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An Exploration of Interdisciplinary Graduate Education and Training: Currently Available Information, Perspectives, and Beliefs

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AN EXPLORATION OF INTERDISCIPLINARY GRADUATE EDUCATION AND TRAINING: CURRENTLY AVAILABLE INFORMATION, PERSPECTIVES, AND BELIEFS

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ABSTRACT

Background and Objectives

Interdisciplinary research has come into the limelight over the last 30 years. Current literature identifies interdisciplinary research as having the potential to assist in solving complex contemporary problems or issues through the inclusion of multiple disciplinary perspectives to account for the systematic intricacies therein. This project served as an exploration of interdisciplinary graduate education, graduate interdisciplinary research training, and the practice of interdisciplinary research, using three primary objectives. We first sought to identify and present current information around interdisciplinary graduate education and research training. Second, study personnel aimed to explore opinions and beliefs on interdisciplinary education and interdisciplinary research held by graduate students. Lastly, this project aimed to understand the interest in and willingness of graduate faculty to teach interdisciplinary courses or experiences.

Methods

This project utilized a mixed-methods approach across three studies in pursuit of the project's objectives. First a narrative review was conducted to ascertain and describe currently available information. A qualitative study utilizing semi-structured interviews was employed to understand the perspectives and beliefs held by graduate students and graduate faculty while also inquiring about their histories and interests around interdisciplinary education and research.

Online quantitative surveys were used to further understand the interests, perspectives and beliefs held by graduate students around interdisciplinarity.

Results

The narrative review identified 58 articles for inclusion and disseminated information within this project. The interviews found an interest in and belief of importance in interdisciplinary education and research held by graduate students and graduate faculty members. Graduate students were interested in and willing to take interdisciplinary courses and work on interdisciplinary research, while graduate faculty members believed in their ability to instruct interdisciplinary courses and were already conducting interdisciplinary research. The survey study found that graduate students report they believe they are ready, willing, and able to perform well in interdisciplinary education and research. Additionally graduate students reported a perceived importance of interdisciplinary research that was not significantly different from a perceived importance of disciplinary research.

Implications and Conclusions

Our initial hypotheses were supported. There is a common positive perception of the importance and value of interdisciplinary graduate education and research. Current literature supports its use and implementation, graduate students are interested in engaging and learning from interdisciplinary contexts, and faculty members are willing to teach through and already engage in interdisciplinary education and research. This project presents a rationale for further

examination of interest in interdisciplinary graduate education, and discuses some benefits, barriers, and motivations associated with interdisciplinary education and research training that may help in improving the practice of interdisciplinary research among current graduate students and future professionals.

DEDICATION

This Dissertation is dedicated to my parents and brother for their abundant support in helping me reach this point in my academic career, while also guiding me through the challenges and struggles I have encountered.

I specifically dedicate my Dissertation to Loree Goheen Allen, my mother. I miss your caring and encouraging presence, always rooting for me at every turn along the way. You always knew and told me that I could and would succeed in the completion of this project and my degree. I wish you were still here to see the finish line, as you would have been exuberant and overjoyed at these accomplishments.

LIST OF ACRONYMS

IPE	Interprofessional Education
RWA	Readiness, Willingness, and Ableness
SEIdET	Self-Efficacy for Interdisciplinary Education and Training
SEIEL	Self-Efficacy for Interprofessional Experiential Learning
UML	University of Mississippi Libraries

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CHAPTER 1:

Background

Introduction:

Interdisciplinary graduate student education and training has come into the limelight in the past five decades with continual calls for its implementation in graduate pedagogy.[1–5] Disciplinary research may be a potential medium to advance scientific inquiry through intensive collaborative practices that rely on the strengths of individual disciplines, while interdisciplinary research involves the participation of two or more disciplines to solve a specific problem.[1,6] Mansilla, Miller, and Gardner described interdisciplinary understanding as "the capacity to integrate knowledge and modes of thinking in two or more disciplines or established areas of expertise to produce a cognitive advancement—such as explaining a phenomenon, solving a problem, or creating a product—in ways that would have been impossible or unlikely through single disciplinary means."[7–9] Interdisciplinary approaches are integrative in nature, utilizing methods from two or more disciplines to create a consensus of knowledge.[10] This differs from multidisciplinary work which is additive.[10] This consensus between disciplines is the basis for quality interdisciplinary work.

Current graduate education:

Graduate education in its current state has a primary focus on developing students to be masters of a specific subset of content housed within the discipline in which they are trained. This allows for high quality professionals to enter and succeed in career paths within their specific sector of industry, academia, or other forms of employment. Graduate students are trained to develop a sense of an disciplinary identity that enables the students to feel a place in

the social processes of their discipline. While discipline based knowledge can answer a range of questions, it may lack the ability to comprehensively answer many real-world problems and phenomena that require perspectives from two or more fields of inquiry that would be beyond the scope of a single discipline or area of research practice.[1,2,6,11] Thus, we reach the paradox of graduate education: academia needs to train graduate students to be masters of their disciplines, but also to succeed in interdisciplinary settings. As we move toward a more globally connected world, the imperative that we train graduate students to function in interdisciplinary settings only increases. Graduate students in training often lack experiences in interdisciplinary collaborations and may not have developed an interdisciplinary identity. Furthermore, graduate students may lack collaborative experiences with individuals outside of their academic institutions or specific university departments. However, few graduate programs explicitly include interdisciplinary training,[12,13] graduate students are rarely studied,[14] and little research has explored graduate student participation in collaborative research.[1]

Each discipline or area of scholarly inquiry is important and necessary for the pursuit of knowledge in specific areas of research. However, each discipline also can add to other fields of inquiry or interdisciplinary bodies of knowledge. Most modern social science disciplines utilize some form of interdisciplinary methods while staying within the confines of their discipline. Moreover, social sciences utilize similar methodology and statistical analyses to analyze the relevant material of their respective professions. Holley stated, "While acknowledging that the different [disciplines] rely upon unique bodies of knowledge, each can be conceptualized as a social process occurring within a specific context and through relevant proficiencies."[11] Holley conducted a study observing and interviewing graduate students in a neuroscience doctoral program and concluded that doctoral students in interdisciplinary programs were not well-served

with only their required disciplinary courses.[11] Their data suggested that developing interdisciplinary proficiencies develops from the practice of interdisciplinarity.[11] Training graduate students to be able to function at a sufficient level in collaborative interdisciplinary projects could be attained through a focus on common methodologies bridging the gaps between the disciplines. Furthermore, graduate students building this interdisciplinary bridge may reach deeper levels of understanding within their own discipline and in the additional disciplines to which they are exposed.[7]

Current graduate programs may be able to train graduate students in interdisciplinary methods by taking small steps towards collaborative practices.[13] This could be achieved by having students cross one disciplinary boundary and then subsequently diverge into additional disciplines.[13] These smaller steps beyond disciplinary boundaries may assist students in developing an understanding of interdisciplinary practices, as attempting to broach the whole topic of interdisciplinarity may seem daunting to students in the initial stages of their training.[15] Furthermore, encouraging and allowing students to develop their own line of inquiry, with their student peers or faculty members, in interdisciplinary practices can improve their understanding and may bolster self-efficacy for individual and collaborative research.[11,15–17] This approach at mastery through experience is already employed by graduate programs in several settings, including the conducting of thesis/dissertation projects, during student assistantship collaborations with faculty members, and through group projects in classroom settings.

Graduate training currently aims to create methodology experts in their respective discipline, which could also serve as a potential route to effectively train graduate students in interdisciplinary collaborations by supplementing graduate curriculum with exposure to coursework, research, students and/or faculty from additional disciplines. Schmidt et al. detailed

useful strategies for the successful implementation of collaborative training, including teamwork, problem-based learning, and scaffolding.[13] Students working in teams and experiencing the nuances of interdisciplinary collaboration may develop the necessary skills to succeed in these environments. Depending on the graduate program, this may have already been implemented in some form or fashion to develop graduate student proficiencies in collaborative disciplinary research and methods. Additionally, relying on scaffolding as a basis for training could benefit students in both their disciplinary and interdisciplinary training by continually strengthening their existing methodological knowledge and providing further opportunities for students to employ that knowledge in active learning settings.

Socialization is another key practice in graduate education that emphasizes the engagement of students in their academic communities to help develop their scholarly identities while further strengthening their methodological skill sets.[5,11] However, doctoral socialization requires acclimating students to their professional and academic identities, which may deter some students from finishing their respective degree programs.[5] Whereas current graduate training already employs these practices, some programs may only need to make curriculum adjustments to provide adequate interdisciplinary training to their students.

Universities could begin or expand their promotion of interdisciplinary research by enabling and encouraging faculty members to collaborate with faculty and graduate students from other departments. This may be achieved by developing new policies or strengthening existing policies to remove barriers to interdisciplinary research, through promotion and tenure flexibility, or interdisciplinary review committees.[6] If faculty members are already participating in interdisciplinary projects, including graduate students in the project could provide an avenue to assist in interdisciplinary research training. Professional societies can report on

interdisciplinary research and development around their fields bolstering reporting which may promote a positive effect on the training of future professionals.[6]

While universities, departments, and professional societies can certainly play a role in the development of graduate student interdisciplinary abilities, graduate students themselves are ultimately the individuals who are responsible for their own education.[6] While graduate students may still be limited by current departmental or university policies, they can craft an interdisciplinary training path by taking courses in other disciplines, seeking out research projects that they can assist on in other departments, or by involving advisors from other disciplines on their thesis or dissertation projects.[6] However, they must have an interest and drive to participate in interdisciplinary research, and some may not be interested in these practices.

Gardner et al. discussed that the cognitive development associated with liberal arts undergraduate experiences and professional experiences may increase graduate student engagement and could be attributed, in part, to their successes in interdisciplinary work.[5] Spelt et al. conducted a systematic review around interdisciplinary teaching and learning in a higher education setting and found a set of potential subskills that could contribute to graduate success.[10] They indicated that students with higher levels of curiosity, respect, openness, patience, diligence, self-regulation, and prior social and educational experiences with interdisciplinary education may enable their ability to engage in interdisciplinary thinking.[10] Perceptions, beliefs, and motivations that graduate students have, in addition to their existing skills and prior experiences, may affect their interest in participating in interdisciplinary education or training. Du et al. conducted a study examining predictors of self-efficacy among graduate students participating in online collaborative research, finding that student self-efficacy was related to willingness to handle group challenges, trust relationships, and leadership

influence.[17] Self-efficacy is one's belief in their ability to complete specific behaviors or actions, and it has the potential to modify student behaviors and perceptions associated with interdisciplinary research.[16–18] Individuals with a greater self-efficacy may view problems as objectives to be mastered, develop stronger interest in their activities through participation, develop stronger commitment to their interests and activities, and may recover more quickly during setbacks.[16,18] No currently existing research on graduate student interdisciplinary research self-efficacy was found during our preliminary literature search. Examining graduate student self-efficacy on interdisciplinarity may help to provide a basis of understanding on what strategies could be best suited to train and develop graduate student's knowledge and skills around interdisciplinary research.

Barriers to Interdisciplinary Graduate Education:

University settings and graduate programs may already be structured to maintain students within departments and disciplines while unintentionally preventing student engagement with other students and/or faculty from other departments.[11] Schmidt et al. stated, "Few [graduate] programs explicitly include an interdisciplinary training, an international focus, or interorganizational experience, which thereby disadvantages students, who will go on to work in an increasingly globalized world."[12,13] This could be in part due to the program course requirements or the cultures within each university that encourage the pursuit of a highly refined disciplinary specialty and the research involved therein. Furthermore, university departments have an inherent need for students to focus on their respective graduate programs that may include avenues for funding, advancement of their home disciplines, educating future members of their discipline, or requirements set by departmental, school/college, or university policies.

Van Rijnsoever and Hessels conducted a study examining factors associated with disciplinary and interdisciplinary collaborative research, finding that females, researchers with more previous universities of employment, and researchers with more years of work experience were more likely to participate in both disciplinary and interdisciplinary collaborative research.[19] However, Golembiewski et al. found that public health doctoral trainees who were females, or United States citizens had lower odds of completing interdisciplinary dissertations.[20] Their study could point to some barriers for newer professionals or graduate students, or to a lack of interest in interdisciplinary research among male researchers. Aside from institutional barriers, and potential cultural barriers, we were not able to identify any other currently reported barriers. Future discussion could examine current barriers and challenges to implementing interdisciplinary programs.

Interdisciplinary Graduate Education and Interprofessional Healthcare Education:

Interdisciplinary education and training have the potential to assist in the development of quality professionals in various fields of scientific inquiry. Although interdisciplinary graduate programs have not been widely implemented, we can draw from the experiences, insights, and successes of interprofessional healthcare education for future healthcare professionals in training. Interprofessional education (IPE), training and practices have been well documented and researched in the development of future health professionals, including physicians, pharmacists, nurses, social workers, and other highly trained practitioners.[21] The World Health Organization defines IPE as "when students from two or more professions learn about, from and with each other to enable effective collaboration and improve health outcomes."[22] IPE focuses on improving the patient experience of care received, the general health of the whole population, and reducing the costs associated with the delivery of healthcare.[23]

Reeves et al. conducted a review of articles focused on learner outcomes associated with IPE, finding that it was associated with a positive reaction (general views and perspectives), had a positive influence on knowledge and skills, on organizational practices, and on patient/client care outcomes.[24] IPE can benefit the students involved with its educational processes by enabling them to attain a better understanding of healthcare delivery and a perspective view on other specialties around healthcare practices. Similarly, interdisciplinary education has the potential to expose students to the methods, focuses, and literature of other disciplines which could have a positive impact on the general performance of the students involved. Their improved performance may cumulate in a greater quality and/or quantity of produced research and information.

Summary:

Graduate education currently serves to meet many end goals with a high degree of quality that benefits its students and their potential career and research successes. Furthermore, continuing to improve graduate education is beneficial towards furthering lines of scientific inquiry and serves to benefit all parties involved with its development. An interdisciplinary focus in graduate school has the potential to aid in improving the already high quality of educated professionals exiting their respective graduate programs. Although some barriers currently hinder the full implementation of interdisciplinary programs, these barriers can be addressed allowing for repeated improvements in the quality of a graduate program by exposing graduate students to other disciplines, schools of thought, and methodological rationale.

Rationale:

Before investing in transitions to include interdisciplinary education and/or training are implemented in existing single-discipline graduate education program, it would be beneficial to assess the current state of knowledge around interdisciplinary education, and to inquire with graduate students and graduate faculty members about their perceptions, beliefs, experiences, and inclinations towards the inclusion of interdisciplinary research training in existing graduate education models.

These three studies aim to provide a ground level understanding of where research currently stands around interdisciplinary graduate education and training, to provide information on the beliefs, opinions, and experiences of current graduate students in the social sciences, and to explore the willingness of graduate faculty members to include interdisciplinary focuses in their respective programs. From these, we aim to provide a basic understanding of relevant information associated with the implementation of interdisciplinary graduate curricula.

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CHAPTER 2:

A Narrative Review of Graduate Student Education, Curriculum Impact, and Interest in Interdisciplinary Research Training

INTRODUCTION

Alongside traditional graduate education practices, implementing curriculum that is focused on providing interdisciplinary research training to graduate students may help support their academic development. This additional educational focus can bolster graduate student understanding of methodological practices, may develop alternative routes of thinking or approaching a problem/issue/topic, may assist in developing student professional socialization skills, and may positively impact student internal motivations, beliefs, and perceptions.

Interdisciplinary programs may help to improve current graduate education; however before implementing a new program or while developing an existing program it is beneficial to understand what can help said program to succeed in furthering the professional development of graduate students. What could benefit or detract from an interdisciplinary program may include associated individuals, resources, educational practices, or even policies to help these programs thrive. The development of an interdisciplinary program may be achieved by taking small steps from current graduate education toward the development of collaborative interdisciplinary research training. In a similar light, there is a need to understand if graduate students are interested in learning in interdisciplinary settings or participate in carrying out interdisciplinary research. Without student interest in interdisciplinary education, programs may have issues recruiting students to develop into future interdisciplinary professionals.

RATIONALE

Spelt et al. conducted a systematic review in 2009 identifying and discussing interdisciplinary higher education.[1] Their study developed a strong base of interdisciplinary higher education information while providing information on directions future research could pursue, including an investigation of difference between or across educational contexts.[1] However, from our background literature search, we were unable to identify any narrative, scoping or systematic literature reviews outlining further discussion of graduate level interdisciplinary education and training. This study aimed to initiate filling this informational gap by providing a brief synopsis of information around graduate student interdisciplinary education and research training through conduct of a narrative review to provide a baseline understanding of current knowledge related to interest, benefits, barriers, and learning.

Through the study review questions we explore current knowledge around graduate student interest in interdisciplinary education and research; benefits and barriers around interdisciplinary programs; and motivational and methodological improvements in graduate students associated with interdisciplinary education and research training. These areas of exploration could provide a basic rationale for the continuation of research around interdisciplinary graduate education or the development of new programs that can aid in the creation of quality interdisciplinary professionals. Graduate student interest is imperative for interdisciplinary programs, as they may not succeed in their early stages or continued execution without support from their targeted educational audiences. Identifying and exploring the benefits and barriers around interdisciplinary education and research training programs can provide insight that may help to improve existing programs or enable newly developed programs to navigate the ambiguities around interdisciplinarity. While examining the professional and

methodological improvements shown by graduate students can help to provide support for programs in their ability to improve the already high quality of current graduate education.

REVIEW QUESTIONS

- Review Question 1: Are graduate students interested in interdisciplinary research and/or interdisciplinary research training?
- Review Question 2: What benefits or barriers are associated with the implementation of interdisciplinary research training among graduate students?
- Review Question 3: Do graduate students have motivational improvements or show methodological knowledge improvements associated with interdisciplinary education or while working on interdisciplinary research projects?

METHODS

Protocol:

Our narrative review protocol was developed *a priori* utilizing the Joanna Briggs Institute guidance, by Peters et al., and supplemented by a scoping review conducted by Tricco et al.[2–4] However, this protocol underwent an iterative process. Where information was found that necessitated changes to be made to the review questions or study methodology, alterations occurred and are reported in the results.

This narrative review's primary focus is on graduate student education and training in interdisciplinary practices and research. Aims were to identify graduate student interest in interdisciplinary education and research, graduate student perceptions of interdisciplinary education, information on current practices in graduate education and training, information on

interdisciplinary program implementation, outcomes from implemented pedagogical strategies, and information on graduate student improvements associated with interdisciplinary curriculum.

Literature Search Criteria and Process:

This study utilized the University of Mississippi Libraries' (UML) 'One Search' for all literature searches conducted under this protocol.[5] UML One Search searches through over 410 databases, including EBSCO Host, ERIC, ProQuest, Science Direct, Teaching Reference Center, EconLit, PsychINFO, and SocINDEX, among other databases rich with information (see Appendix 1.B).[6] Although One Search has access to all of these databases, our review may not include every database, due to the differences from our research questions to the topics each database covers. Some included databases are not related to the review questions. Article searches utilized a set list of search terms for information exploration. These terms included 'interdisciplinary,' 'graduate,' 'education,' 'training,' 'research,' 'implementation,' 'motivation,' 'knowledge,' and 'interest.'

All searches included the 'interdisciplinary' search term as a base. All searches used at least two additional search terms, using 'AND' Boolean logic statements. 'Student' as a search term was not used as it has been reported to produce too many extraneous results.[1] All search terms and associated Boolean logic terms were recorded to maintain a record for study personnel and are reported. In alignment with the inclusion and exclusion criteria in this protocol, all searches only included peer-reviewed journal articles that were published between January 1st, 2000, and December 31st, 2020, that were available in English.

This study utilized two article reviewers to ascertain a set of articles less influenced by individual biases. Additionally, a third member of study personnel served as a moderator to assist

in evaluating the inclusion/exclusion of articles conducted by the two article reviewers and helped to settle any discrepancies between the two article reviewers. Study inclusion consisted of three phases: Identification, Screening, and Eligibility (see Appendix 1.B). During the Identification phase, all search results were examined by their titles and abstracts and reviewed for relevance to graduate student training and education in interdisciplinary practices and research, with relevant articles meeting initial inclusion. During the Screening phase, the two article reviewers discussed which articles to include between their searches and had a third member of study review any disagreements that occurred. Additionally, all duplicates, and inaccessible articles were removed during the screening phase. During the Eligibility phase, each article remaining in the eligible set was read through in its entirety and relevant information was extracted and recorded for reporting. Articles could be excluded at this phase if their contents were outside the scope of our research questions.

Study Inclusion and Exclusion Criteria:

Articles meet the inclusion criteria if they were available as a full text, were peer reviewed, were published in a scholarly journal, were published in English, and were published between January 1st, 2000, and December 31st, 2020. All study designs were allowed under the inclusion criteria. If an article was not available as full text from the University of Mississippi Libraries, an interlibrary loan was completed to attempt to obtain the material. Of the interlibrary loans requested, all but two were successfully obtained. Articles were excluded if they were not peer-reviewed, or if they were published before 2000 or after 2020.

Articles that had not been published in peer reviewed formats, ‘grey literature’ (literature that has yet to be published), were excluded. English language was a requirement for a publication’s inclusion because study personnel are limited to understanding it as a language.

Studies for inclusion were primarily focused on graduate student education or training. However, exceptions were allowed to be made where an article was found that focused on a different collegiate level student population while also examining a facet of interdisciplinarity relevant to graduate student education or training. This study did not involve an appraisal of the quality of included articles outside the basis of our inclusion and exclusion criteria. Future studies or systematic reviews could conduct quality appraisals of articles included under this study protocol.

Result Reporting:

Throughout the literature review process involved in this study, a record was maintained that detailed what studies had been considered for inclusion. The number of studies that were reviewed at individual stages of the narrative review are reported in the results. If a study did not meet all inclusion criteria, it is included in the count of articles excluded at various stages of the review process, but it is not specifically mentioned or discussed in this review. Articles that met the final inclusion criteria are included in Results section, but not all are discussed at length. All results were discussed by the two reviewing research team members and mediation occurred for disagreements or concerns that arose. Data charting included the article author(s), title, publication date, journal publication information, and an abstract, introduction, or summary the described the project. Which review questions we associated with each article are also reported. Please see Appendix 1.C for more information on articles that met final inclusion.

Ethical Statement:

Since this project had no human participants and only entailed searching through currently published and peer reviewed materials, it did not need to be submitted for review by the University of Mississippi Institutional Review Board.

