

Interdisciplinary Team Science: Perceptions of First-Year Ph.D. Students

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Abstract: Increased relevance in academic pursuits surrounding interdisciplinary team science has elicited a positive impact on collaborative research. Historically distinct disciplines are coming together to do research that embraces interdisciplinarity. Training new researchers in interdisciplinary team science skillsets could be beneficial. This study examines the attitudes and perceptions of first-year Ph.D. students in the University of North Texas Learning Technologies program toward interdisciplinary team science. Results suggest most respondents were interested in learning more regarding this topic, that they perceived interdisciplinary team science to be beneficial to their doctoral program, and that they were interested in the logistics of potential implementation.

Keywords: Team science, interdisciplinary, research collaboration, team processes, new researchers

Introduction

Over the last sixty years, challenges due to increased sophistication in physical and social science disciplines have prompted an increase in collaborative research or *team science*, noted by a high percentage of publications being co-authored by several individuals across disciplines from differing institutions (Bennett & Gadlin, 2012; National Research Council, 2015). This upward trend of collaborative team science is relevant for students and new career scientists entering their chosen field with skills in interdisciplinary team science already in place. According to DeHart (2017), team science is an essential concept for researchers as they attempt to collaborate across disciplines and apply their collective knowledge to challenging issues.

In researching team science, we identified a potential emergent theme that good group dynamics is a key success factor (Hampton et al., 2017; Tebes, 2018; Tebes & Thai, 2018). Button (2020) believes that the pursuit of scientific knowledge is directly related to team science and that academia should be advocating for its training. However, we have found very little research conducted on team science curriculum or training. There was much agreement on the need for leadership, diversity, and emotional security, but little related to training teamwork skills. Allison et al. (2017) posited on this issue when speaking about music, health, and the lack of communication between academic departments:

We need to find collaborators with imaging, statistical, and large data set research skills if we are to properly explore the mechanisms underlying the effects we observe. We need to grow comfortable reading

journal articles organized by background, methods, results, and conclusion if we want to collaborate. We need to overcome our fear of the PubMed search engine. We need to understand that social theory and scientific theory are not correlates. What we in the humanities call theory may too easily be dismissed by scientists as speculation because our methodologies have not been made explicit in our writings. (p.11)

For the purposes of this paper, we define interdisciplinary team science as the process of crossing over traditional industry and academic lines to combine specialty skills to advance knowledge. We chose first-year doctoral students as our sample population to have a diverse and broad base of disciplines. Our study seeks to identify the perceptions of first-year doctoral students towards interdisciplinary team science. We feel that the data accumulated can contribute to the growing literature on interdisciplinary team science, and the importance of training to this skillset.

Literature Review

A review of the literature provided the authors with background information regarding Interdisciplinary Team Science (ITSci). However, the literature produced a paucity of information regarding students' perceptions of team science. Fiore's (2008) definitive claim is especially poignant in light of the malnourished literature when he states, "interdisciplinary science is team science – it is team science because it is infeasible to conduct interdisciplinary research independently" (p.272). Little et al. (2018) determined that team science is a dimension of contributing inter-professional collaborative research processes. Additionally, the Science of Team Science (SciTS) field was established to address questions relating to science teams, such as funding and scientific strategy, because few studies focused on the science of team science (Hall et al., 2018).

As team science trends upwards due to a global, remotely connected workforce, the relatively small number of relevant articles serves to magnify the growing nature and importance of interdisciplinary team science (Bennett & Gradlin, 2012). With a global network of researchers, Allison et al. (2017) identifies potential feelings of interdisciplinary intimidation. To potentially combat these feelings of inadequacy, we would like to see more literature focusing on team science to mentor and inform students as they progress through academia and ultimately add team science to their relevant workforce skillset. More findings of student perceptions regarding team science and curriculum could potentially expand available public literature with increased research.

Training the next generation of academic and professional learners in interdisciplinary collaborative team science could promote innovation (Dietze et al., 2018). As simultaneous members of the public and academe, current and future students may have dual opportunities to participate in interdisciplinary team science; as members of a lay participatory public, and other times as specialists or subject matter experts representing academe or industry. It follows that developing proficiency in team science skills may prove beneficial for students entering their chosen field (Tebes & Thai, 2018). We plan to research the perceptions of first-year Ph.D. students to collect data and extrapolate a sample from current student responses. Beyond student perception, two of our relevant sub-questions are:

- 1) Do students understand the importance of team science in the future of work?
- 2) What potential team science curricula might benefit graduate and doctoral level students?

