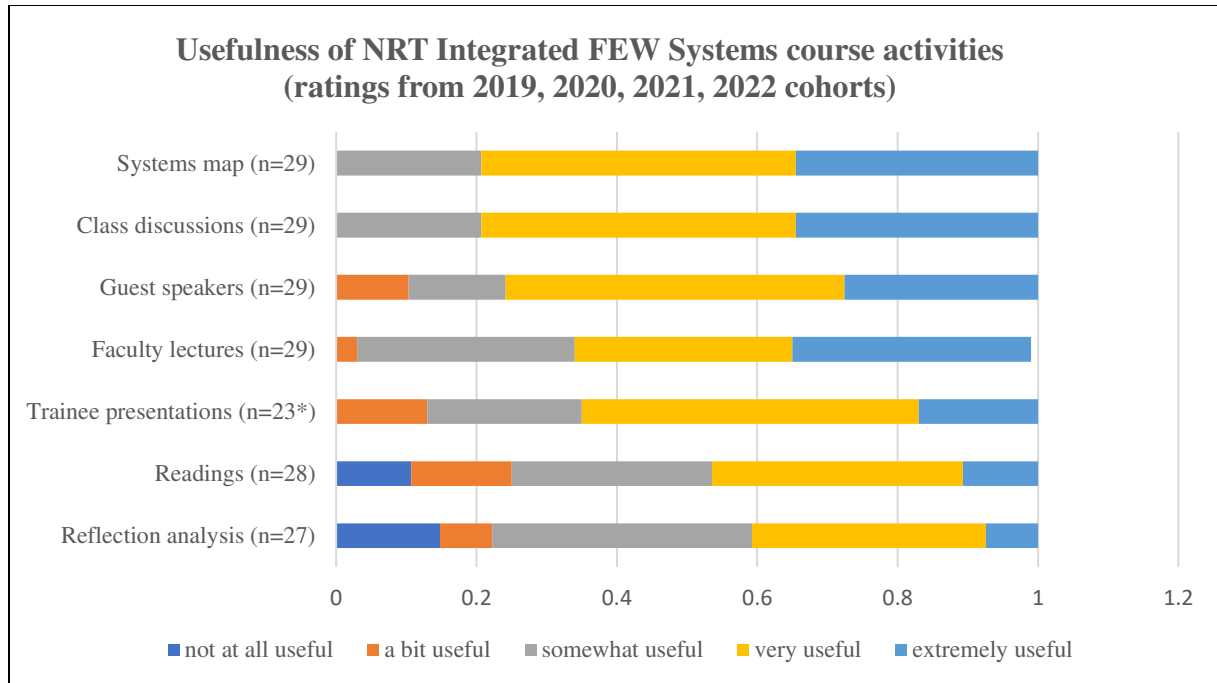


Figure 2: Student ratings of the usefulness of the NRT Integrated FEW Systems course activities. Ratings from four cohorts, 2019-2022.

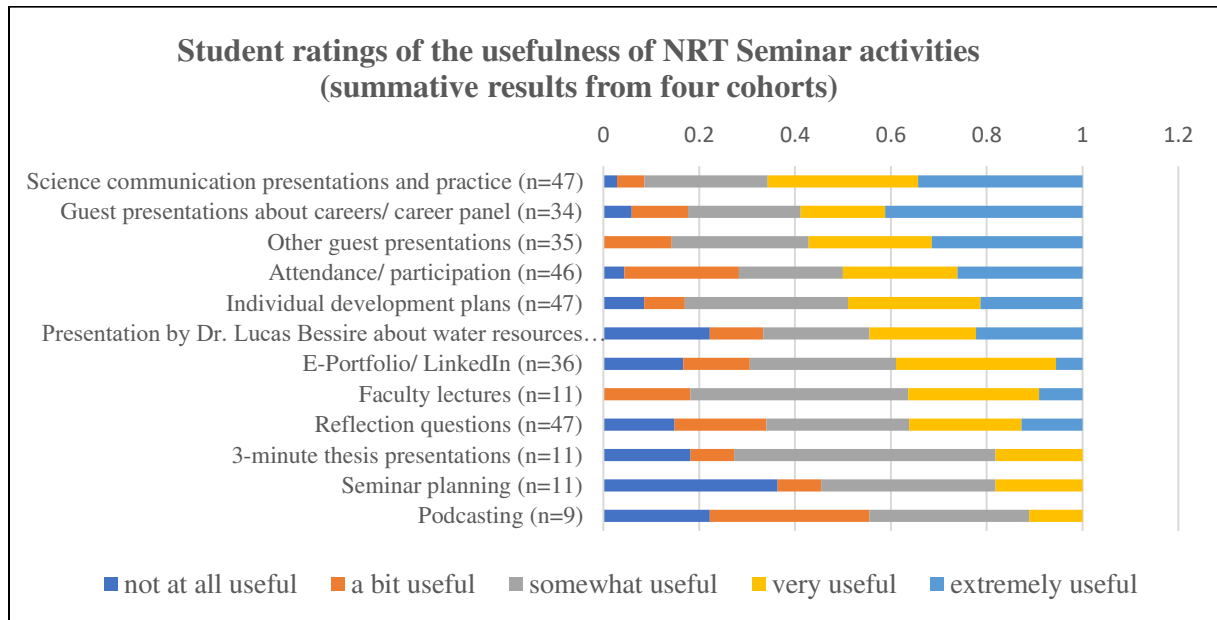


Figure 3: Student ratings of the usefulness of NRT Seminar activities Ratings from four NRT student cohorts 2019-2022