RESULTS

Protocol Changes:

Two research questions were adjusted during the literature search process. Research Question 2 was replaced as we were unable to find information that directly answered the original question. The original review Question 2 was "What factors are associated with a successful or an unsuccessful implementation of interdisciplinary research training among graduate students?" and was changed to "What benefits or barriers are associated with the implementation of interdisciplinary research training among graduate students?" The updated question language allowed us to answer elements of the original question and provide relevant information that could be useful in the implementation of an interdisciplinary graduate program. Review Question 3 underwent a small wording change to expand its scope to include interdisciplinary education in addition to interdisciplinary research. Question 3 originally asked, "Do graduate students have motivational improvements or show methodological knowledge improvements while working on interdisciplinary research projects?" and was updated to "Do graduate students have motivational improvements or show methodological knowledge improvements associated with interdisciplinary education or while working on interdisciplinary research projects?" Three search terms, 'higher education,' 'successful,' and 'unsuccessful,' were not utilized during the literature search. The 'higher education' search term was covered

under the use of the ‘education’ search term. The search terms ‘successful,’ and ‘unsuccessful,’ were excluded upon changing review question one.

Literature Search:

The Identification phase of the literature search was carried out from April 5th, 2022, through June 20th, 2022. During this phase of the literature search seven unique searches were conducted (see table 1.A for more information), where 1,856 article titles and abstracts were reviewed for their relevance to this study’s research questions. During the third search we found that excluding the “graduate” search term led to a larger number of articles unrelated to the research questions. ‘Graduate’ was included as a search term in the remaining 4 searches. Of the articles reviewed, 332 were selected for inclusion into the Screening phase. At this point in the literature search, a level of information saturation was attained: new searches were repeatedly resulting in more duplicates and less new articles to add into the potential list papers for study inclusion. Additionally, as we continued deeper into each unique search, the results became less relevant.

After completion of the Identification phase, the Screening phase was initiated by two members of study personnel that held discussions on which articles to keep for full text review in the Eligibility phase. Before discussions commenced, 88 duplicate articles were removed, one article was removed as it was unobtainable through an interlibrary loan, and three articles were removed as their topics were noticeably outside of the scope of this study. Both article reviewers reread through the 240 article titles and abstracts and then held discussions as to which articles to include for the Eligibility phase. At the end of discussions between article reviewers, 100 articles were included into the Eligibility phase based on the inclusion criteria, exclusion criteria, and relevance to the review questions.

At the initiation of the Eligibility phase, all 100 included articles had their full text reviewed by both article reviewers. Reviewers were asked to pay specific attention to the research questions, results, discussion, and conclusion sections of each article to identify their unique contributions. After discussions occurred between the two reviewers, 42 articles were excluded for being outside the scope of the study; 58 articles met the inclusion criteria and were included for the final sample (Appendix 1.C).

Study Characteristics:

Articles included in the final study were assessed for their relevance to each research question: 16 were related to research Question 1, 53 were related to research Question 2, and 22 were related to research Question 1. These articles were disseminated between June 2001 and December 2020, where the number of included articles per publication year generally increased from one in 2001, to seven in 2020, with 2019 having the highest article count at nine. Forty-seven percent of included articles were published between 2017 and 2020. Among the 58 articles, there were 43 unique journals for publication with 'Higher Education,' and the 'Journal of Environmental Studies and Science,' having the highest representation with four articles each. Most articles were published in single disciplinary journals or topic-based journals.

LITERATURE DISCUSSION

Graduate Student Interest in Interdisciplinary Research and Training:

Interdisciplinary education and research training programs rely on careful planning, input from various stakeholders, resources, and opportunity; yet in tandem they have an inherent need for graduate students to have and maintain a vested interest in their ongoing learning and experiences. Our protocol identified a few overarching themes related to graduate student

interdisciplinary interest including importance, exposure, enjoyment, benefits, and challenges. Among our included articles, graduate students have expressed an interest in interdisciplinary knowledge, that they believe they should devote time towards interdisciplinary research, and have an exposure enhanced perception of importance for interdisciplinary learning.[7–9] Zhang and Shen reported that graduate students recognized the importance of an interdisciplinary approach, and held positive attitudes towards it.[7] In other studies, students expressed interest in interdisciplinary education and research, citing the potential for practical applications in problem solving, and relevance to their personal research needs.[8,9]

Exposure to information, experiences, community support, and interdisciplinary research opportunities has been shown to increase student interest for interdisciplinary learning and interdisciplinary research.[10–13] Allendorf et al. compared two graduate programs where one expressly advertised their focus on interdisciplinary research, finding that students had a greater initial interest in interdisciplinary research in the program that advertised a focus on interdisciplinary research.[11] Francis et al. discussed that after working with others from different backgrounds, graduate students reported an increased eagerness and ability to work in interdisciplinary collaborative settings.[10] Rissman and Barrow discussed how graduate students with more collaboration experiences, and graduate students who felt supported by their intellectual communities helped to increase perceptions of importance for interdisciplinary work.[12] Along similar lines, graduate students can serve as interdisciplinary near peer mentors for undergraduate students when they are learning to conduct research in academic settings, where both parties benefit from the interaction and it may serve to increase graduate student interest in interdisciplinary mentoring.[13]

Individual graduate students may have more experience with, have preferences for, or enjoy certain topics or disciplines over others; this may have an effect on their interest in all or part of interdisciplinary education and research.[7,14,15] Moreno and Danowitz discussed how prior student skills and knowledge as well as a student overall experience may increase their interest and motivation to conduct interdisciplinary research.[15] Zhang and Shen discussed how students appear to place more value on interdisciplinary topics that include their preferred disciplines or subjects.[7] Knobloch et al. reported that all students in their sample reported they liked learning from various speakers in multiple disciplines in both their pre and post-test questionnaires.[14]

Students may have increased interest in interdisciplinary education or research if they perceive potential benefits to be associated with their involvement in a program or study.[16–19] When graduate students perceive a benefit to their own knowledge or skills that can assist them in their own personal research or help to develop potential working relationships, they may have an increased interest in interdisciplinary education or research.[16,18] Estes et al. discussed how graduate students in medicine recognized that they were going to be working together with other disciplines, which made them interested in more interprofessional (as interdisciplinary efforts are described in healthcare) education for themselves and future graduate students.[17]
Interdisciplinary research in graduate training also presents the opportunity for doctoral candidates to develop and complete interdisciplinary dissertations.[20] Al Shayeb conducted a survey study among Finance graduates and their employers on the importance of various skillsets for employability, including interdisciplinary academic skills.[21] They found that graduates agreed overall (4.13 out of 5, SD=0.60) that interdisciplinary academic skills were important for employability, however employers held a significantly higher view (4.43 out of 5, SD=0.46). [21] This study did not focus on graduate students, but we believe it serves as an example of a study

on hirability, a student's capability of being hired, that could be readily applied to a graduating, or recently graduated, graduate student sample.

Graduate students can also face challenges or obstacles that would have to be overcome in interdisciplinary education or research.[13,16,22] If students lose interest or identify more negatives in their pursuit of interdisciplinary knowledge or understanding, they may be more prone to disciplinary backsliding. As mentioned in a previous section, graduate students may experience anxiety, or feeling like 'academic deviants.'[23,24] Additionally, students have reported a need to protect themselves by returning to their own disciplines, a feeling of frustration at having restrictions that keep them with their own disciplines, and the perception of interdisciplinary research as more challenging or difficult, or that interdisciplinarity was not enhancing their own research.[12,16,22]

Benefits and Barriers to Graduate Interdisciplinary Education and Research Training:

An overarching theme from our literature search was a focus on the value, relevance, and importance of interdisciplinary research and interdisciplinary education. Interdisciplinary research or interactions have the potential to provide a multitude of new ideas and perspectives on current information to help improve the quality of created research. Many articles in our sample discussed, either directly or indirectly, the potential for interdisciplinary research to approach and address complex contemporary societal topics, or to explore ideas with varied perspectives to develop a multifaceted solution or response to address known issues or problems. Although most of our sample mentioned it at some level, a few articles suggested a direct need to teach the value of interdisciplinary research to garner support from students, faculty, and other stakeholders. In relation to the development of an interdisciplinary course, Andrade et al. discussed that interdisciplinary courses should emphasize integrative learning while showing

what could be gained from an integrative approach over the approach of a single discipline.[25] This emphasis could serve as a basis for developing an interest in interdisciplinary education and interdisciplinary research.

Whether an interdisciplinary program is in the pre-planning stages, has just been initiated or is an ongoing program, it necessitates thoughtful and meticulous curriculum and course planning as well as continual development for its initial and ongoing success.[10,14,26–30] Interdisciplinary programs and their associated faculty members should develop courses and curricula to best serve the development of quality interdisciplinary researchers where they can rely on a multitude of pedagogies, program policies, their teaching peers, and the individual strengths of each student that passes through their respective programs. Our search identified several possible pedagogical avenues to support the development and continuation of an interdisciplinary program including scaffolding, topic-based learning, case-based examples, critical discussion, assigned team/group projects, team teaching, active learning environments, real world environments, and student course evaluations.[7–10,16,23,25,30–39] Many of these are already used in disciplinary graduate education and can be readily applied to an interdisciplinary program format.

One strategy that can provide a beneficial starting point for new interdisciplinary programs is team teaching, which can bring together faculty from multiple disciplines to aid in the instruction of course content while simultaneously providing disciplinary expertise and content exposure to graduate students.[10,23,30] However, team teaching in of itself requires rigorous planning and the development of an equitable professional relationship between the associated faculty or professors.[23] Deriving from different disciplines, faculty or professors may feel obligated to share their disciplinary expertise when their fellow team teaching member(s)

discuss some course materials; however in sharing from their focused disciplinary standpoints, they can create an overwhelming atmosphere that discourages active student engagement and involvement.[23] This challenge may be overcome with the development of a mutual understanding between team teaching members that the course is for the betterment of overall student knowledge, and a continual cohesive engagement from faculty and professors that models an appreciation of their respective disciplines.

Characteristics, and prior topic knowledge of individual graduate students can also affect the success of interdisciplinary education.[15,23,24,30,32–34,40,41] Some authors have suggested that it takes a unique type of student to excel in interdisciplinary education and research.[15,24] Current literature postulates a plethora of student characteristics that may be related with higher success in interdisciplinary education and a potential to excel at interdisciplinary research. Related characteristics include whether students are more cooperation oriented, are more of a risk taker, can 'think outside the box,' are open-minded, are enthusiastic about their work, are less self-conscious about interdisciplinarity, have an innate curiosity, are willing to be incorrect, and are willing to have their views challenged by others.[23,40,41] Hackett and Rhoten discussed that students may feel more self-conscious about interdisciplinarity later in their academic careers when more is at stake, or perceived a vulnerability to failure.[41] Students would take more conservative approaches to research to protect themselves while straying away from open interdisciplinary research.[41] Student topic familiarity can also affect their initial ability to succeed in education and research settings, but with further exposure students may develop additional interest in learning more about interdisciplinarity, or practicing interdisciplinary research.[30,33–35]

Graduate students and faculty associated with interdisciplinary programs can benefit from various avenues of information exposure. This exposure can be delivered as interactions with graduate students from other disciplines, experience conducting interdisciplinary research, or exposing graduate students to disciplinary, content, or methodological experts.[8,9,11,15,17,18,24–26,33,39,42–50] However, exposure to interdisciplinary ideas and concepts can also occur at earlier timepoints in a student's academic career, as early exposure may support an expedited adoption of knowledge and skills at a graduate curriculum level.[17,26] While early exposure can be beneficial to interdisciplinary education, there is a need to provide continual development of skills and knowledge for graduate students in interdisciplinary programs or who seek to develop their interdisciplinary research skillsets.[11,49]

Faculty members play an imperative central role as the gatekeepers to interdisciplinary education and research training, as they can serve as proponents, detractors, or impartial parties to interdisciplinary practices.[15,47,48] As part of graduate students' socialization into disciplinarity or interdisciplinarity they are exposed to and interact with faculty members, learning from them and modeling their perspectives. Faculty members who are not interested in interdisciplinary research, or who do not have experience with interdisciplinary research may unintentionally deter or prevent students from engaging in interdisciplinary research or interdisciplinary training.[15] Antithetical to this, faculty may also serve as the champions and propagators of interdisciplinary education and quality interdisciplinary research. As with disciplinary training, faculty can serve as mentors and on interdisciplinary or multidisciplinary committees to assist in guiding graduate student development.[9,24–26,39,42–44] Mentoring provides an opportunity for graduate students to learn directly from a disciplinary or content expert, through critical discussion, growth reflection, student research support, and research experience opportunities,

alongside numerous other options for student engagement. [9,24–26,33,39,42–44] Also, mentoring interactions can enrich a graduate student's learning process and help them to develop skills, learn methodologies, develop an interdisciplinary identity, and develop a sense of professionalism. [9,24–26,33,39,42–44] Furthermore, faculty members can serve a vital role in a student's interdisciplinary development by serving on a thesis or dissertation committee, serving in the role of a content expert helping to guide student research and learning processes.[8,26]

Interdisciplinary graduate education, similar to disciplinary graduate education, necessitates the availability of opportunities for students to learn skills, methods and knowledge while in groups/teams, from their peers, and from social interactions with various professionals, in both formal and informal settings.[9,11,17,18,36–38,44,49–53] Peer learning provides graduate students with an opportunity to engage in discussions and collaborations with individuals near their own level of expertise.[11,17,44] Graduate student interactions with student peers from other disciplines can provide a mutually beneficial environment for interdisciplinary communication skills development, and affable exposure to another discipline's unique language, knowledge areas, and preferred methodologies.[11,17,44] Additional interaction with a variety of peers, faculty members, and other professionals affords opportunities for graduate students to engage in activities that will serve as experiences for them to grow from and further build their own research toolkits. These experiences can drive student acquisition of teamwork skills, communication skills, and methodological skills, while simultaneously assisting to develop a student's professional network.[8,9,18,38,51] Furthermore, these opportunities for discussions and skill improvement can occur in formal academic settings or in informal social settings outside of the general academic curriculum for graduate students.[36,38,53]

Whether formal or informal, a safe, supportive, and diverse educational and research environment can assist in maintaining or developing an interdisciplinary program, as it too can benefit disciplinary programs and other stages of education.[24,25,27,29,31,36,38,40,42,53] As with all of higher education, interdisciplinary education thrives with diversity, as it brings together an abundance of perspectives, philosophies, life experiences, and ideas which further the creation and advancement of quality educational settings that develop future professionals, and quality research that has the potential to support and empower the communities around us.[29,36,40,42] Safe spaces that allow for and support an open discussion of ideas and provide time for students to ask questions, share their thoughts, or express any lack of understanding that they may have can assist in assuring their academic development and provide a sense of belonging within their respective communities.[25] Alongside diversity, and safe spaces, interdisciplinary academic settings may necessitate a supportive environment that encourages graduate students to develop a sense of ownership in their own academic and future professional careers.[27,31] Whereas graduate students are the primary consumers of education within their respective programs, it falls to them to plan and map out their personal paths to success, yet this can be supported by adjacent parties around the university setting [27,31]

Support from peers, faculty members, departments, university administration, academic institutions as a whole, and national agencies is vital to sustain the growth and development of interdisciplinary programs, and graduate students with interdisciplinary interests and pursuits.[8,15,19,20,23,24,26–28,39–42,46,47,54,55] Support comes in many forms including physical or virtual spaces, grants or financial resources, departmental policies, school or college policies, institutional policies, interdisciplinary degree options, degree requirement flexibilities for graduate students to pursue interdisciplinary education, and flexibility on tenure and promotion

requirements for faculty members to pursue interdisciplinary research or to teach interdisciplinary courses. Institutions can serve to bolster or stifle interdisciplinary education or research pursuits; if there is a direct and vocal support for the creation and development of interdisciplinary education programs or research, faculty, and therefore graduate students, may be more readily inclined to engage in these types of academic and scholarly pursuits.[8,19,20,26,27,40–42,47] So too of the reverse, if institutions have policies or a culture that do not support, or unintentionally disincentivize interdisciplinary pursuits, faculty may be less likely to engage in interdisciplinary research or education.[8,20] This may result in graduate student inculcation into the same culture, or a student perception that they will ultimately have to initiate and facilitate progress towards interdisciplinary acceptability and advancement.[8,20]

Individual departments have an inherent interest and necessity to maintain and advance their respective disciplines as they recognize the great importance of their own discipline and rely on the discipline for their own department's continuation. From this, departmental policies or degree options have the potential to discourage graduate students from pursing interdisciplinary education or utilizing interdisciplinary research for their theses or dissertations.[42,56] Furthermore, departments may be unintentionally maintaining a silo within their own disciplines.[23,25,42,57] The literature around disciplines, in association with interdisciplinary pursuits, has a few constant themes: individual disciplines and their practitioners can help to further interdisciplinary education and research; interdisciplinary education and research can help to solidify and strengthen disciplinary skillsets; and the idea of disciplinary equity: while every discipline is different and unique, they are all important, have value, and want to be appreciated by other disciplines.[10,23,32,35,41,54] A common difference between disciplines, as noted in the literature, is that different disciplines may utilize a unique

'language,' as they may refer to concepts or ideas with terminology used by their disciplinary peers.[8,28,45,46,52] This difference in disciplinary languages or lexicons requires an additional step when discussions or collaborations occur between two professionals, but this barrier can be overcome with a shared understanding or by approaching a shared language, with further interactions between these professionals. However, when bridging between certain disciplines, students or faculty may not have to overcome the disciplinary language barrier, while some individuals regardless of discipline may be adept at interdisciplinary discussions.[9]

The effect of disciplinarity on interdisciplinary research and education has a debated impact. Some segments of the literature emphasize a strong disciplinary background, while others discuss challenges faced by graduate students, and faculty members who are overly ingrained in disciplinary cultures or practices.[7,9,10,20,35,41,45,46,49,52,54,58–61] Parts of the literature suggest that higher levels of disciplinarity are beneficial for interdisciplinary research and education, and may have the potential for cyclical advantages that further improve disciplinary skillsets.[7,10,35,41,45,46] There is also literature that suggests that higher levels of disciplinary socialization, or backsliding into the silos of their disciplinary expertise comfort zones (disciplinary backsliding), can detract from a graduate student's potential for success in interdisciplinary education or research.[7,23,42,49,52,59,60] As interdisciplinary research and education come with additional relationship challenges, additional time requirements, and a degree of ambiguity, graduate students may feel more restrained by their home disciplines, be more prone to disciplinary backsliding, favor increasing relationships with their disciplinary peers, or solely utilizing their singular disciplinary skillsets on questions or issues that necessitate multifaceted solutions and perspectives.[7,46,49,54,58–61] Disciplinary and interdisciplinary socialization are both

important in their own right, and occur naturally in graduate programs, but further research is needed to determine the interrelationship between these two and how they affect one another.

Graduate Student Motivational, Attribute, Skillset, and Perception Changes:

From our literature search, we were able to identify two studies that discussed student motivation for interdisciplinary education or research.[14,15] Knobloch et al. conducted a mixed methods study with student and faculty participants, associated with a semester-long flipped classroom model interdisciplinary course with 32 students: 11 doctoral students, 20 masters students, and one undergraduate student.[14] Their study entailed a one-group pre-experimental design employing a set of pre- and post-test questionnaires grounded in two motivational theories, 'expectancy value motivation' and 'self-determination motivation,' to describe student learning experiences and motivations.[14] Thirty-two pre-test and 19 post-test questionnaires were analyzed; however, only the post-test contained a question directly asking about motivation.[14] Knobloch et al. found that 90% of students reported that they were motivated to learn in their course.[14] Moreno and Danowitz discussed how student motivation for conducting interdisciplinary research could increase with graduate students' prior skills, prior knowledge, and prior experience with other disciplines.[15] Future studies could further examine graduate student motivation and motivational changes around interdisciplinary education, interdisciplinary learning, and interdisciplinary research.

Outside of motivation, current literature has associated interdisciplinary education and graduate student interdisciplinary research experiences with an opportunity for students to show increased confidence, creativity, and interest.[14,47,53,62] Marback-Ad and Marr discussed that graduate students reported increased confidence associated with participation in an interdisciplinary education course.[62] Hains-Wesson and Ji found that student creativity increased

after participating in a short-term study tour that integrated interdisciplinary learning.[47] Negative responses have also been associated with interdisciplinary education; graduate students have reported increased anxiety, or feeling like 'academic deviants,' by breaking the traditional disciplinary mold.[9,23] As aforementioned, it may take a unique type of student to overcome the challenges presented by interdisciplinary education or research, as they are usually breaking the traditional academic or scholarly mold.[24]

Articles from our literature search point to multiple skill areas where graduate students have had improvements associated with interdisciplinary education or interdisciplinary research experiences. These skill areas include methods knowledge, writing, communication, teamwork, leadership, public speaking, knowledge translation, networking, and disciplinary literature knowledge.[10,14,18,24,28,29,33–35,37,38,44,53,62,63] Drotar et al. discussed including interdisciplinary faculty during research training, which helped students learn about informed consent, multisite data collection, planning data analysis, and preparing manuscripts and presentations.[44] Using active learning with the 'Evidence in Aging' study, Finlay et al. reported that students gained experience in questionnaire development, interview development, facilitating interviews, and analyzing results using quantitative or qualitative methods.[33]

Multiple studies from our search related interdisciplinary education with the development of student communication skills, as students had the opportunity to interact with peers and faculty members from various disciplines, while concurrently learning about the languages and terminologies of these disciplines.[10,18,24,28,37,62] Along the same lines, graduate students developed teamwork and leadership skills associated with interdisciplinary course group work and active learning opportunities working on interdisciplinary research projects.[37,38,44,63] Of the professional and social interactions experienced, students were given the opportunity to learn new

professional and technical skills, develop their existing skillsets, and actively apply their knowledge in various hands-on and applied settings. Furthermore, from these experiences, graduate students gained an appreciation of the value of other disciplines and an understanding of the knowledge and expertise they provide.[23,28,37,38,47,50,53,63]

Beyond improvements or changes in methodology knowledge, attributes, skillsets, and perceptions, our literature search also found that interdisciplinary education and research training has been associated with increased career productivity where individuals may yield more publications and citations.[53,56,64] Millar examined interdisciplinary doctoral dissertation research and its effect on early career placement and publications; they found that interdisciplinary dissertation research was positively associated with publication productivity as compared to individuals who reported non-interdisciplinary dissertation research.[64] However, this finding was also associated with academic positions in a subsequent model which often entail publication requirements, but interdisciplinary dissertation research retained a modest positive association on publications.[64] Tucker discussed career outcomes associated with levels of interdisciplinarity, finding that higher levels of interdisciplinarity were associated with more publications and citations across a 13-year period, among social work, social science, and allied health graduates.[56] Although our literature search was able to find some improvements, changes, and benefits, further research is needed to better inform potential associations with interdisciplinary education and research training.