As teams grow in size to include a global membership, it follows that participant diversity will expand in direct proportion. Diversity is the trend forward as remote working conditions become normalized and teams subsequently become more globally inclusive (Hampton et al., 2017). With this in mind, there is a need for team leaders to cultivate a feeling of participation and respect the diversity of global team members. Effective team science necessitates an intentional functional diversity, which can include a diversity of skill sets, cultures, regions, and abilities (Roelofs et al., 2018). Additionally, there is an emergent trend in the literature that focuses on the psychological well-being of the team as important for participatory collaboration (Tebes, 2018; Tebes & Thai, 2018).

Laursen, as cited in National Research Council, 2018, reported that more than 80% of papers in certain disciplines (i.e. science and engineering) are written with more than one author. Laursen (2018) notes that interdisciplinary team science adds strength to research teams and has been underrated historically. Collaborating using interdisciplinary team science integrates the values and standards of the teams involved to create a shared understanding and action.

As we move to our methods section, the justification coming from the review of the literature is that team science is relevant and growing. Students may benefit from having team science curricula as background before

joining the workforce. We aim to collect data that can contribute to the available information of students' perceptions of team science.

Methods

Participants

To understand students' perception of interdisciplinary team science at the University of North Texas (UNT), we set to sample first-year Doctor of Philosophy (Ph.D.) students from the Learning Technologies cohorts of 2024 and 2025 due to the wide-ranging nature of individual doctoral study topics, representing interdisciplinary team science. All respondents consented to participate in the study.

Materials

This mixed-method research collected data from a 27-question survey utilizing a combination of primary 5-point Likert scale participant survey questions (strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree), five dichotomous survey questions (yes/no), and six open-ended questions were included to allow participants to elaborate on their answers.

Procedures

The study was conducted at a single center, the University of North Texas, and approval for survey activities were received from the UNT Investigational Review Board (Study #: IRB-21-385). A survey was distributed to study subjects via email and asked to participate in the study from July 16, 2021, to July 26, 2021, from the Learning Technologies Ph.D. Program. A direct link to the survey was provided to all interested participants within the email, with a single reminder email sent to maximize the overall response rate. Upon accessing the provided link, informed consent was obtained, allowing the participant to proceed to the survey. Investigators preserved respondent anonymity. Data was collected and maintained by Qualtrics, a secure web application.

The results will be analyzed to gauge the attitudes and knowledge level of first-year Ph.D. students pertaining to interdisciplinary team science, as well as understanding the importance of team science in future works and the potential benefit of team science curricula at the graduate and doctoral level. The mean number of participants in each described category will be compared for both cohorts. Descriptive statistics (mean, percentage) will be used to characterize the scores for each Likert question. Due to the limited number of qualitative responses, manual coding was performed individually and analyzed amongst the researchers.

Results

From July 16, 2021, to July 26, 2021, the survey was distributed to all Ph.D. students from the Learning Technologies Program at the University of North Texas with 28 participants in total. Of the 28 respondents, only 19 (67.9%) respondents qualified for this study (1st year Ph.D. student) with the majority of research participants were white (57.9%), female (73.7%), and 35 – 44 years of age (47.4%) (Table 1).

Table 1. Demographics

Age	Gender (N = 19)		Cultural Ethnicity* (N = 19)			
	M	F	AS	B	HI	W
18 - 24	0	2 (10.5%)	0	0	1 (5.3%)	1 (5.3%)
25 - 34	2 (10.5%)	1 (5.3%)	1 (5.3%)	0	0	2 (10.5%)
35 - 44	3 (15.8%)	6 (31.6%)	3 (15.8%)	0	1 (5.3%)	5 (26.3%)
45 - 54	0	3 (15.8%)	0	1 (5.3%)	0	2 (10.5%)
55 +	0	2 (10.5%)	1 (5.3%)	0	0	1 (5.3%)
	5 (26.3%)	14 (73.7%)	5 (26.3%)	1 (5.3%)	2 (10.5%)	11 (57.9%)