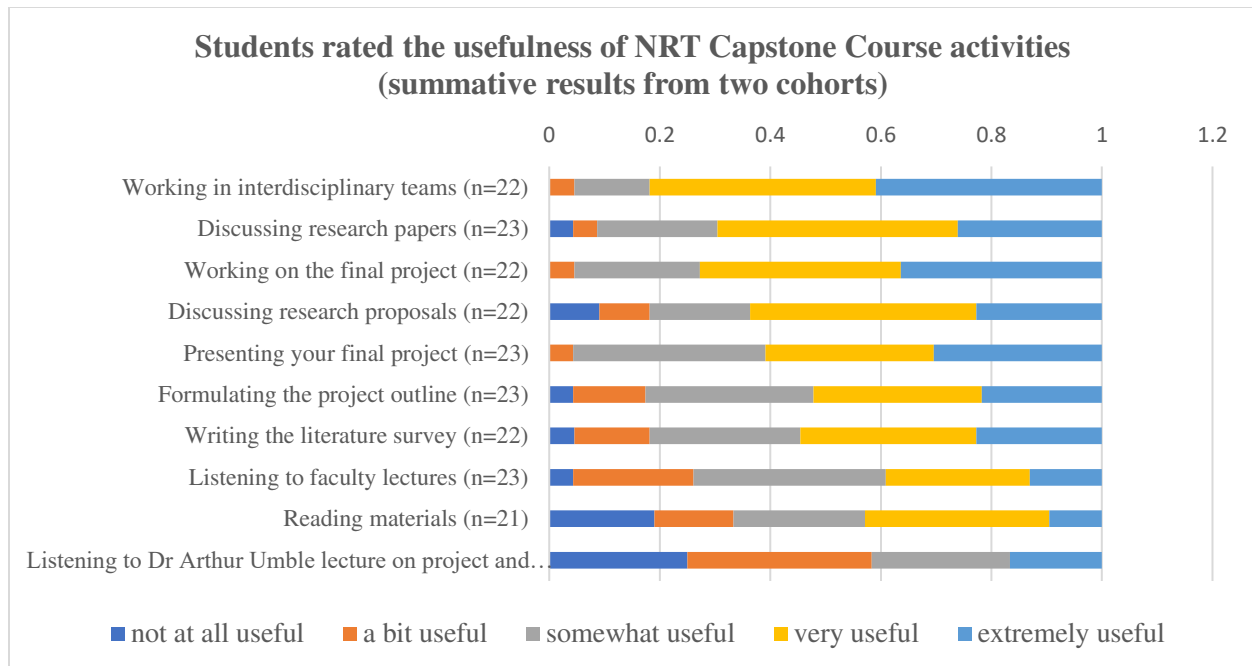


Figure 4: Students' ratings of the usefulness of NRT Capstone Course activities that took place in spring 2021 and 2023

Survey results as shown in Figures 2, 3, and 4 above indicated that many students thought the activities were useful, especially NRT Capstone course activities. Many of the activities students rated as more useful had to do with communication and teamwork, presentations, class discussion, guest speakers, faculty lectures, and trainee presentations. This could reflect that the students came to appreciate the importance of interdisciplinary teamwork and of communicating with stakeholders.

Lessons learned from Evaluation feedback

At semi-regular (about monthly) meetings, the external evaluator shared formative feedback, along with evaluation results, with the NRT leadership team. The formative feedback came in the form of "co-interpretation questions" that were designed to help program leaders consider how the results compare with their experiences with students during program activities and figure out what actions, if any, to take to adjust the program design. The leadership team also reviewed some evaluation findings at bi-annual meetings with the student advisory board. For example, first semester NRT trainee survey feedback (2019) indicated that trainees needed job search coaching earlier in their program than NRT leaders had originally planned. So, starting in the second cohort (2020), these career planning meetings were scheduled earlier. We also learned that faculty mentoring, career panels, and guest speakers were very useful for career planning. Thus, we continued this kind of programming and worked over the semesters to enrich it, based on trainee feedback each semester. As a result, team-based faculty mentoring supported students in identifying the careers they wanted and NRT graduates have found jobs in industry, military, and academia. In addition, through conversations with NRT students, program leaders learned that NRT graduates are more competitive in their job searches because of their interdisciplinary

experiences, which they could display to potential employers through research papers and on their resume.