STUDY LIMITATIONS

This study has some limitations that originate from its design protocol.[2] Under this study's protocol for the literature search, there may be articles and studies of relevance to the research questions that were not identified or included in our sample. Some absent studies could

have publication dates starting in 2021, be a part of the 'grey literature,' or were not housed under the UML's 'One Search' algorithm as the study was being carried out. Per protocol, this study did not have an immediate focus in "interprofessional" literature and may be missing some key information from this segment of scholarly inquiry. Individual study personnel reviewing articles for inclusion may have an inherent bias regarding which information they select for study inclusion; however, this was controlled for by having more than one article reviewer and having a third member of study personnel evaluate any debatable inclusion/exclusion decisions of the article reviewers. Individual biases may also affect reporting of included articles, but this was controlled for by maintaining two individuals reviewing articles and a third individual serving as a moderator in case of disagreement. However, the two reviewers and the mediator are all from the same department and have been trained in the same disciplinary content. As we did not evaluate the quality of any included article for this study, it is possible that an included article may not meet a sufficient level of quality, but we attempted to control for this somewhat by only selecting articles that have been peer reviewed and published in a scholarly journal.

CONCLUSION

This study was intended to provide a baseline understanding of current literature on interdisciplinary education and research training, with an eye toward the beneficial revelation of graduate student interest, benefits, barriers, and motivation levels. Through our literature search, we were able to provide information related to our research questions, although there remains much to learn and explore around interdisciplinary education, interdisciplinary research training, and opportunities for interdisciplinary research. Interprofessional education and research around the healthcare fields was not specifically examined in this review. However, current literature has a breadth of information around interprofessional education, research, and its practice in real-

world settings. This study did not include 'grey literature,' articles published before January 1, 2000, or articles published after December 31, 2020; thus, we may not have all and the most current information on interdisciplinary education and research training. Future literature reviews, scoping, systematic, narrative or other, with a similar topic could pursue information from unpublished sources and information published outside of the inclusion timeframe. Additionally, reviews could be completed including articles published in languages other than English where study personnel have proficiencies in those languages.

One topic of note that appeared during our literature search was the idea of initiating the development of a common methodological framework, across all sects of scholarly inquiry.[52] This framework could utilize a common vocabulary or language, focus on research questions as the pivotal decision makers in research, and allow for methodologies to be applied to any scientific research problem.[52] Many of the studies we examined discussed in varying lengths the differences between disciplinary languages and preferred methodologies, and the potential challenges these differences presented for the development and practice of interdisciplinary research and the implementation of interdisciplinary education. Furthermore, the development of a common methodology framework could provide for seamless information dissemination across disciplines and to the general public. This could be a potential topic of discussion between various disciplines while also serving as an opportunity for different disciplines to interact. However, implementation of this idea on a wide scale would be highly challenging, cost prohibitive, and improbable.

A potential avenue for future research could pursue best practices for providing interdisciplinary exposure to students at earlier points in their academic careers, which may help to incline them towards an easier adaptation and employment of interdisciplinary rationale and

practices during their time in graduate school. We were able to identify four studies pointing to early exposure for interdisciplinary as a possibility for improving graduate interdisciplinary education outcomes.[7,17,26,65]

Interdisciplinary graduate education can benefit from careful planning, consistent engagement, sufficient resources, support from various stakeholders, and input from individual disciplines; but to what extent these can support individual programs needs further clarification. Future studies could examine existing interdisciplinary education or research training programs to identify what factors are associated with their success or reasons why a program is failing, to provide more information on the creation and development of such programs.

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CHAPTER 3:

A Qualitative Interview Study Evaluating the Perceptions and Beliefs of Graduate Students and Graduate Faculty Around Graduate Student Interdisciplinary Research Education and Training

INTRODUCTION

Amidst an increasingly connected and globalized world and scientific community, interdisciplinary research has continually been identified to further develop existing information and delve into new topics for the advancement of scientific knowledge.[1–5] From this, educating and training graduate students in interdisciplinary methods, practices, and skills has become necessary to better enable professional successes in current graduate students, the future professionals of their respective disciplines.[1,2,6,7] As experiences in one's training can comprise a form of socialization, it is possible that interdisciplinary successes in the graduate program may foster interdisciplinary practice after graduation.[5,7] There is evidence that interdisciplinary graduate training and research can have benefits for individual disciplines[8–10], even potentially strengthening disciplinary skillsets.[10–13] Still, within-discipline socialization is strong, and can limit the positive perception of interdisciplinary effort for both graduate students and faculty.

In a study conducted by Holley, researchers interviewed 40 doctoral graduate students on their interdisciplinary identity, and what factors may be associated with it.[7] Their findings suggested that interdisciplinary programs and traditional doctoral programs have innate similarities: that students had trouble defining interdisciplinary expertise due to its integrative nature, that students utilized their existing disciplinary knowledge in interdisciplinary practices, and that interdisciplinary proficiencies develop from the practice of interdisciplinarity.[7] Graduate

student perspectives, beliefs, and interest around interdisciplinary education and research can affect the success of current and future programs, necessitating an exploration on this topic.

Moreno and Danowitz discussed that graduate faculty members serve as the 'gate keepers' to interdisciplinary education and research training for graduate students.[14] The introduction must be made, so that graduate students see the interdisciplinary path before them. A faculty member's interest in serving in a supervisory role towards student learning are beneficial for interdisciplinary education and training.[14] Conversely, if a faculty instructor, advisor, or mentor has a negative perception of interdisciplinary efforts, the effect on related graduate students is likely to yield similar perceptions. Thus, there is merit in the exploration of perceptions of both graduate faculty and graduate students with respect to this topic.

RATIONALE

From our background literature review, we were unable to identify any studies that detailed the beliefs and perceptions of graduate students regarding interdisciplinary research education and training. Their beliefs and perceptions could help to identify potential avenues for improvement around interdisciplinary education and training and to help understand if graduate students are interested in learning in these environments. Additionally, while the practice certainly exists, we were unable to find any studies describing faculty interest in serving in interdisciplinary teaching roles for graduate students, or information on faculty pursuing interdisciplinary research. Faculty willingness to teach in interdisciplinary courses and settings could serve as the backbone for potential interdisciplinary programs. A qualitative study to explore such perceptions was conducted to provide a foundation for further quantitative research.

This study aimed to fill these informational gaps by examining the beliefs and perceptions of graduate students and graduate faculty members in the social sciences. Understanding the beliefs and perspectives of graduate students and graduate faculty members can help to inform newly developed or existing interdisciplinary graduate education programs. Graduate students are the primary consumers of graduate level interdisciplinary education and research training and as such it is necessary to understand their beliefs, perspectives, interests, and experiences as to best inform interdisciplinary programs. Furthermore, graduate faculty members serve as the backbone of interdisciplinary education and research training through their active roles in teaching and research in addition to their knowledge and methodological expertise. Faculty members can have insights in their beliefs, perspectives or experiences around interdisciplinary graduate education that could further aid in developing interdisciplinary graduate programs.

RESEARCH QUESTIONS

- Research Question 1: What perceptions and beliefs do graduate students in social sciences have on interdisciplinary research?
- Research Question 2: What perceptions and beliefs do graduate students in social sciences have on interdisciplinary research education/training?
- Research Question 3: What perceptions and beliefs do graduate faculty in social sciences have on interdisciplinary research?
- Research Question 4: What perceptions and beliefs do graduate faculty in social sciences have on graduate student interdisciplinary research education/training?

METHODS

Study Design:

This study utilized a qualitative design to ascertain perceptions, beliefs, and experiences of graduate students and graduate faculty around interdisciplinary research and interdisciplinary research training. Interviews were employed with participants drawn from the recruitment university's graduate students and graduate faculty. Semi-structured interviews were employed to discern participant perceptions and beliefs on graduate student interdisciplinary research and training. Additionally, participants were asked about their experiences with interdisciplinary research.

Sample and Recruitment Strategy:

Participant recruitment was carried out at a large research-intensive public university in the southeastern United States. Our sample consists of graduate students who were enrolled in the 2022 spring semester and graduate teaching faculty at the recruitment university. To improve the potential focus of the results, recruitment for this study was only carried out in applied social science research-focused departments with existing graduate programs. For this study the definition of social science used was 'a study of human behavior and organization.'[15] Social science graduate programs with course requirements including at least one course in research methodology (general, qualitative, or quantitative), and at least one course in applied statistical analyses were selected.

Social science departments were selected as a pilot population for the introductory exploration of this research for two primary reasons: 1) the likelihood of a similar research lexicon among disciplines; and 2) their similarity to the home disciplines of study personnel. Exploring the

perceptions and beliefs of graduate students and graduate faculty members in social sciences enabled study personnel to have a working understanding of the educational and research practices of the included departments (future studies should include additional departments). Purposeful sampling and 'snowball' sampling were utilized to recruit graduate students and graduate faculty members. These sampling methods produced a non-randomized convenience sample of participants for this study.

Graduate student sampling began in two graduate level statistics courses and with a graduate student legislative body on campus. These bodies of graduate students were selected for their broad representation of graduate students in social science-focused departments. Initial recruitment in the statistics courses was carried out in person where a member of study personnel gave a description of the project and asked for graduate student participants in person during a class period. The study personnel member also asked students in these courses to ask their fellow students to complete an interview. A follow up with email was sent to all students in the two courses. A recruitment email was distributed to the graduate student body on campus requesting participants from social science departments, but we were unable to visit the graduate student legislative body in person as the last legislative session had occurred prior to initiation of study recruitment. After initial recruitment, an email was distributed to all graduate students in all social science-focused departments at the recruitment university. A follow up email was distributed two weeks later asking for additional participants and thanking those who already participated.

The first graduate faculty member interviewed was purposefully selected to give feedback on the interview guide. After the initial graduate faculty interview, recruitment was carried out via an email sent to all graduate faculty members in the included departments. A

second round of emails was distributed to faculty members two weeks after the initial email. As some questions in the interviews relied on memory, graduate faculty member participants were asked to have a version of their Curriculum Vitae prepared before the interview so they could refer to it if necessary. All recruitment emails included statements asking for the individual's participation in this study, a brief description of the study, and contact information for study personnel if the individual wanted more information or had any questions. During some interviews, participants from departments with lower participation were asked to encourage other members of their department to participate in this study.

For the purposes of this study a department's discipline must have at least one associated scholarly journal available for publications, the department must have been an active program at the recruitment university, and the department must have had enrolled graduate students. Seventeen departments were included for participant recruitment. These departments included *'Accountancy,' 'Communication Science and Disorders,' 'Criminal Justice and Legal Studies,' 'Economics,' 'Finance,' 'Health, Exercise Science, and Recreation Management,' 'Higher Education,' 'Leadership and Councilor Education,' 'Management,' 'Marketing,' 'Nutrition and Hospitality Management,' 'Pharmacy Administration,' 'Political Science,' 'Psychology,' 'Social Work,' 'Sociology and Anthropology,'* and *'Teacher Education.'* All social science-focused departments, disciplines, and degree programs may not be included or represented in this study. Some departments, or disciplines included may not be universally identified under the umbrella of applied social sciences.

Participant recruitment was carried out until information saturation had been achieved for both student participants, and faculty participants. Participant recruitment was initially aimed to be carried out until information saturation had been achieved in four categories. The categories

were based on which school/college a department was housed within, and consisted of 'Liberal Arts,' 'Education,' 'Business and Accountancy,' and 'Applied Sciences and Pharmacy.' These schools/colleges are each unique in their own right; where the Schools of Applied Sciences and the School of Pharmacy have a focus on health, healthcare, and legal topics, the School of Liberal Arts has representation from classical disciplines and schools of thought, the College of Education conducts pedagogical research and trains future educators and administrators, while the School of Business and the School of Accountancy focus on entrepreneurial and business practices. While each of these schools/colleges have different representation and foci, they share the inclusion of social science departments. For reporting, 'Business and Accountancy,' and 'Applied Sciences and Pharmacy' have been separated. No participants were associated with the School of Accountancy, and it is not reported. We have a large representation from the School of Applied Sciences and the School of Pharmacy but lower representation from the other schools. However, many participants regardless of their department or school spoke to similar ideas and themes with few dissenting opinions.

Graduate student participants met the inclusion criteria if they were enrolled in the 2022 spring semester at the recruitment university, were enrolled in a degree program housed in a social science research focused department, and if they consented to participate in the study. Graduate faculty participants met the inclusion criteria if they were full time employees of the recruitment university, had a teaching appointment in a social science research-focused department, and if they consented to participate in the study. Participants met the exclusion criteria if they had not conducted, or will not conduct, social science-focused research, are a graduate student enrolled in an online only program, are an adjunct faculty member with an employment position outside the university, or if they are under the age of eighteen. Students in

online only programs were excluded on the basis that they may have different graduate education culture experiences due to the remote completion of their degree programs. Graduate students that complete their degree programs through an in-person setting may have more opportunities to interact with or be exposed to peers and professionals around the university setting. Participant recruitment could not begin until this study had been approved by the University Mississippi Institutional Review Board. Due to the nature of the study, all possible departments and disciplines may not be represented because of the confines of a single university. Interviews reached information saturation before all available departments were included.

Data Collection:

Interviews were semi-structured with scripted questions on demographic variables and open-ended questions on the participant's perceptions, beliefs, and experiences around interdisciplinary research and training. Due to the COVID-19 Pandemic, interviews were carried out remotely over a phone call or on a Zoom video call to protect the health and wellbeing of our participants. Interview participants were given the choice of which platform, Zoom or phone, they prefer. If a participant indicated they did not have a preference, interviews were conducted in Zoom to allow for a 'face to face' conversation to occur. Interview facilitators utilized a conversational guide to better direct the interviewee on the interested topics, and when appropriate asked follow up questions to explore responses in more detail. Please see Appendix 2.A for the graduate student interview guide, and Appendix 2.B for the graduate faculty interview guide

All interviews were audio recorded if conducted by phone, or video recorded if conducted on Zoom. In the event a participant preferred to use Zoom but did not want to be video recorded, the participant was asked to leave their video off for the duration of the

recording. Zoom audio recordings were separated from the video files before transcription to protect participant personal information. Interview recordings served to produce transcripts of the discussions. Transcripts were created by Trint,[16] an online transcription program, after which a study personnel member verified the transcripts. Transcripts were utilized to draw quotes and for thematic review during analysis. All transcripts were exported from Trint to Microsoft Word for analysis. All participants are referred to by pseudonyms in transcripts and quotes, as to protect their individual identities. Interviews continued until information saturation was achieved. Interview recordings will be deleted after a year, or upon acceptance to a scholarly journal for publication. All transcripts and associated data will be deidentified, from participants' names to interview identifiers. After transcript deidentification, all transcripts will be turned over to the Department of Pharmacy Administration, University of Mississippi. This study was approved by the University of Mississippi's Institutional Review Board before interviews and data collection began.

Interview Open Response Questions:

Open response questions were aimed to understand participant perceptions around interdisciplinary collaborative research. Initially, graduate student participants were asked to describe their readiness, willingness, and ableness to participate in interdisciplinary research, along with what they believed attributed to their responses. Follow up questions were asked to encourage deeper responses around readiness, willingness and ableness for interdisciplinary research. Readiness is a participant's belief that they could engage in interdisciplinary education or research with their current understandings. Willingness represents a participant's openness to engaging in interdisciplinary research or education. While ableness was asked to understand if participants believed in their ability to succeed in interdisciplinary education or research.

Additional questions were aimed to ascertain the graduate student participants' beliefs, and perceptions around the practice of interdisciplinary research. Furthermore, subsequent questions ascertained descriptions, perceptions, and beliefs around the participant's student training experiences in interdisciplinary research. Follow up questions dove deeper into the information provided, to better understand the intricacies involved within their responses.

Graduate faculty participants were asked to describe their readiness, willingness, and ableness to conduct interdisciplinary training for graduate students. Follow up questions were asked to examine what faculty attributed to their beliefs around interdisciplinary education and training, while also attempting to ascertain potential avenues for interdisciplinary course development or improvement. Additional questions were asked about their personal experiences with interdisciplinary projects where they worked with members of other disciplines. Furthermore, faculty were asked about any interdisciplinary research training they may have undergone in graduate school or during their continuing education courses. Finally, questions were asked aimed at understanding what barriers or paths may be available for the implementation of interdisciplinary research training in their respective programs.

Interview Structured Questions:

The structured questions in the interview served to obtain an understanding of the participant's demographics and to obtain a brief history of involvement with collaborative research in both disciplinary and interdisciplinary settings. Base demographic questions for graduate students included gender, student year, student department, previous educational attainment, years working in academia, years working professionally outside of academia, and previous experience in disciplinary collaborative research and interdisciplinary collaborative research. Base demographic questions for graduate faculty included gender, years working in

academia, years working professionally outside of academia, associated faculty department(s), previous educational attainment, previous experience in disciplinary research and previous experience in interdisciplinary research. Follow up questions were asked for both graduate students and graduate faculty to describe previous experiences in disciplinary and interdisciplinary research.

Data Analysis:

Content analysis utilized a phenomenological approach to emphasize the perceptions, beliefs, and experiences around interdisciplinary research and training/education. Two members from the study research members team worked in tandem as interview coders to identify recurring themes within the transcripts, notes, and recordings. Having two reviewers was necessary for analysis to reduce any potential biases with a single researcher reviewing the results. Interview coders read through all interview transcripts identifying portions with codes that reflected occurring themes, around the research questions, within the responses. If the two interview coders disagreed on a code, and did not come to a consensus, a third member of study personnel served as a moderator and assisted in determining if the code in question was accurate. Recurring themes were analyzed for central themes around each research question. The central themes, sub-themes, and quotes around them are reported. Descriptive statistics were conducted on interview structured variables and are reported.

Timeline:

This study was expected to take four months to complete. We expected participant recruitment to last about one month, data collection through interviews to last about one month,

thematic analysis to last for about one month, and final write up and revisions to take about one month. This study took five months to complete, post proposal.

Ethical Statement:

This study was approved by the University of Mississippi Institutional Review Board under Protocol 22x-253.

RESULTS

Sample:

Study recruitment concluded after three rounds of graduate student recruitment and two rounds of graduate faculty recruitment. Information saturation was achieved with little to no new information being obtained with the final few interviews. At the point of saturation, 10 interviews had been conducted with graduate student participants, and 13 interviews were completed with graduate faculty participants. All participants were given pseudonyms chosen at random, based on Nobel Prize recipients. Both graduate student and graduate faulty participants were primarily female (70% and 62%, respectively). The majority of participants were from the School of Applied Sciences (35%) and the School of Pharmacy (35%). Please see 'Table 2.A' for additional sample characteristics.

Graduate Student Themes

Student Theme 1: Learning Opportunities in Interdisciplinary Education and Research:

All student participants in our sample reported having taken at least one interdisciplinary course or a course with multidisciplinary representation, and six student participants in our sample had experience with a least one interdisciplinary research project during graduate school.

Graduate student participants in our sample discussed interdisciplinary education and research as an opportunity to learn new skills, explore new topics, and exposure to new disciplinary perspectives as opportunities for learning and engagement.

Learn new skills:

Students recognized that taking a course from outside their department or working on research in an interdisciplinary setting could expose them to new methods or skills. These could be new regarding their own methodological strengths, or a method not commonly found in their own disciplines. Additionally, they expressed that they could employ the learned method or skill for research within their own discipline.

> "So, I think one, the educational aspect is that you get to learn another skill or another methodology that you could apply, and it could be a new addition to your own field. So that is all the academic advantage." (Harvey)

Explore new topics:

When asked about taking courses with other departments, multiple students discussed the opportunity to learn about and explore new topics that were outside of their own discipline's area of expertise. Some of these respondents cited general interests in learning the materials while others aimed to expand their own knowledge for future application.

> "Since I'm interested in social justice, let's say I took a class in the Political Science department. I think having some kind of knowledge on some political science stuff could feed into my own research on how people make judgments regarding like political candidates and things like that. So, I think kind of learning what other people were doing out there in the world can help me in my own research." (Dmitry)

Disciplinary perspective exposure:

Taking courses with other departments or experiences with interdisciplinary collaboration allowed them to learn about the perspectives of other disciplines that helped to broaden their own perspectives. They also recognized that it was valuable to understand different perspectives to examine problems or issues more thoroughly.

> "I enjoy it any time I feel like I'm learning something new, you know, being able to work with two different experience and a different perspective than I do, it makes things more enjoyable. So, any time we can get people together with different ideas and perspectives, and just have those discussions is valuable. And I really enjoy that." (Selma)

> "And I would [be interested in taking more classes outside my department] yes. I would prefer to see more interdisciplinary options because, or the option to take classes outside of the [my department's] program, just because I think it's really helpful to have a broader perspective." (Joshua)

Student Theme 2: Perceived Benefits of Interdisciplinary Education and Research:

Beyond opportunities to learn and develop their own skills, graduate students identified benefits to their own research or understanding, the applicability of interdisciplinary research to solve novel issues or problems, the chance to network and interact with peers and faculty from outside of their department, and the prospect of developing professional relationships as perceived potential benefits associated with interdisciplinary education and research experience.

Benefits to own research or understanding:

When taking their own learning and research into consideration, student participants talked about interdisciplinary opportunities to develop their own understandings and advance their own research pursuits. Some participants described their own discipline as a collection of other disciplines and discussed the potential to learn from external fields of study. Students believed that learning from other fields could deepen their own disciplinary methodological knowledge, and aid in improving their personal research.

> "I think that with [my discipline], it is so broad. I think the way in [my discipline], to narrow in on just like, you know, for instance [my discipline's specialty area] or things like that. But I think there's these other aspects of [my discipline] such as management and marketing and communication and program development and all of these things you can't just get that, or it can't be found in just the department alone. And it does require kind of going outside the department to get that information and then bring that back and try to tie it back into our research interests and what makes sense for [my discipline]." (Ardem)

Solve novel issues or problems:

From our background literature search, many articles discussed a benefit of interdisciplinary research as the potential to develop novel research projects, or to address complex contemporary issues or problems. Student participants discussed this potential and believed that experience working with these projects could further develop their own skill sets.

> "Just the chance of working on something that would be novel because of mixing of a few disciplines to kind of answer a research question. So that could definitely be

interesting. And then just learning and growing from the experience of adding something new to my own set of skills, that would also be another positive part of it." (Harvey)

Networking and interacting with peers and faculty from outside their home department:

Graduate students recognized the importance of professional relationship development, and peer learning. They discussed the potential for interdisciplinary education and research experiences to help stimulate these interactions. Students were able to have conversations with students from other departments that helped to expand their professional networks, while bolstering their scholarly communication skills. Additionally, one student participant in our sample recommended the creation of more interdisciplinary graduate minors to foster connections between students of different disciplinary backgrounds, while simultaneously offering supplementary learning opportunities.