* Cultural Ethnicity: *AS* Asian, *B* Black or African American, *HI* Hispanic or Latino, *W* White

Prior to the start of the survey, study participants completed an electronic consent form. The results are categorized into three domains: knowledge and attitudes, content and training, and educational opportunities. Individual scores for each domain were analyzed. The domain of knowledge and attitudes was ranked on a 5-point Likert scale from 1 = strongly disagree to 5 = strongly agree. In contrast, the domains content/training and educational opportunities collected qualitative data utilizing open-ended questions.

Knowledge and Attitudes

Survey questions seven and eight investigated how first-year Ph.D. students perceived interdisciplinary team science. Survey results indicated that 68.4% of students agreed that interdisciplinary team science can have a positive impact on research, additionally, 52.6% agreed and 47.4% strongly agreed that they would welcome the chance to be part of an interdisciplinary team. Interestingly, when asked if they were able to lead an interdisciplinary team of researchers, 31.6% of respondents indicated they disagreed with the statement, and 47.4% indicated that they could list possible barriers to implementing interdisciplinary team science. Furthermore, we found that when asked if it was important to offer training opportunities for young investigators, one respondent (5.3%) stated that they strongly disagreed with the statement. We followed up this question by asking the respondents to explain their responses and found that the words “student(s),” “team(s),” and various forms of the word “collaborate” were mentioned eight, six, and five times, respectively. Quantitative analysis is summarized in Table 2.

Table 2. Knowledge and Attitudes Analysis

Survey Item	Survey Responses (N = 19)						Min - Max	Mean
	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Disagree			
Q7_1. I know the definition of interdisciplinary team science	0 (0%)	0 (0%)	0 (0%)	17 (89.5%)	2 (10.5%)	4.00 - 5.00	4.11	
Q7_2. I am familiar with interdisciplinary team science	0 (0%)	2 (10.5%)	3 (15.8%)	13 (68.4%)	1 (5.3%)	2.00 - 5.00	3.68	
Q7_3. I can list possible barriers to implementing interdisciplinary team science	2 (10.5%)	1 (5.3%)	6 (31.6%)	9 (47.4%)	1 (5.3%)	1.00 - 5.00	3.32	
Q7_4. I am able to lead an interdisciplinary team of researchers	1 (5.3%)	6 (31.6%)	6 (31.6%)	6 (31.6%)	0 (0%)	1.00 - 5.00	2.89	
Q7_5. I believe that interdisciplinary team science is important for improving collaborative research	0 (0%)	0 (0%)	1 (5.3%)	12 (63.2%)	6 (31.6%)	3.00 - 5.00	4.26	
Q7_7. I believe that interdisciplinary team science can have a positive impact on research	0 (0%)	0 (0%)	0 (0%)	13 (68.4%)	6 (31.6%)	4.00 - 5.00	4.32	
Q7_8. I believe that interdisciplinary team science is too difficult to implement	2 (10.5%)	7 (36.8%)	6 (31.6%)	3 (15.8%)	1 (5.3%)	1.00 - 5.00	2.68	
Q7_9. I would welcome the chance to be a part of an interdisciplinary team	0 (0%)	0 (0%)	0 (0%)	10 (52.6%)	9 (47.4%)	4.00 - 5.00	4.47	

Q7_10. Interdisciplinary team science training should be required as part of my educational program	0 (0%)	0 (0%)	7 (36.8%)	6 (31.6%)	6 (31.6%)	3.00 - 5.00	3.95
Q7_11. I believe that my program's training efforts in interdisciplinary science to be effective	4 (21.0%)	2 (10.5%)	6 (31.6%)	6 (31.6%)	1 (5.3%)	1.00 - 5.00	2.89
Q8_1. It is important to offer specific training opportunities in interdisciplinary team science for young investigators	1 (5.3%)	0 (0%)	1 (5.3%)	11 (57.9%)	6 (31.6%)	1.00 - 5.00	4.11