Feedback was particularly important for informing the NRT leadership team about how to support students as they worked to develop skills to do interdisciplinary research. This was because, even though students reported gains in interdisciplinary teamwork skills, especially communications skills, NRT leadership encountered challenges in bringing together students from diverse disciplines to do interdisciplinary research in the FEW nexus as part of the NRT Capstone course. Through evaluation feedback and interactions with students, Capstone course leaders saw that the most challenging aspects of interdisciplinary teamwork for students had to do with team logistics such as delegating and sharing project tasks, project pacing, and peer interaction. The success of interdisciplinary research requires collaborators to develop a consensus in terms of topic, methods, and outcomes at the beginning of the project [14]. The NRT leaders' response action to help students was to enhance team collaboration and communication by adding more team building activities to the NRT curricula. One of these activities was the "Listeners and Talkers" activity, which gave students practice communicating within groups. Mango Singham from Case Western Reserve University has developed the Listeners and Talkers activity to increase participation with no coercion [15]. During this activity, students were asked to self-identify as either "talkers" or "listeners." Then, all students who identified as talkers were asked to sit together in one part of the classroom, and discuss what made them become a talker, how they can develop their listening skills, and how they can help listeners talk more. All students who identified as listeners were also asked to sit together in another part of the classroom and discuss what made them become listeners, how they can develop their talking skills, and how they can help talkers to listen more. After 20 minutes of group discussion, the two groups reported to the class. Another challenge trainees had was identifying meeting times that worked for all group members to meet. To overcome scheduling conflicts, the NRT incorporated workdays into the NRT Capstone course schedule, so student teams could work on the Capstone research project during some class periods. Although these workdays were helpful, successful teams needed to meet outside of the course time and find common meeting times to publish their final product.

We also learned, through formative evaluation feedback and informal conversations among students and faculty, that disseminating interdisciplinary research poses challenges for students and faculty. A major reason for this was that many conferences and journals are discipline specific, finding the right audience (e.g., journal or conference) for interdisciplinary research was challenging. Finding time to publish research was also a factor. Students were motivated by the opportunity to publish an interdisciplinary journal paper and add it to their curriculum vitae, but were not able to finish it within one semester. To support students and faculty, the NRT leadership team encouraged NRT trainees to publish a conference paper. Another challenging aspect of organizing an interdisciplinary Capstone course was forming the teams so that research topics aligned with all students' academic backgrounds. The NRT leadership team explored how to make interdisciplinary research more central to graduate work and discovered that it varies among departments and disciplines at our university.

In addition, we learned through the formative evaluation feedback that it is useful to use a visualization tool, such as Loopy, to teach systems thinking. The tool allowed students to simulate the behavior of the FEW systems and the interactions between FEW systems and the built environment. Because of the mixed survey ratings from the second cohort about the Integrated FEW Systems textbook readings, the NRT leadership team kept the textbook but adjusted the number of readings for the one-credit-hour course. NRT leaders decided to keep the textbook because it was a very accessible resource, both financially and for convenience, because it is open-sourced and because its content supports coursework by introducing systems thinking using examples from the natural-environmental systems and the human-social systems.

Finally, we found from formative evaluation feedback that trainees' favorite aspect of the NRT, for each cohort was the same: exposure to and interactions with faculty and fellow students who have diverse academic and personal backgrounds. The value of these interactions, and how to leverage them for program and research goals, would be interesting to explore further in future research about how NRT programs can be more effective.

We learned from informal conversations with NRT faculty that co-teaching and developing an interdisciplinary curriculum requires communication among faculty from different disciplines, so lessons relate to each other and to course objectives. Developing interdisciplinary courses requires faculty to move beyond their own comfort zone of teaching in their core areas of expertise (silo teaching) and to connect lecture material to other topics in the course.

Conclusions

This paper offers a detailed description of the NRT program at our university and how evaluation feedback, derived through systematic investigation, supported program leaders as they refined the program design and operation. Since 2018 our NRT program has trained 40 master's and doctoral students to study issues pertaining to the FEW nexus from diverse engineering, scientific, and social science perspectives. Survey ratings and written feedback, along with observations made by NRT faculty, show how the NRT program prepared NRT students to carry out interdisciplinary work, understand FEW stakeholders, communicate effectively to diverse audiences, understand their potential vocational pathways, and to thrive as interdisciplinary scholars. We offer this paper as a guide to existing and future NRT programs, who may benefit from reading about our challenges and opportunities associated with an interdisciplinary graduate traineeship. This paper also provides insight into the elements of the NRT traineeship that were the most effective. Many NRT students thought the activities were useful, especially NRT Capstone course activities. Also noticeable is that many of the activities students rated as more useful had to do with communication and teamwork, presentations, class discussion, guest speakers, faculty lectures, and trainee presentations. We recommend further research be conducted to investigate how to successfully leverage the valuable interactions NRT students had with other students, faculty, and staff to improve student experiences and accomplishments, and NRT climate.

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