"I'm doing the graduate minor in applied statistics and because that one is interdisciplinary, that program is interdisciplinary by nature. I've been able to meet a lot of people from other areas who I never would have been able to meet otherwise and have some really good conversations with people that I wouldn't have been able to talk to. Several people from social work, people from exercise science, from pharmacy, from psychology. Yeah. That has definitely been a positive. Being involved in that interdisciplinary minor." (Selma)

"I would say it's positive because also I think it goes back to personality style too, because I also like meeting different people as well. So, I also like meeting people from different disciplines. I'm learning from them as well. So, I think it's always interesting to see the way that they think about things too." (Ardem)

Professional relationship development:

Through the development of professional relationships, student participants highlighted the potential for the development of new working relationships that could culminate in new research. Ardem had already initiated a discussion with an external student peer on pursuing a common research interest.

> “But that's another opportunity for graduate students who maybe are like me and don't have a lot of opportunities in their program to engage in interdisciplinary work, to go out and take courses with other people and meet other people in other departments and have those conversations that might lead to research projects across disciplines.” (Selma)

> “I had a research project idea I brought up to someone in [another] department where it's something that I definitely do want to probe a little bit more on us working together on it because it's involving like, the person's interests in [their discipline] and [a group of individuals] care. And then also [my discipline’s] perspective of like the types of medication that they're giving to treat [their disease]. So, for instance, in that, in that research project, it's really merging the two interests together.” (Ardem)

Student Theme 3: Challenges of Interdisciplinary Education and Research:

Although our sample identified many perceived positives associated with interdisciplinary education and training, it was not without the caveat for potential challenges and barriers faced by graduate students seeking to engage in interdisciplinary education and research. Student participants recognized that interdisciplinary education or research could: add potential burdens associated with additional requirements; force students outside of their

academic comfort zones; that they could have a lack of skills or prior training experience; it could be challenging working with new individuals; disciplinary differences; and perceived disciplinary silos. While some of these issues can also be experienced in solely disciplinary settings, others may only occur in interdisciplinary environments.

Potential burdens:

Graduate school inherently requires a large amount of time and a high level of commitment for students to succeed in their academic environment. While our sample was interested in pursuing interdisciplinary research and education, they were cognizant that it would entail additional time requirements, potential scheduling issues, and other project related problems.

> "I think scheduling and timing are just like the major things because just being from two different departments, sometimes departments just work on different timings and scheduling, and like [have] seminars at a certain time." (Ardem)

> "The more people you start adding to projects…" "…the more they kind of feel distant, you know? You're not seeing them around your department every day, the easier it can maybe be to, like, put off deadlines and not be on the same page. And so, I think some of the difficulties would be just kind of, 'okay, we have to set this regimented schedule.' We need to all be in the same place at one time." "…I'm supposed to be working on this, and you're supposed to be working on that. So, kind of more technical issues. And I assume there could also be a lot of issues with…." "…disagreements over, I guess, what is most important in the project." (Dmitry)

Outside academic comfort zone:

Home departments allow graduate students to maintain a comfort zone in their respective universities, where it may be difficult for them to leave those comfort zones when approaching courses offered by other departments or in the pursuit of interdisciplinary research. Graduate students in our sample discussed this as a challenge, both in approaching a new discipline and in developing new professional relationships with peers and faculty from outside their home departments.

> "Sometimes it may be intimidating to think about taking classes outside of the department, especially when you haven't worked with them before." (Ardem)

Lack of skills or training experience:

When mixing students between disciplines, they may have different levels of training and knowledge bases. While some of these differences can be attributed to newer versus more experienced students, others may occur due to training or degree requirement differences that exist between disciplines or departments. These differences between departmental degree requirements may present as knowledge gap issues between students at similar points in their graduate academic careers. Students and faculty could consider the courses individual students have already completed and how that may position a student for success or struggles in interdisciplinary or multidisciplinary courses.

> "The only issue in my understanding, was [graduate students from other disciplines] were much more advanced. So, for them it was a piece of cake. For us, it's a struggle…. But again, for them it could have been [their] fifth statistical class, and for us it was only [our]

> third. So, they were far more advanced, far more understanding, or [it was] easier [for them] to dwell into the intricacies of statistics." (Ada)

Working with others:

Student participants identified challenges related to differences between their own skill levels and the skill levels of other students. The more experienced students felt they had to guide or mentor the newer students. Additionally, students pointed to work ethic and differences between student work habits as potentially off-putting for collaborative efforts. Students are ingrained in their own discipline where they adjust over time to the work habits of individuals around them, but crossing disciplinary lines comes with new and added challenges that students may face. This challenge can also be present in disciplinary interactions and professional relationships outside of graduate student interactions.

> "I liked the time that I got to meet these new students and [we] are forced to interact with them. But I really didn't love [the collaborative course assignments]. And I think this could be because when I was going through these courses some, a lot of the times our programs have the PhD and the master students intertwined, and sometimes the master's student is just fresh out of undergrad as well. So it's very difficult when I'm on [my] fifth year and I'm talking to a first year master's student when it comes to trying to get assignments done so that it becomes, like it becomes my work or something and then I'm not very good, I say, 'Oh, let's, let's have you do all this' and then watch them not be able to do it, so that I feel like I'm mentoring instead." (Louise)

> “But I will say I think maybe a challenge was, I didn't think of it as much of a challenge, but I think in general like adjusting to other people's work ethic and I'm not sure if that's a matter of like their discipline is different than ours.” (Ardem)

Disciplinary differences:

Students had to adjust to working with individuals from other disciplines, where they may have held different disciplinary perspectives on certain topics. Beyond this, interdisciplinary groups had differences in knowledge areas or preferences for particular methodologies.

> “So, I mean, collaboration required me to be a little more flexible and a little more mindful of that. And yeah, and be, learn to adapt or understand the perspectives of people from other disciplines.” (Harvey)

Disciplinary silos:

Along with disciplinary comfort zones, graduate students and others around academia may be inclined to remain near their respective disciplines or departments. This comes with an opportunity to maintain and develop a smaller set of professional relationships among individuals with a shared or common interest. However, as interdisciplinary pursuits necessitate graduate students and other professionals to cross disciplinary lines, disciplinary silos and disciplinary backsliding present issues for the delivery, development, and dissemination of research and information from interdisciplinary sources.

> “Everybody laments the fact that different fields are siloed and there's not a lot of like interdisciplinary collaboration and communication, and that hinders innovation, but nobody really does anything about it because at the end of the day, it's just academia has

the problem of everybody's just obsessed and frustrated by whatever is in front of them. And it ends up leading to like a lot of, like myopia." (Michael)

"I think a lot of times when you have projects where it's [my discipline] plus [another discipline], people tend to silo themselves, which I don't think is right. They see you've got [my discipline] expert and you've got [another discipline] expert and they need to stay in their lane." (Selma)

Graduate Faculty Themes

Faculty Theme 1: Effective Interdisciplinary Education and Training:

Graduate faculty participants in our sample discussed strategies and ways to provide quality educational settings and on potential routes to maintain effective interdisciplinary research training. All but one faculty participant had published at least one interdisciplinary article and all but two had taught in an interdisciplinary course setting. From their experiences, faculty participants identified the utilization of human capital, team teaching, effective communication when working with peers and students, having disciplinary respect, and experiences that can be relayed to students in an academic setting.

Human capital:

Faculty participants recognized their own disciplinary and methodological strengths but in turn also understood the importance of relying on peers for the delivery of information, skills, and expertise in educational course settings, as well as for support for the practice of quality research.

> “I think I've been here long enough at the university that I know who to contact for questions that I might have on instruction within any of the different disciplines. And then also I think tools are within my own department. We have a lot of very experienced researchers and people who have taught for many years. And so usually we all pull from each other.” (Andrea)

> “So, incorporating guest speakers and then if it's, if it's a topic that's a fairly new prep, but you're sort of looking to get into teaching that particular class more and more. You talk to other people who have taught that class or similar courses and, you know, look at their, you know, if they're willing to share syllabi, take a look at what they've done, the readings they've included.” (Emmanuelle)

Team teaching:

The majority of our faculty participants discussed team teaching as an avenue to deliver quality interdisciplinary education. While faculty believed in their own teaching abilities, methodology knowledge, and experiences, they also recognized the importance of incorporating multiple disciplinary perspectives, and content experts as to provide the best possible learning experience for graduate students.

> “I believe I'm ready to instruct that type of graduate course if it is team taught. I don't think that one discipline should teach that course. You should have as many disciplines that are in that course. There should be faculty of different disciplines in that as well. So as a part of a team, yes.” (Klaus)

> "Because I can't imagine the hypocrisy in teaching an interdisciplinary course all by myself. So, it will have to be team taught, I believe. And if so, yeah, I'm happy to bring in whatever, you know, piece of the puzzle I can best contribute." (Esther)

Effective communication:

Communication between faculty members and with graduate students was identified as an important factor in collaborative research projects, and for teaching interdisciplinary courses. Faculty participants saw a need for a willingness to understand the viewpoints and experiences of others as it could support the development of quality research or the development and delivery of a graduate level course.

> "Where can we find a common ground and to be able to find a common ground communication skills. I think that would be another part where the willingness to communicate and work with others would be another thing that I think would be essential here." (Klaus)

> "Those other team members and sitting down with them and having them kind of communicate what's valuable in their discipline to me communicating what's valuable in my discipline and finding where those commonalities are and understanding where the differences are and how we can work together to move around that…" "…And I think hearing from the students, too, I think would be important. Getting student feedback, I think would be really, really valuable." (Benjamin)

Disciplinary respect:

Respecting other disciplines, seeking to understand other disciplines, and actively working to earn their trust were important factors for faculty participants. As respecting and

learning about other disciplines can help to develop lines of communication, working relationships, and open channels to interdisciplinary research projects. Of note, one participant went a step further and stated support for scholars not pursuing interdisciplinary research.

> "...I feel like my [discipline's] students need to appreciate the other disciplines. I want the other disciplines to understand what [my discipline] can do and appreciate [my discipline]." (Aiby)

> "You have to earn that trust first. I think when working outside your department more, a lot more so than working within your department." (Andrea)

> "I do not want to ever really try and give the perception that I think unless people are doing interdisciplinary work of the nature that I do, that they're doing something wrong, or that they're failing in any way. I don't think that's the case. I think that's one of the nice things about academia is that you have a lot of freedom to work on whatever topic you want in really whatever way that you want to." (Emmanuelle)

Experience:

Experiences were key in the perceptions of our faculty participants. They mentioned experience related to teaching, research, content areas, and professional work experiences. Additionally, they emphasized a willingness to continue learning and experiencing as a platform for the delivery of interdisciplinary courses, and for working on interdisciplinary research. Ten out of our 13 participants highlighted the importance of gaining experience in all fashions to further develop their own skills and help to develop the skills of graduate students.

> "It's better to experience it than to have me talk about it in the abstract, right?... you learn it in a different way if you have to live through it." (Leymah)

> "…When I was recruited into academia by a [faculty member] here at the university, the first thing that [they] said to me was, you know, 'your background and experience is going to be so vital to these students. They're not just reading the book, but you've experienced it.' And so, I bring a lot of that, my case studies and things to the classroom." (Malala)

Graduate Faculty Theme 2: Improving Interdisciplinary Education and Training

While faculty were confident in their abilities to provide interdisciplinary education and training, they also highlighted the potential for continual improvement and learning. Faculty participants expressed an importance in improving current interdisciplinary educational and training practices. They identified exposure to disciplinary knowledge, developing interdisciplinary scholarship, and information bridging as avenues for improvement.

Disciplinary exposure:

Interdisciplinary education and research rely on the continued input of individual disciplines. Graduate students and faculty members need exposure to new information, outside disciplinary experts, and additional methodologies to best inform their practice of interdisciplinarity. Faculty members discussed the importance of providing outside disciplinary exposure to students in their courses.

> "The students really get value from different perspectives because if they work in industry or academia, right, you're going to be doing you think that's what we do every day. And so giving them that kind of exposure and just show and demonstrate how. Faculty can work well in a team is a good example, right? Seeing it being done in a team

type format, assuming it's done in a good and organized way and a healthy way, I think it's just a great example for the student." (Benjamin)

Interdisciplinary scholarship:

As with an individual's development of disciplinary knowledge and skillsets, interdisciplinarity also requires an invested interest and active pursuit of additional and new knowledge. Faculty encouraged the development of interdisciplinary scholarship to improve the delivery of interdisciplinary education and training, and to improve the quality of created interdisciplinary research.

"So, yes, I think the fundamental bottom line for any interdisciplinary study is to know about what other people do without knowing their direction of thought. It's just working. Not even working. Just being together. And it's not working together. If you want to be. You want to form a team, to work together. I think you have to know what other people are." (Reinhard)

"It's a chance to always be encountering something novel, getting to meet new people, talk with new people, ask them questions. But it can have there can be bumps in the road. It can be, you know, if you if you sort of take a step into a new discipline and you're not quite ready, you can get those pretty stinging rebuke from journal reviewers or whatever the case might be. So. It's for me, it's been helpful. But I think that to the degree it's helpful depends on the person and the topic that they're interested in." (Emmanuelle)

Information bridging:

During courses with students from outside their disciplines, faculty noted the inclusion of varying perspectives based on the home disciplines of included students. This served to provide

additional information during each class session and to encourage discussion between students. Faculty participants noted they would provide varying examples to include graduate students from different disciplinary backgrounds.

> "I would say that the questions that these students from outside the department ask are often in addition to the regular learning questions that I think questions about how to bridge what they're learning in the classroom. But what they want to do with that knowledge area are what they're learning in the classroom with the specific project they are working on that is more unique and that is what led them to take this course." (Esther)

Graduate Faculty Theme 3: Challenges of Interdisciplinary Education and Research

While faculty participants were confident in their own abilities, believed in the potential that others could bring to a course or research project, and offered ways to improve interdisciplinary education, they too discussed challenges they had faced in previous research projects or while teaching interdisciplinary courses. Faculty members pointed to disciplinary language, and disciplinary differences as potential challenges of interdisciplinary education and training, but faculty also discussed how these challenges could be overcome and did not see them as detrimental barriers.

Disciplinary language:

About half of our faculty participants mentioned differences in disciplinary language, vernacular, or shorthand that serve as an initial barrier to interdisciplinary research and collaboration efforts. However, faculty members further discussed that it was a barrier that could be overcome through effective communication between professional peers. Individuals initially

crossing disciplinary boundary lines may need to take additional steps to familiarize themselves with the language used by other disciplines.

> "…It comes back to that language issue. The way we talk about things in [my discipline] is different than how people talk about problems in business. And so, understanding and I think sometimes there's a shorthand that can be developed for, for people who come from a similar background that you need to be cognizant of when there's somebody in the room that doesn't have that shorthand. And so, for me, it's just making sure to, to explain things that I would usually take for granted that everyone would normally understand and then kind of slowing down in that sense." (Leymah)

> "I feel like that's the bread and butter of science, is that, you know, finding a common language to speak on it and being able to do it clearly and distinctly." (Klaus)

Disciplinary differences:

Among the challenges noted by faculty participants, they identified differences between disciplines, deriving from their training backgrounds, as a potential challenge to overcome when engaging in interdisciplinary teaching or research. In addition to disciplinary language differences, faculty participants focused on differences in preferred methods, analysis standards, publishing standards, article writing differences, and research priorities and interests.

> "I could say a challenge was working with the [another discipline], their journals that they publish in have a little bit different format. The ones that I've worked with were not quite as technical or research-y. You know, I wanted real structure of, you know, the intro, the methods, the results, the discussion, you know, conclusion and application. And

there is, was more descriptive, I guess, a longer introduction and background focused and application." (Andrea)

"So, I would say the big things for me are vernacular, and then what particular methods or particular statistical analysis that maybe are, are pet to those different disciplines." (Klaus)

DISCUSSION

This study examined perceptions and beliefs on interdisciplinary education/training, and interdisciplinary research held by graduate students and graduate faculty members, who were in social science departments. Among the graduate student responses; graduate students are interested in interdisciplinary education and research; graduate students perceive benefits for knowledge acquisition associated with interdisciplinary interactions; graduate students believe interdisciplinary education can assist in their own research; and that graduate students have experienced or can identify potential challenges for interdisciplinary education and research. Similarly, interview results from graduate faculty members are within our expectations that; faculty believe they can teach in interdisciplinary formats; faculty have conducted interdisciplinary research; and faculty have experienced or can identify potential challenges of interdisciplinary research and education.

Graduate students discussed their interest in learning opportunities, potential benefits, and some challenges of interdisciplinary education and research. Student participants believed they could learn new skills, explore new topics, and gain exposure to the perspectives held by disciplines other than their own. Furthermore, graduate students perceived benefits associated with interdisciplinary education. However, graduate student interest was not without perceptions

of challenges and obstacles they would have to face while engaging in interdisciplinary pursuits. Future studies could seek to examine possible solutions related to the challenges discussed by our participants. On the topic of potential burdens, graduate curricula could be assessed for subject areas or courses that could be combined with or supplemented by other departments.

For graduate faculty, we found that faculty believe in their ability to provide quality interdisciplinary education and training. They also identified potential avenues to continually improve its delivery, and some potential challenges related to interdisciplinary education and research. Future research could further examine interdisciplinary scholarship to improve interdisciplinary education and its associated outcomes for graduate students. Faculty participants in our study had a range of experience teaching interdisciplinary courses and conducting interdisciplinary research. All faculty participants stated that they were willing to teach interdisciplinary courses in the future. Some faculty stated they could individually teach the course, while others stated a need or preference for team teaching as it provided additional opportunities for student learning. Team teaching requires careful planning and an equitable professional relationship between faculty members.[17] With graduate student interest and perceptions of benefits in tandem with faculty belief in their teaching abilities and willingness to teach, there remains an opportunity for further development of interdisciplinary programs. Development could entail the introduction of interdisciplinary courses, graduate minors, or increased opportunities for graduate students to work on research with faculty members outside their respective departments.

This study maintained seventeen (17) departments for interview participant inclusion, while participants reported twelve (12) different home departments. Some included departments as with '*Health, Exercise Science, and Recreation Management*,' '*Pharmacy Administration*,'

and '*Sociology and Anthropology'* include multidisciplinary or interdisciplinary courses as part of their required curriculum or may be more interdisciplinary by nature. While other departments like '*Political Science*,' or '*Psychology*,' may maintain a greater disciplinary focus or could be isolated from other departments due to their requirements in their respective graduate curricula. While the included departments vary in both their disciplines and may vary in the structure of their graduate program curricula, the majority of interview respondents maintained similar beliefs and question responses. This may reflect a common interest in interdisciplinary education and research or a common perception of the importance of interdisciplinary education and research across graduate students and graduate faculty members in the social science disciplines. Future studies could further examine the beliefs and perceptions of graduate students and graduate faculty members around interdisciplinarity both within social science disciplines and expanded to all disciplines represented at an academic institution.

STUDY LIMITATIONS

This study may not be generalizable to all populations. This study was only conducted at a single university and among social science-focused departments which may limit generalizability to other populations. Response bias may present an issue for this study in recall bias, social desirability bias, demand bias, and prior knowledge of this study and its objectives. Recall bias may come into question when asking participants about their past experiences. Social desirability bias may be present if a participant perceives interdisciplinary research and its training as something they should already be participating in or be prepared for by their educational programs. Demand bias comes inherently with the study design and may affect participant responses if they attempt to respond how they believe study personnel would want. Prior knowledge of this study is possible in two forms, first if a participant discusses their

interviews with other possible participants. Second, since this study was conducted as part of a doctoral dissertation project, a proposal presentation was completed in front of graduate students and graduate faculty, some of whom became participants in the study. This is an accepted bias. As our method of sampling is non-random, selection bias may be present. Researchers may present an implicit bias for study material. However, this was controlled by having multiple research personnel members review relevant materials for thematic analysis.

CONCLUSION

Our study emphasizes graduate student interest in interdisciplinary education and research training. Interdisciplinary education presents an opportunity to expand and evolve current graduate education practices. Furthermore, graduate faculty identified perceptions, practices, and skills that could assist in the development of interdisciplinary education courses, or training programs, while also being willing to teach future interdisciplinary courses. Graduate faculty also reported having conducted interdisciplinary research; future research projects could serve as training experiences for graduate students. This study adds to the literature around interdisciplinary education and research training by examining the perspectives and beliefs of graduate students and graduate faculty members. As this study was only carried out at a single university, and only among social science focused disciplines, future studies should be completed with different samples as to verify the information obtained in this study

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CHAPTER 4:

An Exploratory Survey Study of Social Science Focused Graduate Student Readiness, Willingness, and Ableness for Interdisciplinary Research Training

INTRODUCTION

Incorporating interdisciplinary education and training at a graduate level may help develop graduate students' skills, proficiencies, professional socialization, and professional identities. However, from our background literature review, we identified few studies that ascertained if graduate students had an immediate interest or motivation to participate in interdisciplinary research, education, or training.

For the intent of this paper, graduate student readiness may reflect the succusses of current disciplinary focused graduate education or the interest of graduate students to engage in interdisciplinary education. Willingness could show an immediate interest from graduate students for participating in interdisciplinary graduate. While ableness was framed as an examination of the participants' belief in their ability to succeed in interdisciplinary education or research which could provide information on the successes of current graduate education in preparing graduate students for interdisciplinary pursuits. One article by Zhang and Shen asserted that graduate students were willing to engage in interdisciplinary learning.[1] An article by Du et al. examined predictors of self-efficacy in online collaborative research among graduate students finding that willingness to handle group challenges as one associate factor.[2] Little else appeared in a literature search around readiness, willingness, or ableness in the educational context. While implementing interdisciplinary graduate education may be associated with

positive outcomes, understanding if graduate students are ready, willing, and able to learn and/or participate in the associated research projects, or coursework remains a topic in need of inquiry.

Understanding self-efficacy for interdisciplinary pursuits provides another angle for insights into the perceptions and beliefs among graduate students.[3] Self-efficacy entails an individual's belief in their potential to complete specific actions or achieve certain behaviors.[3] However, we were unable to find any research focused on graduate students and their self-efficacy for interdisciplinary education and research. A few articles discussed how it may take a unique type of student to excel in interdisciplinary education and research which could include a student who has a higher self-efficacy for interdisciplinary pursuits, or believes they are ready, willing, and/or able to participate in interdisciplinary pursuits.[4,5] Examining the beliefs of graduate students around their readiness, willingness, ableness, and self-efficacy can provide information on student interest in interdisciplinary education and their beliefs in their abilities and knowledge to actively succeed in these environments.