Content and Training

Question nine of the survey focused on the amount of training the respondents have received regarding interdisciplinary team science. Survey results revealed that 50% of the students surveyed were unsure if their institution offered specific training in interdisciplinary team science as part of their educational portfolio. The survey followed up by asking the student if they were enrolled or planned to enroll in specific training for interdisciplinary team science, and 11 respondents (61.1%) stated “No”. Of the seven (38.9%) respondents who stated yes, 57.14% described their course content as a case-based course in which students reviewed case studies in interdisciplinary team science and developed strategies for pursuing interdisciplinary team science opportunities despite obstacles. However, despite many of the students stating they were not currently, nor did they plan to enroll in specific training for interdisciplinary team science, we found words such as “fascinated/interested”, and “important/benefit” were mentioned three and two times respectively when asked to explain their response, which was a direct contradiction.

Educational Opportunities

Questions 10 and 11 were open-ended asking participants the following questions: (1) What are your feelings towards attending an interdisciplinary team science workshop or information session? and (2) please explain your thoughts regarding doctoral-level classes for interdisciplinary team science. The datum points analyzed from the instrument are summarized in Table 3.

Table 3. Analysis of Qualitative Datum Points

Q. 10 What are your feelings toward attending an interdisciplinary team science workshop or information session?

Theme	Quote
Scope	"It would be cool to have a half day intensive training where we could learn the principles and practices associated with interdisciplinary team science."
Support	"I support this entirely. It would be beneficial as I pursue my own PhD and encourage collaboration and exposure to other ideas/perspectives."
Implementation	"I hope that it would be informative and supply example (sic) of implementation."
Interest	"Excellent opportunity for growth."

Q. 11 Please explain your thoughts regarding doctoral level classes for interdisciplinary team science.

Theme	Quote
Should be offered	"I think these would be important to have integrated into the curriculum."

	"I believe it should be offered as an option for those interested."
Positive, supportive	"These should be offered as an integral part of publishing and research."
	"I believe that these courses could be beneficial for growth in research for doctoral students."
Should not be offered	"...I'm not sure I would take a whole class in it."
	"It's very tempting, but I am not entirely sure how it will be implemented."
Negative, unsupportive	"An entire class would be hard to design unless there was active participation in genuine interdisciplinary teamwork from multiple departments."
	"No thank you."

Discussion

The results from the survey indicate that students can define interdisciplinary team science and are largely familiar with the topic. Also, students were largely optimistic in their belief that team science could positively impact on research and welcomed the chance to be part of an interdisciplinary team. However, students in the study also indicated that they could list barriers related to implementation and that it could prove too challenging to execute.

The qualitative feedback was overwhelmingly positive regarding interest and enrollment in team science workshop or training. Surprisingly, half of the students were unsure if their institution offered training in interdisciplinary team science. One respondent stated that they were "not aware of a training related to interdisciplinary team science but if there were one, I would enroll," with another stating they had "no time to take on non-mandatory coursework." The results suggest that students possess a cursory understanding of interdisciplinary team science but believe it is important for improving collaborative research. When asked if they would attend a workshop or information session, several responded that they were "interested", and only one student stated they would not attend.

Also, the results show that students believe doctoral level classes for interdisciplinary team science should be offered and that it could prove beneficial. Interestingly, one student stated that "it's very tempting but I am not entirely sure how it will be implemented", with another suggesting that "such courses should be optional or offered in a condensed timeline (e.g., a Maymester or a 3-week module). I'm not sure I would take a whole class in it."

Due to the fact that this study was conducted at a single center, expanding the sample size to other campuses could potentially provide a more comprehensive sentiment regarding interdisciplinary team science.

Conclusion

As team science becomes ubiquitous, there is a growing need to inform and educate young researchers, while still in their respective doctoral program, the importance of team science to engage in scientific collaboration. The level of researcher integration and interaction is multifactorial and may be driven by a mixture of attitudes, behavior, team science training, and educational opportunities at the doctoral level, which may influence team and organizational dynamics. While our study revealed that first-year Ph.D. students have concerns about how the implementation process would work, the results also suggest that students would pursue training in interdisciplinary team science due to the positive and collaborative impact it could have on research. One limitation to the study is that the sample population was taken from one campus, with first-year students. Therefore, more research is needed in this area to allow for a more robust foundation, both theoretical and empirical, regarding interdisciplinary team science.

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