RATIONALE

This study employed an online survey among graduate students to ascertain their readiness, willingness, ableness, and self-efficacy regarding interdisciplinary research education and training. Understanding readiness, willingness, ableness, and self-efficacy for interdisciplinary education and research among graduate students may help to highlight the current success of graduate education and its ability to encourage or prepare students for entry to interdisciplinary pursuits, while also giving an insight into the beliefs and perspectives around interdisciplinary education and research held by graduate students. The concept variables of readiness, willingness, and ableness alongside self-efficacy could provide information to support future research or assist in the development of interdisciplinary graduate programs.

RESEARCH QUESTIONS

- Research Question 1: How much self-efficacy do social science focused graduate students have related to interdisciplinary research training?
- Research Question 2: How ready are social science focused graduate students to participate in interdisciplinary research training and what are the predictors of readiness?
- Research Question 3: How willing are social science focused graduate students to participate in interdisciplinary research training and what are the predictors of willingness?
- Research Question 4: How able are social science focused graduate students to participate in interdisciplinary research training and what are the predictors of ableness?

METHODS

Study Design:

This study utilized a quantitative design employing a cross-sectional survey of social science-focused graduate students to ascertain their readiness, willingness, and ableness to participate in interdisciplinary research training. Additionally, this study inquired with graduate students how many and what types of interdisciplinary research training they may already have been exposed to and their perceptions on these experiences. To assure participant confidentiality, this study did not collect any personally identifiable information, such as name, date of birth, email address, phone number, student ID, or social security number. All data associated with this project has been and will be kept in secure password maintained digital formats. This study was approved by the University of Mississippi's Institutional Review Board before participant

recruitment and survey distribution began. Participant consent had to be received before any participant would be allowed to complete the study's survey.

Sample Population and Recruitment Strategy:

This study utilized a convenience sampling strategy, producing a non-randomized sample of applied social science focused graduate students. An *a priori* sample size of 118 was calculated for analysis. For this study the definition of social science is 'a study of human behavior and organization,'[6] and focused on graduate programs with course requirements including at least one course in research methodology (general, qualitative, quantitative, or mixed methods), and at least one course in applied statistical analyses. Recruitment was carried out among graduate students at a large research-intensive public university in the southeastern United States. Participant recruitment was carried out through emails sent to social science focused graduate students. All recruitment emails were sent from an email address associated with the recruitment university. After the initial recruitment email, a follow up email was distributed to graduate students two weeks later. Graduate students were given the choice to consent to the study with a consent form that was be included in the online survey. If a graduate student declined to consent to the survey, the student was instructed to close out of the survey before it began. The survey used an opt-out consent form, where if an individual continued past the consent form, they had consented to the study.

For the purposes of this study an included department's discipline must have at least one associated scholarly journal available for publications, the department must be an active program at the recruitment university, and the department must have had enrolled graduate students in the spring semester. Seventeen departments were included for participant recruitment. These departments included *'Accountancy,' 'Communication Science and Disorders,' 'Criminal Justice*

and Legal Studies,' 'Economics,' 'Finance,' 'Health, Exercise Science, and Recreation Management,' 'Higher Education,' 'Leadership and Councilor Education,' 'Management,' 'Marketing,' 'Nutrition and Hospitality Management,' 'Pharmacy Administration,' 'Political Science,' 'Psychology,' 'Social Work,' 'Sociology and Anthropology,' and 'Teacher Education.' These departments are housed under six schools/colleges across the university that are each unique and maintain distinct and important avenues of scholarly inquiry. Where the Schools of Applied Sciences and the School of Pharmacy have a focus on health, healthcare, and legal topics, the School of Liberal Arts has representation from classical disciplines and schools of thought. The College of Education conducts pedagogical research and trains future educators and administrators, while the School of Business and the School of Accountancy focus on entrepreneurial and business practices. While each of these schools/colleges have different representation and foci, they too share the inclusion of social science departments. All applied social science-focused departments and disciplines may not be included or represented in this study. Some departments, or disciplines included may not be universally identified under the umbrella of applied social sciences.

Participants met the inclusion criteria if they were a graduate student enrolled at the recruitment university during the 2022 spring semester, were enrolled in degree program housed within one of the 17 social science focused departments, and if they consented to the survey. Exclusion criteria was met if the graduate student was not enrolled in a social science-focused department, if the graduate student was enrolled in an online only degree program, or if they were under 18 years of age. Students in online only programs were excluded on the basis that they may not experience graduate education in the same manner as their in-person academic peers that may have more interactions with peers and professionals. Graduate students that

complete their degree programs through an in-person setting may have more opportunities to interact with or be exposed to peers and professionals around the university setting. This study did not offer any rewards for survey completion, although graduate students were encouraged to consider their participation as aiding another graduate student to complete their degree.

Data Collection:

Data collection was carried out by an online survey developed and housed on Qualtrics. The recruitment emails contained a brief synopsis of the survey topics and a link where graduate students could access and complete the survey. In hopes of bolstering the graduate student response rate, two emails were distributed to potential participants. The second email was sent out two weeks after the initial recruitment email. An additional note was added to the follow up emails, thanking anyone who had already completed the survey. All deidentified data reside with the host department under password protection.

Survey Development:

Survey development was carried out in Qualtrics, under a license held by the University of Mississippi.[7] Development was informed by a literature review examining information related to graduate student interdisciplinary research training and education (please see Appendix 3.B for a copy of the survey). The initial page of the online survey contained a consent form detailing an estimated time of completion, any benefits or risks associated with the survey, and that no reward or remuneration would be given for participation. No known risks or benefits were associated with this survey. To continue the protection of graduate student personal information, no signatures were required for consent. Participants were notified that if they continued past the consent form, they had given consent to the study. If a student exited the survey at the consent

form, the student would have not given consent for the survey (please see Appendix 3.C for a copy of the survey consent form). To encourage more complete responses, attempting to have less missing data, all questions had a reminder to complete the question if it was skipped over, with an exception for the two questions on previous research project experiences outside of their educational training as this question may not have applied to all participants.

Following the initial page, demographic variables were collected, including age, gender, race, ethnicity, department, graduate program year, pursued degree[s], and previous educational attainment. The variable of gender was collected as 'female,' 'male,' 'non-binary/third gender,' or 'prefer not to say.' As our sample was smaller in nature, demographic characteristics with sample cell sizes that were less than or equal to 10, that could lead to participant identification, are not reported, to protect participant information and prevent any potential issues that may arise. The demographic variables section also included a question on previous professional experience that was used in the display logic of two questions in a later section. Following the demographic section, questions were asked pertaining to the interdisciplinary and disciplinary research projects that have been participated in by the respondents during graduate school. For the participants with previous professional experience (before enrolling in graduate school), they were also asked about participation in any previous interdisciplinary and disciplinary research projects in those contexts.

After the demographic and experiences sections, self-efficacy was evaluated for interdisciplinary education. Interdisciplinary self-efficacy was measured by a modified version of the "Self-Efficacy for Interprofessional Experiential Learning" (SEIEL) Scale, which was developed in the healthcare training context.[8,9] The modifications for the current study aimed to frame the scale around interdisciplinary graduate education and training. For simplicity in the

remainder of this manuscript, the modified scale will be referred to as the "Self-Efficacy for Interdisciplinary Education and Training" (SEIdET) Scale. The SEIdET Scale was modified as little as possible to facilitate retention of as much of the validity and reliability of the SEIEL Scale as possible (please see Appendix 3.A for a comparison between the original and modified scales). The two original subscales for the SEIEL Scale were 'Interprofessional Interaction' and 'Interprofessional Team Evaluation and Feedback.' This study will report the SEIdET Scale versions of these subscales in our results, replacing 'Interprofessional' with 'Interdisciplinary.'[8,9] These were followed by items aimed to ascertain the student participant's readiness, willingness, and ableness to participate in interdisciplinary research education and training.

Variables:

The survey was utilized to obtain specific variables related to the questions of interest, in addition to demographic variables and other relevant variables. Specific variables collected included the number of disciplinary and interdisciplinary experiences through papers, projects, and classes, perceptions of interdisciplinary research experiences, readiness for interdisciplinary research education/training, willingness to participate in interdisciplinary research education/training, ableness to participate in interdisciplinary education/training, and self-efficacy for interdisciplinary research education/training. Readiness, willingness and ableness were measured with three questions each using a 7-point Likert scale from 'Strongly disagree' to 'Strongly agree.' The three responses for each variable were averaged together to create their respective scores. Readiness was operationalized as a participant's belief that they could engage in interdisciplinary education or research with their current understandings. Willingness represents a participant's openness to engaging in interdisciplinary research or education, while,

ableness was asked to understand if participants believed in their ability to succeed in interdisciplinary education or research.

Data Analysis:

Descriptive statistics were conducted on all demographic characteristics and associated variables. Specific attention was placed on readiness, willingness, ableness, a joint score consisting of a mean of the three previous variables, and self-efficacy for interdisciplinary research education/training. The joint scale will be referred to as the Readiness, Willingness, and Ableness (RWA) Scale for the remainder of this manuscript. A brief comparison of means was conducted comparing the SEIdET responses to the original SEIEL scale response, and a t-test was used to compare perceived importance of interdisciplinary and disciplinary research. Bivariate correlations were conducted between the between participant readiness, willingness, ableness, and the RWA Score, against all other variables collected for this study. As bivariate correlations cannot be run on nominal categorical variables with more than two categories, linear regressions were conducted with the nominal variables made into dummy variables, and Multiple R is reported for these correlations. Four linear regression models were conducted, one each for readiness, willingness, and ableness, and a fourth model on the RWA Score. These models utilized variables with significant correlations from the bivariate correlations to see if these variables remained significant when accounting for other significant variables. These models were exploratory in their application and are only used to understand more about the correlations between the outcome variables and other variables in this study. An α of 0.05 was used to determine all statistical significances. All data has been and will be maintained in password protected platforms.

Timeline:

This study was estimated to take three months and one week to complete. Where survey recruitment and data collection would occur for one month and one week, data analysis would occur for one month, and final write-up and editing would occur for one month. This estimate was accurate.

Ethical Statement:

This study was approved by the University of Mississippi's Institutional Review Board under Protocol 22x-254.

RESULTS

Sample and Participant Characteristics:

At the end of data collection, 75 surveys were initiated but 13 of these were left blank, leaving us with survey responses from 62 graduate students. Among the 62 responses, nine participants were excluded from analysis for incomplete responses, with 53 being included in the final analysis. Participant recruitment did not reach the *a priori* sample size requirement of 118. However, we had about a 30% response rate across out recruitment population that consisted of about 180 graduate students. Our sample was primarily female (64.2%, 34/53), white/Caucasian (71.7%, 38/53), not Hispanic or Latino/a (96.2%, 51/53), and most were pursuing a doctoral degree (64.2%, 34/53). The majority of our sample was from the School of Applied Sciences (32.1%) and the College of Liberal Arts (22.6%). Please see 'Table 3.A' for more information on this sample's demographic characteristics.

Graduate Student Interest Around Interdisciplinary Education

Graduate students reported an interest in working with faculty outside their own department, working with graduate students from outside their own department, and interdisciplinary courses. When asked about their interest in working on research with faculty from outside their own department and on projects/papers with graduate students from outside their own department, 43 (91.1%) and 38 (71.7%) participants, respectively, agreed (somewhat agree, agree, strongly agree) that they were interested in working with these external colleagues. Along similar lines 51 (96.2%) of participants agreed that they could learn new concepts or methods with graduate students from outside their own department.

All but six participants reported having taken at least one graduate course with a multidisciplinary representation, where 27 participants (50.9%) reported having taken four or more graduate courses with multidisciplinary representation. However, 40 participants (75.5%) reported having participated in one or less interdisciplinary course group project or paper, with 30 of these participants (56.6%) reporting zero or not applicable. Thirty-six participants (67.9%) reported having participated in one or less interdisciplinary research project while in graduate school, with only six participants (11.3%) reporting to have participated in four or more interdisciplinary research projects. Forty-five participants (84.9%) responded that they were interested in graduate classes outside their own department, from somewhat agree to strongly agree. However, 38 participants (71.7%) reported they would choose to take a graduate course in their own department instead of outside their department. Of note, when graduate students were asked if they would complete their degrees entirely in their own department, there was an even distribution across the responses, with 15.1% responding with ‘Strongly Disagree,’ ‘Disagree,’ Neither Agree nor Disagree,’ and ‘Somewhat Agree’ each, while 17.0% responded ‘Somewhat

Disagree,' and 11.3% responded with 'Agree,' or 'Strongly Agree' each. This result needs further verification but could show that among graduate students there is a wide arc of interests as it relates to disciplinary and interdisciplinary education.

When asked about the importance of disciplinary and interdisciplinary research, graduate students in the sample had a mean importance, on a scale from 0 to 10, for disciplinary research of 8.75 (SD=1.555) and a mean importance for interdisciplinary research of 8.26 (SD=1.883). Between these responses, the mean difference was 0.49 (SD=2.326) indicating that overall, the graduate students in our sample had a higher perceived importance for disciplinary research in comparison to interdisciplinary research, this difference was non-significant (p=0.131, t=1.536). However, 22 participants (41.5%) reported a difference in importance of zero, and 14 participants (24.5%) placed more importance on interdisciplinary research over disciplinary research.

Interdisciplinary Self-Efficacy and Graduate Readiness, Willingness, and Ableness:

Utilizing the SEIdET Scale,[8-9] graduate students scored a mean of 62.89 (SD=11.854) out of 80 on subscale 1, 'Interdisciplinary Interaction,' and 57.98 (SD=14.711) out of 80 on subscale 2, 'Interdisciplinary Team Evaluation and Feedback.' In a brief comparison of means, our SEIdET sample had similar values to the SEIEL sample from the original Mann et al. 2012 study.[4] For readiness, willingness, and ableness to engage in interdisciplinary research education and training, participants had a mean score of 5.58 (SD=1.14), 5.77 (SD=0.98), and 5.79 (0.93) out of 7, respectively. Among the reported scores 49 (92.5%), 49 (92.5%), and 50 (94.3%) had scores greater than 4, 'Neither agree nor disagree,' and six participants (11.3%) reported a 7 out of 7, 'Strongly agree,' on all three scores. Please see 'Table 3.B' for more information on scale scores and graduate student interest around interdisciplinary education.

Bivariate Analysis:

We conducted bivariate correlation analyses with the readiness score, willingness score, ableness score, and the RWA score against all other variables in the study to find if any were significantly correlated. All four outcome variables were significantly correlated to the SEIdET subscale 1, and subscale 2, and to the participant's interest in taking graduate courses outside of their home departments. Of interest the readiness score (R=0.294, p=0.496), willingness score (R=0.287, p=0.527), ableness score (R=0.349, p=0.277), and the RWA score (R=0.308, p=0.436) were similar across included schools/colleges within the recruitment university. Similarly, while examining across the included departments, the readiness score (R=0.566, p=0.140), willingness score (R=0.429, p=0.694), ableness score (R=0.507, p=0.350), and RWA score (R=0.446, p=0.621) were similar. The RWA score was also significantly correlated with years of professional experience, their interest in conducting research with faculty members outside their home department, their interest in working on projects or papers with graduate students outside their home departments, their belief that they could learn new concepts or methods with graduates students outside their home department, and it was negatively correlated with if they would complete their degrees entirely in their home departments. (See Table 3.C or RWA Score bivariate analysis results)

Individually, the readiness score was further significantly correlated with years of professional experience, having participated in interdisciplinary classes, their interest in conducting research with faculty members outside their home department, their interest in working on projects or papers with graduate students outside their home departments, their belief that they could learn new concepts or methods with graduates students outside their home department, and it was negatively correlated with if they would complete their degrees entirely in

their home departments. (See Table 3.D for the Readiness Score bivariate analysis results) The willingness score was significantly correlated with their perceived importance of interdisciplinary research, their interest in conducting research with faculty members outside their home department, their interest in working on projects or papers with graduate students outside their home departments, and their belief that they could learn new concepts or methods with graduate students outside their home department. (See Table 3.E for the Willingness Score bivariate analysis results) The ableness score was not significantly correlated with any additional variables. (See Table 3.F for the Ableness Score bivariate analysis results)

Exploratory Linear Regressions with Significant Bivariate Variables:

When creating the linear regressions on the four scores, the significant relationships from the bivariate correlations were utilized to build each model. These models are only for exploratory purposes and all significant relationships found will need to be verified by future studies. For the model on the RWA score (see Table 3.G), the SEIdET subscale 1 (b=0.38, t=2.861, p=0.006; 95%CI: 0.011 to 0.065), years of professional experience (b=0.038, t=2.335, p=0.024; 95%CI: 0.005 to 0.070), and participant interest in taking graduate courses outside their home department (b=0.344, t=4.428, p<0.001; 95%CI: 0.167 to 0.625), remained significantly correlated with positive relationships. While the variable on a participant's belief that they could learn new concepts or methods with graduate students outside of their home department remained significant (b=-0.330, t=-2.564, p=0.014; 95%CI: -0.590 to -0.071), it switched from a positive relationship in the bivariate correlations to a negative relationship for this model.

For the model on the readiness score (see Table 3.H), the SEIdET subscale 1 (b=0.58, t=3.188, p=0.003; 95%CI:0.021 to 0.094), and participant interest in taking graduate courses outside their home department (b=0.396, t=3.481, p=0.001; 95%CI: 0.167 to 0.625), remained

significantly correlated with positive relationships. Similar to the RWA model the variable for a participant's belief that they could learn new concepts or methods with graduate students outside of their home department remained significant (b=-0.498, t=-2.847, p=0.007; 95%CI: -0.851 to -0.145), but it switched from a positive relationship in the bivariate correlations to a negative relationship for this model. Two variables remained significantly correlated with the willingness score model (see Table 3.I), participant interest in taking graduate courses outside their home department (b=0.173, t=2.157, p=0.039; 95%CI: 0.011 to 0.335), and participant interest in working on course projects and papers with graduate students outside their home department (b=0.301, t=3.515, p=0.001; 95%CI: 0.128 to 0.474). Of note, the willingness model (see Table 3.J) was the only model that did not maintain a significant correlation with at least one SEIdET subscale. In the final model on the ableness score, the SEIdET subscale 1 (b=0.035, t=2.090, p=0.042; 95%CI: 0.001 to 0.068), and a participant's interest in taking graduate courses outside of their home departments (b=0.237, t=3.111, p=0.003; 95%CI: 0.084 to 0.390) remained significantly correlated.

DISCUSSION

The sample reported that on average they 'Somewhat Agreed' to 'Agreed' that they were ready, willing, and able to participate in interdisciplinary education, and research training. With this, one may interpret that students in this sample may consider themselves to be both prepared and interested in interdisciplinary education and research training. Readiness, willingness, and ableness may be able to explain underlying beliefs or perceptions in conjunction with self-efficacy, yet these concepts need further exploration by future studies to better understand how they may be related to self-efficacy. Along the same lines for self-efficacy, participants had an average score of 62.89 out of 80 on the 'Interdisciplinary interaction' subscale, and 57.98 out of

80 on the 'Interdisciplinary Team Evaluation and Feedback' subscale. These averages illustrate that participants had an average of 7 out of 10 or higher on all SEIdET scale questions, indicating a higher level of self-efficacy for interdisciplinary education and research training. The SEIdET scale has not been assessed for its reliability and will need to be verified in future studies. However, for this article, it served well as a predictor for the RWA score, readiness, willingness, and ableness, with which we expected self-efficacy to have positive relationship.

Graduate students may be interested in assisting external faculty members on research projects, where 91.1% of our sample participants indicated a level of agreement (somewhat agree, agree, strongly agree). These research collaborations with external faculty members could serve as learning and training opportunities in an interdisciplinary setting. Seventy-one percent of our sample reported an interest in working on group projects/papers with external graduate students. This serves as another opportunity to develop graduate student skillsets and improve their methodological knowledge. Graduate student participants in our sample recognize the importance of both disciplinary research and interdisciplinary research. Not all were of the same mind with respect to relative value: 24.5% (13/53) reported that interdisciplinary research was more important than disciplinary research, while 34.0% (18/53) reported that disciplinary research was more important than interdisciplinary research. However, our sample identified disciplinary research as more important, but this difference was not significant. Future studies could further explore and monitor graduate student perceptions of relative importance related to disciplinary and interdisciplinary work or ascertain the beliefs of other populations, such as undergraduate students, faculty members, or university administration.

Graduate students were already taking courses with multidisciplinary representation, where 88.7% of sample reported having taken at least one course with multidisciplinary

representation. These courses could utilize interdisciplinary group assignments or projects to supplement graduate student skill development and knowledge acquisition. Graduate students may choose to take a course outside their home departments even when they have the option to remain in their disciplinary comfort zones. Our sample reflected this as 71.7% reported they would choose to take the external course. External courses may be perceived by students as having a potential for additional learning related to the disciplinary knowledge, and alternate disciplinary preferences for methodology or analyses. Additionally, students taking external courses have the opportunity to further develop their communication skills, expand their professional networks, and have the potential to initiate working relationships with external student peers or faculty members.

Student interest in taking courses outside of their home department was associated with readiness, willingness, and ableness in the bivariate correlations. This may point to a cautious curiosity towards interdisciplinarity. Graduate students may perceive taking a course from another department as a low stakes introduction to another discipline or identify its value in strengthening their own disciplinary skillsets. An interesting result from the exploratory linear regression models indicated a negative relationship between the RWA score, and readiness, with a student's belief that they could learn new methods or concepts with graduate students from other departments. This negative correlation may indicate that students believe they would have an easier time learning from peers in their own departments; however, with the bivariate correlations having a positive correlation, these relationships require further exploration. Of the included departments some are more interdisciplinary by nature that utilize courses with multidisciplinary representation or may have their graduate students take courses with other departments as part of their degree program curriculum. Other departments may have curricula

that encourages or requires graduate students to remain in their home departments for courses. However, while the included departments have differences regarding interdisciplinary and multidisciplinary curricula, graduate student respondents across the included schools/colleges had similar responses on the readiness, willingness, ableness, and RWA scores. The regression models were conducted to provide additional information that may be used to inform future studies. This information may be valuable in future examinations around this topic in the creation of variables that could be associated with increases in RWA in interdisciplinary education and research among graduate students. Future studies are needed to verify and further explore the relationships we found in our models.

STUDY LIMITATIONS

This study may not be generalizable to all populations. This study was only conducted at a single university and among social science-focused departments which may limit generalizability to other populations. However, these limitations were deemed acceptable for an exploratory pilot. Due to this study's recruitment strategy leading to selection bias, and the use of a cross-sectional survey, all results are reported as observed correlations, and we cannot infer causality. Participant recruitment was isolated to a single university and may not be representative of all graduate students or universities. Response bias may be present in the form of socially desirable response bias and recall bias with this study as we are asking about graduate student preparedness for, and their past experiences with interdisciplinary research training. Prior knowledge of this study is possible in two forms, first if a participant discussed their survey with other possible participants. Second, since this is a dissertation project, a proposal presentation was completed in front of graduate students that may have become participants in the study. This is an accepted potential bias for this study.

Another potential bias derived from our use of a modified version of the SEIEL Scale, as our modifications may affect item interpretations thereby limiting the previous reliability and validity of the scale. The modifications were necessary for the context of this study, and this is an accepted bias of this study. As this study did not reach the *a priori* sample size requirements, all analysis results are reported as an exploratory look into variables that could be correlated to the dependent variables. Future studies will be necessary to verify this information at other universities and with other samples of graduate students. This study is only intended to serve as a basis for the development of information around graduate student readiness, willingness, ableness, and self-efficacy around interdisciplinary research training and education.

CONCLUSION

This quantitative study identified that graduate student participants, in applied social sciences, perceive (on average) that they were ready, willing, and able to participate in interdisciplinary education and training. Most have taken, or were positive about choosing, a multidisciplinary graduate course. Furthermore, participants expressed a level of existing self-efficacy for interdisciplinary research practices. However future studies are needed to verify and examine graduate student self-efficacy around interdisciplinary education and research.

Future studies should further explore the interests and beliefs of graduate students around interdisciplinary research and its associated education and training. As graduate students are in essence the primary consumers of interdisciplinary education and training, there is a need to understand what they are seeking to obtain from interdisciplinary programs, what parts of these

programs are working as intended, and the areas for improvement among these programs. Interdisciplinary research, and interdisciplinary education and training have been a fixture in higher education for over five decades[10-14] but there remains an opportunity to develop and improve interdisciplinary practices.

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CHAPTER 5:

Implications and Future Directions

Interdisciplinary education and research have come into the spotlight over the past five decades for their potential to improve academic and research practices.[1-5] Current literature discusses interdisciplinary education at a graduate level as having the capability to bolster the academic and professional development of graduate students.[1,6] This may be accomplished through the inclusion of additional training opportunities that encourage students to cross disciplinary boundaries, or through the implementation of interdisciplinary programs that utilize multiple disciplines and interdisciplinary scholars to provide a specialized training format for graduate studies. Interdisciplinary research has the potential to assist in more comprehensively solving contemporary issues and problems due to the varying professional inputs of individuals from different disciplinary backgrounds working to achieve similar goals.

The narrative review study in Chapter 2 provides a description of two decades of current literature where there are agreements on benefits associated with interdisciplinary education and research, while also pointing to challenges and struggles faced by cross-disciplinary pursuits in general, as well as individual academic and research programs. This narrative collection of information can serve to inform the development of future research aimed at further developing educational and research practices around interdisciplinarity. The review also highlights that while there exists a sizable amount of information and discussion around interdisciplinary education and research, there remain opportunities to expand implementation and to study the successes and failures of these implementation attempts, thus providing invaluable insights into

the development of future programs while also aiding in improving current interdisciplinary programs.

Chapter 3 contains a qualitative interview study aimed to explore the perceptions and beliefs of graduate faculty members and graduate students regarding interdisciplinary research, research training, and education. The majority of our participants voiced support for and affirmed the importance of interdisciplinary pursuits with only a few dissenting opinions that emphasized instead a disciplinary focus. Many graduate students are already taking academic courses in multidisciplinary or interdisciplinary environments that may facilitate interdisciplinary interactions and exposure. They recognize the potential of further education and training to improve their own skillsets and knowledge, while helping to provide additional experiences that may benefit their future careers. Most of our participant faculty members instructing at the graduate level are already teaching multidisciplinary or interdisciplinary classes and had completed interdisciplinary or multidisciplinary scholarly research with disciplines other than their own. Similar to the responses received from graduate students, graduate faculty members also voiced their belief in the importance and necessity of interdisciplinary academic settings and interdisciplinary research and were willing to continue to engage with those in future.

In the third study, described in Chapter 4, a survey study of graduate students was conducted to understand their interest and drive towards interdisciplinarity. Graduate students were found to have an interest in interdisciplinary education and interdisciplinary research, while also believing that they were ready, willing, and able to perform well in these interdisciplinary settings. Additionally, most graduate students reported that they were already engaging in multidisciplinary/interdisciplinary academic courses outside of their own department, and over half had already worked on at least one interdisciplinary research project during graduate school.

This study highlights a need for the development of new interdisciplinary opportunities for graduate students, as well as a need to continue current programs and practices that aid in interdisciplinary instruction.

This mixed methods dissertation project utilized three studies as an exploration of interdisciplinary graduate education and research training. The major findings indicate: 1. Scholarly articles around interdisciplinary education and interdisciplinary research have been increasing over time but there is still a need for new information to fill knowledge gaps; 2. Current literature supports the development and implementation of interdisciplinary programs for graduate education; 3. Graduate students were interested in interdisciplinary education and research, and believe that they are ready, willing, and able to participate in these programs; 4. Graduate faculty perceive the importance of interdisciplinary education and research, and believe they are equipped to teach it in varying formats; and 5. Interdisciplinary education and interdisciplinary research both require support and input from multiple academic and professional stakeholders, ranging from graduate students to whole academic institutions and beyond, to include governmental agencies and varying sectors of industry. These findings could support an interest and perception of value in interdisciplinary education and research from multiple parties within academia and pursuits related to scholarly inquiry.

However, while this dissertation identified these findings around interdisciplinary education and research, it comes with a caveat that additional research is needed for a better understanding of these possible associations. Our narrative review was limited to one University's library collection of information, albeit a relatively comprehensive one. "Grey literature" was not included, leading to a possibility that some information was not identified. Additional studies could aim to increase the breadth and depth of this literature, which may

continue to expand. Attempting to ascertain information around interdisciplinarity comes with an additional challenge that future research should consider: While some interdisciplinary-focused journals are currently available and in circulation, most of the literature we identified was from disciplinary journals, or topic-based journals. This necessitates broad and rigorous literature searches that include interdisciplinary information housed in the scholarly literature of single disciplines. Furthermore, future studies could also expand the boundaries of the search criteria by including articles and information on undergraduate students, or students in primary or secondary school settings. It is essential to include these student populations, as some of the current literature proposes the adoption of interdisciplinary education at earlier timepoints in a student's academic career to better prepare future graduate students and professionals to engage in collaborative and interdisciplinary settings in their future roles.[7,8]

Our interview study was limited to 17 university departments with social science-oriented graduate programs at a research-intensive institution in the Southeastern United States. Future studies could attempt to ascertain a broader range of perceptions and beliefs through inclusion of all available university departments with graduate programs, through the inclusion of students and faculty from other levels of academia (such as undergraduates), or by carrying out a similar study at other institutions. Interviews with graduate students and faculty members on the topic of interdisciplinarity inherently come with the potential for response bias that may be related to university or school/college level tenure and promotion polices. Future studies employing interviews should also examine the policies related to the practice and teaching of interdisciplinarity, as these policies may influence participant responses. Another route for scholarly inquiry follows the perceptions and beliefs of graduate students and faculty members, which could be compared between universities or schools/colleges to understand the effect of

environment and certain policies on the practice and pursuit of interdisciplinary education or interdisciplinary research.

Further studies are needed to better understand graduate student interest, self-efficacy, readiness, willingness, ableness around interdisciplinary education and research. Factors prevented achieving the necessary *a priori* sample size for the survey study, which necessitates a replication of this study with a larger sample. As with our interview study, the survey study participant recruitment included the same 17 university departments focused on social science research, which leaves an opportunity for future studies to expand participant recruitment to all available university departments housing graduate student programs. Additionally, future studies could expand their focus to include undergraduate students to ascertain their interest, self-efficacy, readiness, willingness, and ableness around interdisciplinary education and interdisciplinary research.

The initial hypotheses for the objectives of this project were supported. There is a common positive perception on the importance and value of interdisciplinary education and interdisciplinary research. Current literature supports its use and implementation, graduate students are interested in engaging and learning from it, and faculty members are willing to teach and already engage in interdisciplinary education and research. This project presents a rationale, an interest in, and some benefits and barriers associated with interdisciplinary education and research training that may help in improving the practice of interdisciplinary research among current graduate students and future professionals. The findings echo existing literature on the importance of interdisciplinary education in expanding and improving graduate education, and interdisciplinary research for the potential to help solve complex contemporary issues. Learning about interdisciplinarity, and the practice of interdisciplinarity are challenging and uniquely

complex in their necessity for a broader understanding, deeper rationale, and an acceptance of inescapable uncertainty; but that learning about and exposure to interdisciplinarity present an opportunity for positive educational, professional, and societal impacts. These studies have achieved the goal of providing a basic level understanding of the current status of interdisciplinary graduate education, graduate interdisciplinary research training, and the practice of interdisciplinarity among graduate students and graduate faculty members in the social sciences. Future research can utilize our findings as a foundation to initiate or drive the development of new or reiterated studies to ascertain information around interdisciplinary graduate education, graduate interdisciplinary research training, and the practice of interdisciplinarity in broader contexts.

The information presented in these studies lead to additional questions in: 'Where do we go now?'; and 'how can interdisciplinary education and research be advanced?' It is important to continue the development of existing interdisciplinary practices and programs as to best develop quality professionals that can practice interdisciplinary research. This also entails the creation of new programs or disciplinary sects that can help to further scientific inquiry. While it is important to maintain advancing progress around interdisciplinarity, it is also important to encourage disciplinary pursuits and developments. Individual disciplines help to discover new information and assist in solving societal issues and problems and are imperative to the success of interdisciplinary pursuits. As discussed in the narrative review, both disciplinary and interdisciplinary pursuits can benefit from a cyclical advantage in knowledge creation and skills development.[9-14] They are each important in their own right and can help to solve issues or problems faced by society.

A Personal Perspective:

My own experiences with interdisciplinary graduate education and interdisciplinary research occurred through the Department of Pharmacy Administration, which is interdisciplinary by nature, combining aspects of Pharmacy, Public Health, Public Policy, Sociology, Economics, Epidemiology, Marketing, and Management. From my first year of graduate school, I was exposed to various professionals and students from other disciplines. Admittedly some courses were more multidisciplinary in practice (rather than "interdisciplinary"), as students isolated with peers from their home departments, or the coursework was largely individual work. However, learning alongside students from other social science departments served as a rudimentary exposure to interacting with other disciplines. These courses often used discipline-based examples that required me to bridge back to Pharmacy Administration. Albeit a rather small bridge because of some common lexicons between the disciplines, but a bridge none the less. These experiences outside of my department provided an opportunity to learn from other disciplines and challenged me to think across and in between disciplinary lines.

Beyond the coursework, as a graduate assistant I had the opportunity to conduct research with and assist in teaching alongside faculty members from my home department but also with faculty from the departments of Pharmacy Practice, Sociology, Social Work, Nursing, Nutrition and Hospitality Management, and Philosophy and Religion. With each new research opportunity or teaching experience that included external colleagues, I became more comfortable in an interdisciplinary teaching and research environment. Working collaboratively in these contexts helped me to gain confidence in my own research skills, improve my methodological skills, gain

experience with survey research, gain experience with interview research, and develop communication skills with scholars outside of my home department.

The idea for this dissertation project emerged from an interest in finding answers to a complex research question for a course proposal. Concluding that I was limited to my own perspective and the perspective of my discipline, I recognized the need for multiple perspectives to be able to fully answer the questions, and to provide a robust evaluation sufficient for multiple fields of disciplinary inquiry. Hence a need for interdisciplinary research, and a personal realization of the importance of interdisciplinary education and research training. Following some initial searches, I was left asking: What other information do we already know? Are other graduate students interested? Can faculty provide this type of training? Are there already programs that could be used as examples or models? Can we show that interdisciplinary or multidisciplinary courses improve student knowledge or skills? While some of these questions remain unanswered, and offer an opportunity for further subject examination, this Dissertation project served as an exploration of interdisciplinary knowledge and the perceptions and beliefs of graduate students and graduate faculty members. With the invaluable help of my Dissertation Committee Chair and Committee Members, I was able to approach and examine three of these questions and provide a ground level understanding within this manuscript. Further research is needed, and I am excited to pursue additional knowledge around interdisciplinarity.

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Declaration of Interests:

None declared.

TABLES

Table 1.A: Narrative Review "One Search" Search Strategy

#	Query	Results
1	"interdisciplinary" AND "graduate" AND "education"	8,886
2	"interdisciplinary" AND "graduate" AND "training"	3,149
3	"interdisciplinary" AND "research" AND "training"	28,465
4	"interdisciplinary" AND "graduate" AND "implementation"	1,556
5	"interdisciplinary" AND "graduate" AND "motivation" AND "interest"	132
6	"interdisciplinary" AND "graduate" AND "research" AND "knowledge"	3,147
7	"interdisciplinary" AND "graduate" AND "training" AND "implementation"	218

Table 2.A: Interview Participant Characteristics

Student Characteristics (n=10)	n	Mean	Min	Max
Years Working	8	7.88	1	40
Year of Graduate School	10	3.50	1	6
Faculty Characteristics (n=13)	n	Mean	Min	Max
Years in Academia	13	12.46	1	22
Years outside Academia	9	5.56	0	11
Disciplinary Publications	13	12.92	0	70
Interdisciplinary Publications	13	23.54	0	70
	Frequency		Percentage	
Gender (n=23)				
Female	15		65.2%	
School or College (n=23)				
School of Applied Science	8		34.8%	
School of Business	2		8.7%	
School of Education	2		8.7%	
College of Liberal Arts	3		13.0%	
School of Pharmacy	8		34.8%	
Highest Level of Previous Education (Students Only) (n=10)				
Bachelors	1		10.0%	
Masters	7		70.0%	
Professional	2		20.0%	

Table 3.A: Survey Sample Demographic Characteristics

Graduate Student Characteristics	n	Mean (SD)	Median	Min	Max
Years of Professional Experience	53	4.15 (5.10)	2	0	20
		Frequency	Percentage		
Gender					
Female		34	64.2%		
Non-Female or Prefer Not to Say		19	35.8%		
Race					
Asian/Asian American		≤10	-		
Black/African/African American		≤10	-		
White Caucasian		38	71.7%		
Other		≤10	-		
Hispanic or Latino/a					
Not Hispanic or Latino/a		51	96.2%		
Highest Completed Prior Education					
Bachelors		17	32.1%		
Masters		29	54.7%		
Professional		≤10	-		
Doctoral		≤10	-		
Degree Pursued					
Masters		19	35.8%		
Doctoral		34	64.2%		
School or College					
School of Accountancy		≤10	-		
School of Applied Science		17	32.1%		
School of Business		≤10	-		
School of Education		≤10	-		
College of Liberal Arts		12	22.6%		
School of Pharmacy		≤10	-		
Year of Graduate School					
1st year		11	20.8%		
2nd year		16	30.2%		
3rd year		13	24.5%		
4th year		≤10	-		
5th year or greater		≤10	-		

Table 3.B: Survey Sample Descriptive Statistics

Graduate Student Scale Scores	n	Mean (SD)	Median	Min	Max
RWA Score	53	5.715 (0.908)	5.78	3.67	7
Readiness Score	53	5.585 (1.140)	5.67	2	7
Willingness Score	53	5.767 (0.977)	6.00	3	7
Ableness Score	53	5.763 (0.927)	6.00	4	7
SEIdET Subscale 1	53	62.89 (11.854)	62.00	28	80
SEIdET Subscale 2	53	57.98 (14.711)	57	24	80
Graduate Student Perceived Importance	n	Mean (SD)	Median	Min	Max
Disciplinary Research	53	8.75 (1.555)	9	4	10
Interdisciplinary Research	53	8.26 (1.883)	9	2	10
Difference: Disciplinary (minus) Interdisciplinary	53	0.49 (2.326)	0	-5	7

Graduate Student Experience	Zero or n/a n(%)	1 n(%)	2 n(%)	3 n(%)	4 or more n(%)
Interdisciplinary represented classes	6 (11.3%)	6 (11.3%)	7 (13.2%)	7 (13.2%)	27 (50.9%)
Interdisciplinary represented class projects/papers	30 (56.6%)	10 (18.9%)	8 (15.1%)	2 (3.8%)	3 (5.7%)
Disciplinary research projects associated with in graduate school	8 (15.1%)	9 (17.0%)	8 (15.1%)	4 (7.5%)	24 (45.3%)
Interdisciplinary research projects associated with in graduate school	24 (45.3%)	12 (22.6%)	9 (17.0%)	2 (3.8%))	6 (11.3%)

Graduate Student Interest	1 Strongly Disagree	2 n %	3 n %	4 n %	5 n %	6 n %	7 Strongly Agree
Interested in graduate classes outside department	1 1.9%	1 1.9%	2 3.8%	4 7.5%	7 13.2%	18 34.0%	20 37.7%
Interested in research with faculty members outside department	1 1.9%	1 1.9%	4 7.5%	4 7.5%	10 18.9%	17 32.1%	16 30.2%
Interested in working with graduate students from outside department	1 1.9%	2 3.8%	3 5.7%	9 17.0%	6 11.3%	17 32.1%	15 28.3%
Choose to take graduate course in own department over another	3 5.7%	1 1.9%	2 3.8%	6 11.3%	8 15.1%	15 28.3%	18 34.0%
Challenging to work with graduate students from outside department	2 3.8%	7 13.2%	7 13.2%	10 18.9%	18 34.0%	7 13.2%	2 3.8%
Could learn concepts of methods with graduate students from outside department	0 n/a	0 n/a	0 n/a	2 3.8%	12 22.6%	17 32.1%	22 41.5%
Would complete degree entirely in home department	8 15.1%	8 15.1%	9 17.0%	8 15.1%	8 15.1%	6 11.3%	6 11.3%

Table 3.C: RWA Score Bivariate Analysis Results			
Variable	n	Pearson Correlation	p value
SEIdET Subscale 1	53	0.55	<.001***
SEIdET Subscale 2	53	0.476	<.001***
Years of Professional Experience	53	0.32	0.019*
Female (1) against Non-Female **and** Prefer Not to Say or N/A (0)	53	-0.67	0.634
Hispanic or Latino/a	53	0.038	0.785
Interdisciplinary Represented Classes	53	0.254	0.066
Interdisciplinary Represented Class Projects or Papers	53	0.11	0.432
Disciplinary Research in Graduate School	53	-0.046	0.743
Interdisciplinary Research in Graduate School	53	-0.047	0.737
Disciplinary Research Outside Graduate School	42	0.215	0.171
Interdisciplinary Research Outside Graduate School	42	0.091	0.567
Disciplinary Research Importance	53	0.028	0.841
Interdisciplinary Research Importance	53	0.256	0.064
Difference Between Disciplinary and Interdisciplinary Research Importance (Intra - Inter = x)	53	-0.188	0.177
Interested in Graduate Classes Outside Department	53	0.575	<.001***
Interested in Research with Faculty Outside Department	53	0.499	<.001***
Interested in Working with Graduate Students from Outside Department	53	0.501	<.001***
Choose to Take Graduate Course in Own Department Over Outside	53	-0.133	0.343
Challenging to Work with Graduate Students from Outside Department	53	-0.066	0.638
Could Learn Concepts or Methods with Graduate Students from Outside Department	53	0.373	0.006**
Would Complete Degree Entirely in Home Department	53	-0.293	0.033*
RWA Score on Dummy Variable			
Variable	n	Multiple R	p value
Race	53	0.350	0.172
School or College	53	0.308	0.436
Department	53	0.446	0.621
Highest Education Completed	53	0.309	0.173
Degree Pursued	53	0.311	0.170
Year of Graduate School	53	0.215	0.677
*<0.05, **<0.01, ***<0.001			

Table 3.D: Readiness Score Bivariate Analysis Results			
Variable	n	Pearson Correlation	p value
SEIdET Subscale 1	53	0.518	<.001***
SEIdET Subscale 2	53	0.408	0.002**
Years of Professional Experience	53	0.291	0.034*
Female (1) against Non-Female and Prefer Not to Say or N/A (0)	53	-0.124	0.377
Hispanic or Latino/a	53	0.044	0.757
Interdisciplinary Represented Classes	53	0.277	0.045*
Interdisciplinary Represented Class Projects or Papers	53	0.124	0.377
Disciplinary Research in Graduate School	53	0.049	0.728
Interdisciplinary Research in Graduate School	53	0.057	0.683
Disciplinary Research Outside Graduate School	42	0.218	0.165
Interdisciplinary Research Outside Graduate School	42	0.11	0.49
Disciplinary Research Importance	53	0.035	0.801
Interdisciplinary Research Importance	53	0.163	0.245
Difference Between Disciplinary and Interdisciplinary Research Importance (Intra - Inter = x)	53	-0.108	0.442
Interested in Graduate Classes Outside Department	53	0.574	<.001***
Interested in Research with Faculty Outside Department	53	0.444	<.001***
Interested in Working with Graduate Students from Outside Department	53	0.419	0.002**
Choose to Take Graduate Course in Own Department Over Outside	53	-0.231	0.096
Challenging to Work with Graduate Students from Outside Department	53	-0.153	0.275
Could Learn Concepts or Methods with Graduate Students from Outside Department	53	0.3	0.029*
Would Complete Degree Entirely in Home Department	53	-0.355	0.009**
Readiness Score on Dummy Variable			
Variable	n	Multiple R	p value
Race	53	0.317	0.270
School or College	53	0.294	0.496
Department	53	0.566	0.140
Highest Education Completed	53	0.336	0.115
Degree Pursued	53	0.287	0.236
Year of Graduate School	53	0.258	0.496
*<0.05, **<0.01, ***<0.001			

Table 3.E: Willingness Score Bivariate Analysis Results			
Variable	n	Pearson Correlation	p value
SEIdET Subscale 1	53	0.435	0.001**
SEIdET Subscale 2	53	0.455	<.001***
Years of Professional Experience	53	0.311	0.024*
Female (1) against Non-Female and Prefer Not to Say or N/A (0)	53	0.051	0.719
Hispanic or Latino/a	53	0.014	0.924
Interdisciplinary Represented Classes	53	0.23	0.098
Interdisciplinary Represented Class Projects or Papers	53	0.189	0.176
Disciplinary Research in Graduate School	53	-0.143	0.306
Interdisciplinary Research in Graduate School	53	0.038	0.785
Disciplinary Research Outside Graduate School	42	0.233	0.137
Interdisciplinary Research Outside Graduate School	42	0.132	0.405
Disciplinary Research Importance	53	0.012	0.93
Interdisciplinary Research Importance	53	0.417	0.002**
Difference Between Disciplinary and Interdisciplinary Research Importance (Intra - Inter = x)	53	-0.329	0.016*
Interested in Graduate Classes Outside Department	53	0.539	<.001***
Interested in Research with Faculty Outside Department	53	0.638	<.001***
Interested in Working with Graduate Students from Outside Department	53	0.697	<.001***
Choose to Take Graduate Course in Own Department Over Outside	53	-0.066	0.638
Challenging to Work with Graduate Students from Outside Department	53	0.091	0.516
Could Learn Concepts or Methods with Graduate Students from Outside Department	53	0.472	<.001***
Would Complete Degree Entirely in Home Department	53	-0.238	0.086
Willingness Score on Dummy Variable			
Variable	n	Multiple R	p value
Race	53	0.276	0.421
School or College	53	0.287	0.527
Department	53	0.429	0.694
Highest Education Completed	53	0.181	0.650
Degree Pursued	53	0.336	0.115
Year of Graduate School	53	0.240	0.572
*<0.05, **<0.01, ***<0.001			

Table 3.F: Ableness Score Bivariate Analysis Results			
Variable	n	Pearson Correlation	p value
SEIdET Subscale 1	53	0.521	<.001***
SEIdET Subscale 2	53	0.417	0.002**
Years of Professional Experience	53	0.256	0.064
Female (1) against Non-Female and Prefer Not to Say or N/A (0)	53	-0.098	0.487
Hispanic or Latino/a	53	0.045	0.75
Interdisciplinary Represented Classes	53	0.165	0.237
Interdisciplinary Represented Class Projects or Papers	53	-0.027	0.847
Disciplinary Research in Graduate School	53	-0.045	0.749
Interdisciplinary Research in Graduate School	53	-0.25	0.071
Disciplinary Research Outside Graduate School	42	0.117	0.461
Interdisciplinary Research Outside Graduate School	42	-0.006	0.972
Disciplinary Research Importance	53	0.026	0.852
Interdisciplinary Research Importance	53	0.113	0.421
Difference Between Disciplinary and Interdisciplinary Research Importance (Intra - Inter = x)	53	-0.074	0.6
Interested in Graduate Classes Outside Department	53	0.417	0.002**
Interested in Research with Faculty Outside Department	53	0.247	0.075
Interested in Working with Graduate Students from Outside Department	53	0.223	0.108
Choose to Take Graduate Course in Own Department Over Outside	53	-0.036	0.796
Challenging to Work with Graduate Students from Outside Department	53	-0.103	0.463
Could Learn Concepts or Methods with Graduate Students from Outside Department	53	0.231	0.097
Would Complete Degree Entirely in Home Department	53	-0.174	0.214
Ableness Score on Dummy Variables			
Variable	n	Multiple R	p value
Race	53	0.416	0.054
School or College	53	0.349	0.277
Department	53	0.507	0.350
Highest Education Completed	53	0.322	0.143
Degree Pursued	53	0.214	0.509
Year of Graduate School	53	0.193	0.762
*<0.05, **<0.01, ***<0.001			

Table 3.G: RWA Model - Exploratory Linear Regression

Variable	Regression Coefficient (Unstandardized)				Regression Coefficient (Standardized)	p value
	b estimate	SE	95% CI			
Constant	1.645	0.794	0.045	3.246	-	0.044*
SEIdET Subscale 1	0.038	0.013	0.011	0.065	0.499	0.006*
SEIdET Subscale 2	0.005	0.01	-0.016	0.026	0.077	0.652
Years of Professional Experience	0.038	0.016	0.005	0.07	0.212	0.024*
Interested in Graduate Classes Outside Department	0.344	0.078	0.187	0.5	0.525	<.001*
Interested in Research with Faculty Outside Department	0.062	0.077	-0.093	0.217	0.099	0.423
Interested in Working with Graduate Students from Outside Department	0.125	0.075	-0.026	0.275	0.211	0.102
Could Learn Concepts or Methods with Graduate Students from Outside Department	-0.33	0.129	-0.59	-0.071	-0.324	0.014*
Would Complete Degree Entirely in Home Department	0.062	0.049	-0.037	0.162	0.134	0.212
$R^2 = 0.676$ | □F = 11.465 ($p<0.001$)						

Table 3.H: Readiness Model - Exploratory Linear Regression

Variable	Regression Coefficient (Unstandardized)				Regression Coefficient (Standardized)	p value
	b estimate	SE	95% CI			
Constant	1.34	1.106	-0.89	3.569		0.232
SEIdET Subscale 1	0.058	0.018	0.021	0.094	0.6	0.003*
SEIdET Subscale 2	-0.001	0.014	-0.03	0.027	-0.018	0.922
Years of Professional Experience	0.042	0.022	-0.002	0.087	0.19	0.061
Interdisciplinary Represented Classes	0.068	0.09	-0.114	0.25	0.086	0.458
Interested in Graduate Classes Outside Department	0.396	0.114	0.167	0.625	0.482	0.001*
Interested in Research with Faculty Outside Department	0.068	0.104	-0.142	0.278	0.087	0.515
Interested in Working with Graduate Students from Outside Department	0.113	0.101	-0.091	0.318	0.153	0.269
Could Learn Concepts or Methods with Graduate Students from Outside Department	-0.498	0.175	-0.851	-0.145	-0.39	0.007*
Would Complete Degree Entirely in Home Department	0.021	0.068	-0.115	0.157	0.036	0.757
$R^2 = 0.633$ | □F = 8.234 ($p<0.001$)						

Table 3.I: Willingness Model - Exploratory Linear Regression

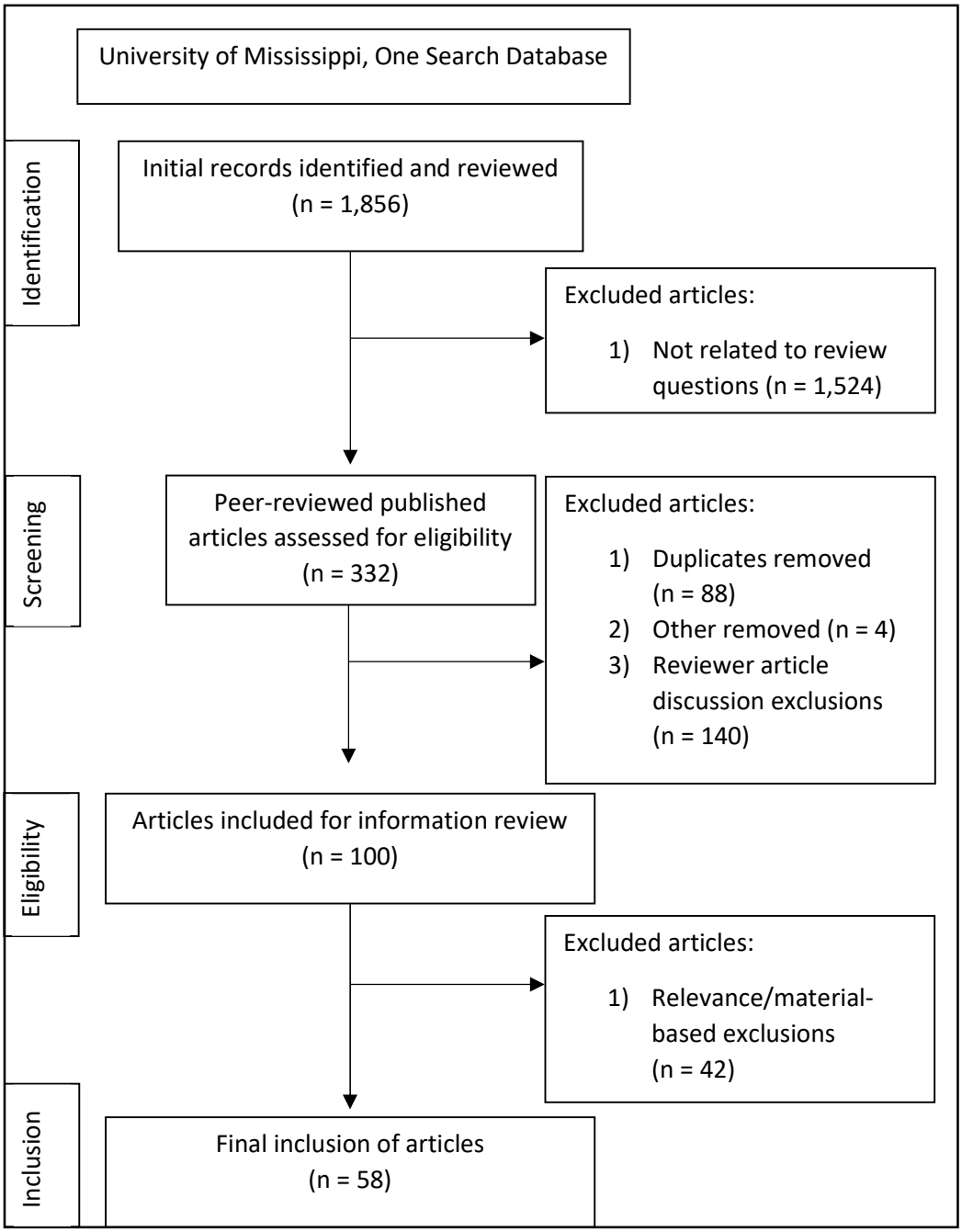
Variable	Regression Coefficient (Unstandardized)				Regression Coefficient (Standardized)	p value
	b estimate	SE	95% CI			
Constant	2.467	0.678	1.1	3.834		<.001*
SEIdET Subscale 1	0.005	0.014	-0.024	0.033	0.058	0.735
SEIdET Subscale 2	0.02	0.012	-0.004	0.044	0.299	0.098
Years of Professional Experience	0.032	0.017	-0.002	0.067	0.169	0.067
Interdisciplinary Research Importance	-0.05	0.066	-0.182	0.082	-0.096	0.45*
Interested in Graduate Classes Outside Department	0.173	0.08	0.011	0.335	0.246	0.036*
Interested in Research with Faculty Outside Department	0.146	0.085	-0.025	0.318	0.217	0.093
Interested in Working with Graduate Students from Outside Department	0.301	0.086	0.128	0.474	0.474	0.001*
Could Learn Concepts or Methods with Graduate Students from Outside Department	-0.217	0.137	-0.493	0.059	-0.198	0.12
$R^2 = 0.681$ | □F = 11.753 ($p<0.001$)						

Table 3.J: Ableness Model - Exploratory Linear Regressions

Variable	Regression Coefficient (Unstandardized)				Regression Coefficient (Standardized)	p value
	b estimate	SE	95% CI			
Constant	2.108	0.664	0.774	3.443	-	0.003*
SEIdET Subscale 1	0.035	0.017	0.001	0.068	0.444	0.042*
SEIdET Subscale 2	0.002	0.013	-0.025	0.029	0.033	0.874
Interested in Graduate Classes Outside Department	0.237	0.076	0.084	0.390	0.355	0.003*
$R^2 = 0.394$ | □F = 10.598 ($p<0.001$)						

APPENDICES

Appendix 1.A: Narrative Review Flowchart



Appendix 1.B: One Search Database List

A

Abstracts in Anthropology

Academic Search Premier

Academic Video Online @ Alexander Street Press

Academic Video Online @ ProQuest

Access World News

Accounting and Tax

ACLS Humanities E-Book Collection

ACM Digital Library

ACM Guide to Computing Literature

ACS Journals

Advertising Red Books via Winmo

AEA Web

African American Communities

African American Newspapers, Series 1, 1827-1998

African American Poetry

African American Police League Records 1961-1988

African Diaspora, 1860-Present

African Journals Online

Agricola

AHD.com : American Hospital Directory

AHFS Consumer Medication Information

Air University Library Index to Military Periodicals

AllAfrica

Alt HealthWatch

America: History & Life

American Antiquarian Society (AAS) Historical Periodicals Collection: All Series

American Civil War Collection, 1860-1922

American Civil War: Letters and Diaries

American Fact Finder

American Film Institute Catalog

American History, 1493-1945

American Indian Histories and Cultures

American Indians and the American West, 1809-1971

American Periodicals Series

American Poetry

American Slavery Collection, 1820-1922

American West

Annual Review of Psychology

Annual Reviews

AnthroSource

Apartheid South Africa 1948-1980

Approved Drug Products with Therapeutic Equivalence Evaluations

ArchiveGrid

Archives Unbound

Art & Architecture Complete

ARTFL

Article First

Artstor Digital Library

ASCE Civil Engineering Database

Associated Press Stylebook Online

ATLA Religion Database with ATLASerials

Atlanta Constitution (1868-1984)

Atlanta Daily World (1931-2003)

Atlas of Rural and Small-Town America

Audio Drama: The L.A. Theatre Works Collection

B

Baltimore Afro-American

Best's Library Center

Bibliography of British and Irish History

Bibliography of Native North Americans

Biological Abstracts

BioOne

Black Abolitionist Papers

Black Drama: Third Edition

Black Freedom Struggle in the 20th Century.

Black Historical Newspaper Collection

Black Studies Center

Black Thought and Culture

Bloomberg BNA: Tax and Accounting Center

Book Collection: Nonfiction

Brill Islamic Studies Online: Reference Works

British Periodicals

BrowZine

Business Expert Press

Business Source Complete

C

C19: The Nineteenth Century Index

Cabell's Directories of Publishing Opportunities

Cambridge Companion to Music

CCH IntelliConnect

Central Intelligence Agency

Chicago Defender, The (1910 - 1975)

Chicago Manual of Style

China, America and the Pacific: Trade and Cultural Exchange

China: Culture and Society

China: Trade, Politics & Culture

Chinese Newspaper Collection (1832-1953)

Christian Science Monitor (1908-2007)

Chronicle of Higher Education Online

Chronicling America

Church Missionary Society Periodicals

CINAHL Plus with Full Text

Civil War Era

Civil War: A Newspaper Perspective

Cleveland Call & Post (1934-1991)

Cochrane Library

ComDisDome

Communication and Mass Media Complete

Computer Source

Computers & Applied Sciences Complete

Confederate Military Manuscripts and Records of Union Generals and the Union Army

Confidential Print: Africa, 1834-1966

Confidential Print: Latin America, 1833-1969

Confidential Print: Middle East, 1839-1969

Confidential Print: North America, 1824-1961

Congressional Publications

Congressional Serial Set

Consumer Brand Analytics

Consumer Health Complete

Coronavirus Research Database

Counseling and Therapy in Video

CQ Press Voting and Elections Collection

CQ Researcher

CRC Handbook of Chemistry and Physics

Criminal Justice Abstracts

D

Defining Gender

Department of Justice

Detroit Free Press (1831-1999)

Dictionary of American Regional English

Dictionary of Literary Biography

Dictionary of Old English Corpus

Dictionary of Old English: A to I

Digital National Security Archive

Digital Sanborn Maps 1867-1970

Digital Theatre+

Directory of Open Access Journals

Dissertations & Theses Global

Dissertations & Theses: University of Mississippi

E

Early American Newspapers, Series 6

Early English Books Online

Early English Books Online:Text Creation Partnership

Ebook Central

Ebook Central Academic Complete

Ebook Central Social Sciences Collection

eBooks on EBSCOhost

EBSCOhost (Academic Search)

EconLit

Educational Administration Abstracts

Eighteenth Century Collections Online

Eighteenth Century Drama: Censorship And The Stage

Eighteenth Century Journals

Emerald Management 120

Empire Online

English Poetry

Environment Complete

ERIC (via EBSCO)

ERIC (via Institute of Education Sciences)

Ethnic NewsWatch

Ethnographic Sound Archives Online

European Views of the Americas: 1493-1750

Everyday Life & Women in America c.1800-1920

F

Fannie Lou Hamer: Papers of a Civil Rights Activist, Political Activist, and Woman

FBI Confidential Files and Radical Politics in the U.S., 1945-1972

FBI File: House Committee on Un-American Activities (HUAC)

FBI File: Watergate

Federal Aviation Administration

Federal Bureau of Investigation

Federal Election Commission

FIAF International Index to Film Periodicals

Film Index International

Films on Demand

First World War

FirstSearch Databases

Food Chemicals Codex (FCC) Online

Food Studies Online

Foreign Office Files for China, 1919-1980

Foreign Office Files for India, Pakistan and Afghanistan, 1947-1980

Foreign Office Files for the Middle East, 1971-1981

Frontier Life: Borderland and Colonial Encounters

Funk & Wagnalls New World Encyclopedia

G

Gale Virtual Reference Library

Garden, Landscape & Horticulture Literature Index

Gender Studies Database

GeoRef

Geoscience World

Global Commodities: Trade, Exploration and Cultural Exchange

Google Scholar

Grand Tour

GreenFILE

Guardian (1821-2003) and The Observer (1791-2003)

H

HAPI: Hispanic American Periodicals Index

HathiTrust

HeinOnline

Historical Abstracts

History Reference Center

Homeland Security Digital Library

Hospitality & Tourism Complete

Humanities International Complete

I

IBISWorld

ICE Virtual Library

ICPSR

IEEE Xplore

Index Islamicus

Index to Medieval Art

India, Raj and Empire

Information Science & Technology Abstracts (ISTA)

Ingenta

INSPEC

Intelex Past Masters

International Bibliography of Theatre & Dance

International Pharmaceutical Abstracts

IPA Source

J

James Meredith, J. Edgar Hoover, and the Integration of the University of Mississippi

Japan Times Archives

Jewish Life in America, c1654-1954

JoVE Unlimited - Science Education

JoVE Unlimited - Video Journal

JSTOR

K

Kanopy Streaming Video

Key Business Ratios

L

L'Annee Philologique

Labor Unions in the U.S., 1862-1974: Knights of Labor, AFL, CIO, and AFL-CIO

Latin American Intelligence Service

Legal Collection

Leisure, Travel & Mass Culture: The History of Tourism

LexiComp Online

LexisNexis

LGBT Magazine Archive

LGBT Thought and Culture

LGBTQ+ Source

Library Literature & Information Science Full Text

Library, Information Science & Technology Abstracts (LISTA)

Linguistics and Language Behavior Abstracts (LLBA)

Literary Manuscripts from the Henry W. and Albert A. Berg Collection of the New York Public Library

Literary Manuscripts, 17th and 18th Century Poetry from the Brotherton Library, University of Leeds

Literary Reference Center

Literature Criticism from 1400 to 1800

Literature Online

London Low Life

Los Angeles Sentinel (1934-2005)

M

Macmillan Cabinet Papers, 1957-1963

Making of Modern Law: Primary Sources, 1620-1926

Margaret Sanger Papers: Smith College Collections and Collected Documents

MarinLit

Market Research and American Business Reports, 1935-1965

MAS Ultra

Mass Incarceration and Prison Studies

Mass Observation Online Archive, 1937-1967

MasterFILE Premier

MathSciNet

Medieval Family Life: The Paston, Cely, Plumpton, Stonor and Armburgh Papers

MEDLINE (via Ebsco)

MEDLINE (via PubMed)

Meiji Japan: The Edward Sylvester Morse papers (ca. 1858-1925)

Mental Measurements Yearbook with Tests in Print

Mergent Archives: Digital Manuals, WebReports, and Key Business Ratios

Mergent Historical Annual Reports (1844-present)

Mergent Intellect

Mergent Online

Met Opera on Demand

Middle and Junior High Core Collection

Middle Search Plus

Migration to New Worlds

Mississippi Members of Congress

Mississippi Newspapers

MLA Directory of Periodicals

MLA International Bibliography

Music Periodicals Database

N

NAACP Papers

Nashville Tennessean (1812-2002)

National Academies Press

National Aeronautics and Space Adminstration

National Archives

National Journal's Policy Central

National Security Agency

National Theatre Collection

Natural Medicines

Naxos Jazz Library

Naxos Music Library

NBER Working Papers

NCJRS Abstracts

New York Amsterdam News

New York Times, The (1851 - 2017)

New York Times, The (2008 - recent)

Newspaper Source

Nexis Uni

Nineteenth Century Collections Online: Asia and the West

Nineteenth-Century Literature Criticism

Nixon Years, 1969-1974

Norfolk Journal and Guide (1921-2003)

NoveList

O

Observer: News for the American Soldier in Vietnam, 1962-1973, The

One Search

OnePetro

Ovid Journals

Oxford Art

Oxford English Dictionary

Oxford History of Western Music

Oxford Music Online

P

Pennsylvania Gazette, 1728-1800

Perdita Manuscripts

Performing Arts Periodicals Database

Periodicals Archive Online

Philadelphia Tribune (1912-2001)

Philosopher's Index

PhilPapers

Pittsburgh Courier, The (1911-2002)

Political Science Complete

Popular Culture in Britain and America, 1950-1975

Popular Medicine in America, 1800-1900

Presidential Recordings Digital Edition

Primary Search

PrivCo

Professional Development Collection

Project Gutenberg

Project Muse

ProQuest Central

ProQuest Central: Advanced Technologies & Aerospace

ProQuest Central: Biological Science

ProQuest Central: Computer Science

ProQuest Central: Criminal Justice

ProQuest Central: Education

ProQuest Central: Engineering

ProQuest Central: Psychology

ProQuest Central: Public Health

ProQuest Central: Telecommunications

PsycARTICLES

Psychology & Behavioral Sciences Collection

Psychotherapy.net Video Collection

PsycINFO

PubMed

PubMed Central

R

Race Relations Abstracts

Real Estate and REITs

Reconstruction and Military Government after the Civil War

Reconstruction of Southern States: Pamphlets

Regional Business News

Religion & Philosophy Collection

Revolutionary War and Early America: Collection from the Massachusetts Historical Society, 1721-1860

RIA Checkpoint

Richard K. Miller Market Research Handbooks

RILM

Romanticism: Life, Literature and Landscape

Roper Center For Public Opinion Research

S

Sage Premier

Sage Research Methods

Salem History Online

Sanborn Maps 1867-1970

Science.Gov

ScienceDirect

Scientific Electronic Library Online (SciELO)

SciFinder-n

Scopus

Screen Studies Collection

Senior High Core Collection

Serials Directory

Shakespeare in Performance: The Folger Shakespeare Library Prompt Books

Shock and Vibration Digest

Short Story Index (H.W. Wilson)

Simmons Insights

Slavery and the Law

Slavery in Antebellum Southern Industries

Slavery, Abolition and Social Justice, 1490-2007

Social Explorer

SocINDEX with Full Text

Southern Life and African American History, 1775-1915; Plantation Records

SportBusiness Media

SPORTDiscus

Sports Market Analytics

Springer

SRDS

St. Petersburg Times/Tampa Bay Times (1901-2009)

Statista

Statistical Abstract of the United States

Statistical Abstract of the World

Struggle for Women's Rights: Organizational Records, 1880-1990

Swank Motion Pictures

T

Taylor & Francis Online

Teacher Reference Center

Teaching Channel Videos

Temperance and Prohibition Movement, 1830-1933

The Sunday Times Historical Archive, 1822-2016

The Times Digital Archive, 1785-2014

Times of India (1838-2007)

TOPICsearch

Travel Writing, Spectacle and World History

TRID

Twentieth Century Religious Thought: Christianity

Twentieth Century Religious Thought: Islam

U

U.S. Citizenship and Immigration Services

U.S. Congressional Serial Set

U.S. Department of State Freedom of Information Act

U.S. Patents, 1971+

U.S. Serial Set and Maps Digital Collection

UNdata: A World of Information

Underground and Independent Comics

Union Lists of Periodicals

USP Dictionary Online

USPNF Online

V

Value Line Research Center

Victorian Popular Culture

Virginia Company Archives

Vocational and Career Collection

Vogue Archive

W

Wall Street Journal

Washington Post, The (1877-2001)

WebCSD

Wellesley Index to Victorian Periodicals, 1824-1900, The

Wharton Research Data Service (WRDS)

Wiley Online

Women and Social Movements in Modern Empires Since 1820

Women and Social Movements in the United States,1600-2000

Women and Social Movements, International - 1840 to Present

Women at Work during World War II: Rosie the Riveter and the Women's Army Corps

Women in The National Archives

Women Working, 1800-1930

Women's Studies International

Women's Studies Manuscripts Collections from the Schlesinger Library: Voting Rights, National Politics, and Reproductive Rights

Women's Wear Daily Archive

Workers, Labor Unions, and the American Left in the 20th Century: Federal Records

World's Fairs

WorldCat Local

#

17th & 18th Century Burney Collection of UK Newspapers

20th-Century American Newspapers, Series 2

Appendix 1.C: Information on Articles in Final Inclusion

Author[s], date of publication (MM-YYYY)	Article Title	Journal, Volume, Issue, Pages	Related Review Question (s)	Summary (abstract, introduction, or study description)
Al Shayeb, 01-2013	Finance Graduates' Knowledge and Skills Development: Graduate and Employer Perceptions in United Arab Emirates	Journal of Education for Business, 88, 6, 307-313	1	There has been considerable debate over the past decades concerning the extent to which finance education has fulfilled employers' and graduates' expectations related to knowledge and skills needed in a changing and challenging business environment. This study seeks to examine whether there are significant differences in expectations between finance graduates and their employers through examining the 3 dimensions of skills and knowledge: routine-technical skills, interdisciplinary skills, and interpersonal and development skills. The results show that graduates put more emphasis on routine-technical skills compared to employers, who emphasize the importance of interdisciplinary knowledge and skills from other areas of business education. Both graduates and employers, however, shared a belief in the importance of interpersonal and developmental skills.
Allendorf et al., 04-2016	Shared place and space: a comparison of two interdisciplinary graduate programs	Journal of Environmental Studies and Sciences, 7, 2, 324-335	1, 2	Interdisciplinary training has an important role to play in environmental research, but what aspects of interdisciplinary training are most helpful for graduate students as they seek to define themselves as interdisciplinary environmental scholars? In this paper, we compare two environmentally related NSF IGERT programs at the University of Wisconsin-Madison that were similar in their research focus but very different in their approach to training. One program required shared coursework, while the other required research in a shared geographical area in Yunnan, China. Our results suggest that the formal structure of interdisciplinary training programs may be less important than providing students with opportunities to interact with people from other disciplines, both intellectually and in practice. However, differences between the programs did impact participants' approach to interdisciplinarity. Our findings also highlight the importance of professional training to ensure that all trainees are able to take advantage of interdisciplinary opportunities.
Andrade et al., 10-2014	Finding your way in the interdisciplinary forest: notes on educating future conservation practitioners	Biodiversity and Conservation, 23, 14, 3405-3423	2	We explore the challenges of educating interdisciplinary thinkers who can address the management of complex socio-ecological systems, such as forests, by sharing our experiences from several perspectives. Five contexts for interdisciplinarity are explored along with examples related to: the department, advising, integrated research collaborations, a graduate working group, an interdisciplinary class, and trans-academic research. These experiences demonstrate the importance of safe space and patience, the need for adequate time to build trust and respect, and the recognition that interdisciplinary thinking is developed and reinforced in multiple contexts. Interdisciplinarity is always a work in progress that differs in its particulars according to

				the research or management question at hand and the kinds of specializations involved. Thus, there are no hard and fast rules for its creation but only guiding principles that must be adapted in the course of their implementation.
Beddoes, 07-2020	Interdisciplinary teamwork artefacts and practices: a typology for promoting successful teamwork in engineering education	Australasian Journal of Engineering Education, 25, 2, 133-141	2	Professional organisations and engineering educators in Australia recognise that interdisciplinary teamwork skills are increasingly important for engineering graduates to develop. However, knowledge and resources for how best to develop those skills is underdeveloped. This article addresses that gap by introducing a new conceptual framework and typology for promoting successful interdisciplinary teamwork. The analysis is based upon several long-term ethnographic studies of interdisciplinary student teams. The conceptual framework is called Interdisciplinary Teamwork Artefacts and Practices (ITAP), and the six types of ITAPs are: (1) orienting, (2) operating, (3) levelling, (4) proposing, (5) aligning, and (6) structuring. This typology can be used to help instructors and students alike navigate the challenges of interdisciplinary teamwork while maximising interdisciplinary learning outcomes.
Bishop-Williams et al., 12-2017	Graduate student perspectives of interdisciplinary and disciplinary programming for teaching development	Canadian Journal of Scholarship of Teaching and Learning, 8, 3, 1 to 28	1, 2, 3	Interdisciplinary (i.e., university-wide programming) and disciplinary (i.e., programming open to participants from one college or department) teaching development programs for graduate students have been used for many years in higher education. Currently, research on the benefits of these teaching models remains scant in terms of a contextualized understanding, and empirical studies are needed. The purpose of this study was to determine graduate students' perspectives related to interdisciplinary and disciplinary teaching and learning experiences. Two online surveys were used: a quantitative survey and a qualitative follow-up survey. Three participatory focus groups were also conducted to allow for further in-depth exploration in both an interdisciplinary and disciplinary group setting that represented seven distinct colleges. Statistical and thematic analyses were conducted with survey responses, and thematic analyses were conducted on focus group data. Similar themes emerged from the survey and focus group data identifying perceived benefits of participation in either interdisciplinary or disciplinary teaching development. Respondents' perceived benefits were related to: (a) becoming a better teacher; (b) social learning; and (c) that while the perceived benefits of the models vary, the outcomes of both experiences are shared. The lived experiences of these graduate students expand the characterization of interdisciplinary and disciplinary programming. This study points to the need for graduate student programs—specifically teaching development offered by educational development units—to provide both interdisciplinary and disciplinary teaching development opportunities that achieve a blend of benefits for learners.
Boden et al., 12-2011	Student socialization in interdisciplinary doctoral education	Higher Education, 62, 6, 741	2, 3	Interdisciplinary approaches are often seen as necessary for attacking the most critical challenges facing the world today, and doctoral students and their training programs are recognized as central to increasing interdisciplinary research capacity. However, the traditional culture and organization of higher education are ill-equipped to facilitate interdisciplinary work. This study employs a lens of socialization to study the process

				through which students learn the norms, values, and culture of both traditional disciplines and integrated knowledge production. It concludes that many of the processes of socialization are similar, but that special attention should be paid to overcoming organizational barriers to interdisciplinarity related to policies, space, engagement with future employers, and open discussion of the politics of interdisciplinarity.
Boland et al., 11-2016	Interprofessional immersion: Use of interprofessional education collaborative competencies in side-by-side training of family medicine, pharmacy, nursing, and counselling psychology trainees	Journal of Interprofessional Care, 30, 6, 739-746	2, 3	While supported by the Affordable Care Act, in the United States, interprofessional training often takes place after healthcare providers graduate and are practicing in the field. This article describes the implementation and evaluation of an interprofessional training for graduate-level healthcare trainees. A group of interprofessional healthcare faculty provided a weeklong interprofessional immersion for doctoral-level healthcare trainees (n = 24) in Pharmacy, Counselling Psychology, Nursing, and Family Medicine residents. Healthcare faculty and staff from each profession worked side-by-side to provide integrated training utilising the Interprofessional Education Collaborative core competency domains. Trainees were placed into small teams with representatives from each profession; each team observed, learned, and practiced working within teams to provide quality patient care. Qualitative and quantitative data were collected to identify the effect of the training on trainees' self-reported team skills, as well as the extent to which the trainees learned and utilised the competencies. The results suggest that after completing the training, trainees felt more confident in their ability to work within an interprofessional team and more likely to utilise a team-based approach in the future
Carlton et al., 05-2015	Our Future's Brightest: Developing Interprofessional Competencies Through an Interdisciplinary Graduate Student Case Competition	Journal of Health Administration Education, 38, 4, 448-464	2, 3	Case competitions are an established method for developing competencies in students in health administration, public health, and other health-related professions. However, many existing competitions do not broadly or intentionally integrate students from other professions such as law, anthropology, social work, and public administration. This study evaluated the impact of the case competition model on development of interprofessional competencies among graduate students participating in an interprofessional case competition. It also provides a model for assessing interprofessional competency development adapted to nonclinical professions. We surveyed 40 graduate students who participated in 2 case competitions. To assess competency development, we adapted nonclinical competencies from the Core Competencies for Interprofessional Collaborative Practice. Students were asked how well they believed they met each competency before and after the competition using a postcompetition survey with a five-point Likert scale. We compared means for each competency (before and after) using paired t-tests with $\alpha = .05$. Students' postcompetition mean competency ratings were significantly higher than the precompetition mean rating for all 16 comparisons. The highest rated competency was "feel my discipline can contribute to improving population health." The lowest rated competency, before and after, was "Others' understanding and respect for your discipline." Results suggest an interdisciplinary approach to case competitions can assist in enhancing graduate education through the development of interprofessional competencies. Educators should be deliberate in their engagement of

				interdisciplinary collaborators and carefully structure the competition and related materials and activities to assure student learning and success.
Dewar et al., 03-2015	The integrated first year experience in the master of public health program	American Journal of Public Health, 32, 1, 47-57	2	Schools of Public Health historically introduced core curriculum courses in the first year of the Master of Public Health program as independent perspectives; these perspectives included epidemiology, biostatistics, environmental health, public health biology, health behaviors, and health policy. We performed a pilot project that integrated the core areas around diabetes as a cross-cutting public health issue to provide early exposure to the interdisciplinary nature of public health. In each core curriculum course, diabetes was explored in the curriculum and related to other core courses. Based on positive evaluations, this project will be replicated using a different health issue. Such an issue can be easily introduced as an overarching umbrella under which students are motivated to work through interdisciplinary collaboration.
Drotar et al., 03-2003	Training Graduate-Level Pediatric Psychology Researchers at Case Western Reserve University: Meeting the Challenges of the New Millennium	Journal of Pediatric Psychology, 105, S1, S97-S98	2, 3	Objective To describe the challenges in training graduate-level pediatric psychology researchers for successful careers and to discuss solutions. Methods We reviewed experiences in training graduate students at Case Western Reserve University to identify key challenges in research training and potential strategies to meet them. Results We identified the following key challenges: stimulating graduate students' career interest in pediatric psychology research; teaching students about the pragmatic challenges of conducting research in pediatric settings, specialized research design, and data analytic issues; helping students to develop essential research skills; developing opportunities for student research-related collaborations; helping students develop professional identities as researchers; and developing and supporting their research careers beyond graduate school. Conclusions Useful strategies for meeting these challenges include involving an interdisciplinary faculty in research training; developing specialized training methods that focus on critical research skills such as writing and data analysis; peer support; and involvement with multiple mentors who are successful researchers. Pediatric psychologists should also develop opportunities for the next generation of researchers by facilitating research job options and leadership opportunities.
Estes et al., 05-2016	Advanced Practice Nursing Students' Perspectives of an Interprofessional Advanced Physical Assessment Learning Experience	Journal for Nurse Practitioners, 28, 2, 123-134	1, 2, 3	Byline: Krista R. Estes, Marylou V. Robinson, Wendy Madigosky Although there are multiple professions providing health care, there is one commonly shared goal: improvement of patient outcomes. To meet this objective, it is important for there to be teamwork, mutual respect, and understanding. This can begin with a shared educational experience. Herein we describe an interprofessional education experience with graduate College of Nursing students and first year School of Medicine students in an advanced physical assessment course. Article Note: (footnote) In compliance with national ethical guidelines, the authors report no relationships with business or industry that would pose a conflict of interest.

Finlay et al., 01-2019	What we learned through asking about evidence: A model for interdisciplinary student engagement	Gerontology and Geriatrics Education, 12, 5, e219-e224	2, 3	Traditional university learning modalities of lectures and examinations do not prepare students fully for the evolving and complex world of gerontology and geriatrics. Students involved in more active, self-directed learning can develop a wider breadth of knowledge and perform better on practical examinations. This article describes the Evidence in Aging (EIA) study as a model of active learning with the aim of preparing students to be effective interdisciplinary researchers, educators, and leaders in aging. We focus particularly on the experiences and reflections of graduate students who collaborated with faculty mentors on study design, data collection, and analysis. Students acquired new methodological skills, gained exposure to diverse disciplines, built interdisciplinary understanding, and cultivated professional development. The EIA study is a model for innovative student engagement and collaboration, interactive learning, and critical scholarly development. Lessons learned can be applied to a range of collaborative research projects in gerontology and geriatrics education.
Francis et al., 01-2018	Collaborative teaching and interdisciplinary learning in graduate environmental studies	Journal of Environmental Studies and Sciences, 40, 1, 90-104	1, 2, 3	Many graduate programs in environmental studies attempt to foster specialized knowledge and technical skills alongside interdisciplinary collaboration and integration. We discuss strategies for addressing these distinct—sometimes competing—goals in Evergreen State College's Graduate Program on the Environment. Key strategies include (1) designing an academic program that balances specialization and integration; (2) approaching course planning with a "backward design model" that focuses on teaching outcomes rather than "covering" disciplinary content; (3) designing group assignments that require collaborative and multidisciplinary research and networking among students; (4) approaching thesis projects using place-based issues or research problems/questions developed in conjunction with local or regional organizations and a clear identification of relevant communities of practice to inform the scholarly work and analysis. Finally, we address the challenge of creating equitable social dynamics in teaching teams and offer reflections based on our 30-year tradition of collaborative team-teaching at the graduate level.
Gantogtokh and Quinlan, 07-2017	Challenges of designing interdisciplinary postgraduate curricula: case studies of interdisciplinary master's programmes at a research-intensive UK university	Teaching in Higher Education, 8, 3, 343-350	2	This study, based on case study analyses of two interdisciplinary programmes in a research-intensive university in the UK, focuses on the challenges involved in designing, coordinating, and leading interdisciplinary postgraduate curricula, including workload, student heterogeneity, and difficulties in achieving coherence. Solutions and approaches developed within these case study programmes are also highlighted. This study raises awareness of the complex nature of interdisciplinary curricula so that it may help academics proactively develop better strategies and approaches to address common challenges. It also synthesises disparate literature into a framework for investigating curricular coherence.

Gardner, 2014	Socialization to interdisciplinarity: Faculty and student perspectives	Higher Education, 22, 5, 569-586	1, 2	Socialization has become a common framework through which to understand the doctoral student experience; however, the framework has predominately been used as a lens through which to understand traditional, single-discipline doctoral student experiences. Interdisciplinary doctoral programs are becoming increasingly common in both the United States and elsewhere but relatively little empirical research exists about this distinct experience. Through multiple interviews with 18 doctoral students and their 35 faculty members, we discuss differences in the socialization process for these students in regard to knowledge acquisition, investment, and involvement. Implications for practice and future research are included.
Giuliante et al., 09-2018	Geriatric Interdisciplinary Team Training 2.0: A collaborative team-based approach to delivering care	Journal of Interprofessional Care, 67, 3, 255-271	2, 3	Interprofessional collaborative education and practice has become a cornerstone of optimal person-centered management in the current complex health care climate. This is especially important when working with older adults, many with multiple chronic conditions and challenging health care needs. This paper describes a feasibility study of the Geriatric Interdisciplinary Team Training 2.0 (GITT 2.0) program focused on providing interprofessional care to complex and frail older adults with multiple chronic conditions. A concurrent triangulation mixed-methods design facilitated program implementation and evaluation. Over three years (2013-2016), 65 graduate students from nursing, midwifery, social work, and pharmacy participated along with 25 preceptors. Participants were surveyed on their attitudes toward interprofessional collaboration pre and post-intervention and participated in focus groups. While attitudes toward interprofessional collaboration did not change quantitatively, focus groups revealed changes in language and enhanced perspectives of participants. Based on the evaluation data, the GITT 2.0 Toolkit was refined for use in interprofessional education and practice activities related to quality initiatives.
Golembiewski et al., 04-2018	Interdisciplinary Dissertation Research Among Public Health Doctoral Trainees, 2003-2015	Public Health Reports, 32, 5, 629-633	1, 2	OBJECTIVES: Given the call for more interdisciplinary research in public health, the objectives of this study were to (1) examine the correlates of interdisciplinary dissertation completion and (2) identify secondary fields most common among interdisciplinary public health graduates. METHODS: We analyzed pooled cross-sectional data from 11 120 doctoral graduates in the Survey of Earned Doctorates, 2003-2015. The primary outcome was interdisciplinary dissertation completion. Covariates included primary public health field, sociodemographic characteristics, and institutional attributes. RESULTS: From 2003 to 2015, a total of 4005 of 11 120 (36.0%) doctoral graduates in public health reported interdisciplinary dissertations, with significant increases observed in recent years. Compared with general public health graduates, graduates of environmental health (odds ratio [OR] = 1.74; P < .001) and health services administration (OR = 1.38; P < .001) doctoral programs were significantly more likely to report completing interdisciplinary dissertation work, whereas graduates from biostatistics (OR = 0.51; P < .001) and epidemiology (OR = 0.76; P < .001) were less likely to do so. Completing an interdisciplinary dissertation was associated with being male, a non-US citizen, a graduate of a private institution, and a graduate of an

				institution with high but not the highest level of research activity. Many secondary dissertation fields reported by interdisciplinary graduates included other public health fields. CONCLUSION: Although interdisciplinary dissertation research among doctoral graduates in public health has increased in recent years, such work is bounded in certain fields of public health and certain types of graduates and institutions. Academic administrators and other stakeholders may use these results to inform greater interdisciplinary activity during doctoral training and to evaluate current and future collaborations across departments or schools.
Graybill et al., 09-2006	A Rough Guide to Interdisciplinarity: Graduate Student Perspectives	Bioscience, 133, 2, 182-190	2	A widely held belief is that only through interdisciplinarity can academics effectively address today's complex ecological problems, because these problems demand cross-disciplinary efforts and specialized knowledge from natural and social scientists. Innovative interdisciplinary research and curricula have been created to train a new generation of scientists to engage with complex issues. It seems critical that those most affected by interdisciplinary education—doctoral students—provide feedback about such innovations. Without understanding students' experiences in interdisciplinary programs, faculty will not know whether they are "getting it right" for future generations of interdisciplinarians. From our experiences as doctoral students, we provide reflections and perspectives on the National Science Foundation–funded Urban Ecology IGERT (Integrative Graduate Education and Research Traineeship) Program at the University of Washington. We discuss the aspects of the program that provided the most beneficial interdisciplinary experiences, as well as those aspects that could be improved. We identify three stages of intellectual development, present questions encountered during each stage, and develop six core recommendations for interdisciplinary research and training programs.
Hacket and Rhoten, 12-2009	The Snowbird Charrette: Integrative Interdisciplinary Collaboration in Environmental Research Design	Minerva, 56, 9, 757-763	2, 3	The integration of ideas, methods, and data from diverse disciplines has been a transformative force in science and higher education, attracting policy interventions, program innovations, financial resources, and talented people. Much energy has been invested in producing a new generation of scientists trained to work fluidly across disciplines, sectors, and research problems, yet the success of such investments has been difficult to measure. Using the Integrative Graduate Education and Research Training (IGERT) program of the U.S. National Science Foundation as a strategic research site, we conducted an experiment to determine whether and how the process and products of research of IGERT-trained scientists differ from those of scientists trained in disciplinary graduate programs. Among scientists in the early years of graduate study we found substantial and consistent differences suggesting that interdisciplinary training improved the quality and process of research, but this pattern was equally strongly reversed among students in the latter years of graduate study. Using systematic observation and other data we suggest why this might be so, then discuss the implications of these results for the design and conduct of graduate education and research.

Hains-Wesson and Ji, 06-2020	Students' perceptions of an interdisciplinary global study tour: uncovering inexplicit employability skills	Higher Education Research and Development, 47, 4, 407-440	2, 3	For higher education graduates to be effective in the workplace, they require strong technical skills and the capability to operate across diverse knowledge landscapes to solve real world problems. At an Australian university, an interdisciplinary, short-term study tour programme was utilised to enhance students' inexplicit employability skills with a focus on managing complexity while developing agility and creativity. To investigate the effectiveness of such a programme, we examined students' perceptions of an interdisciplinary teamwork assessment task that was undertaken in an international context via a study tour model. We achieved this by, first, introducing a purposely designed interdisciplinary teamwork assessment task, which focused on students presenting innovative ideas to peers and industry members. Second, we elicited student responses via a case study approach that incorporated mixed methods, utilising several data collection instruments prior to, during, and after students participated in a study tour. The findings suggest that integrating a purposely designed interdisciplinary teamwork assessment task, via a short-term study tour model, uncovered certain inexplicit employability skills, namely managing complexity, developing agility and creativity. We make specific recommendations to support this insight, contributing to the mobility teaching and learning research field.
Hamilton, 04-2011	Two birds with one stone: Addressing interprofessional education aims and objectives in health profession curricula through interdisciplinary cultural competency training	Medical Teacher, 39, 4, 657-671	2	Interprofessional education (IPE) is acknowledged as important in producing health care profession graduates able to work collaboratively with colleagues from other health professions. There are, however, a range of obstacles to development of effective IPE programmes. Differing health professional cultures and socialisation processes have been identified as two potential barriers. This article notes considerable alignment between the broad aims and objectives of IPE and those of cultural competency training. It suggests that in the course of acquiring values, attitudes and skills consistent with a culturally competent practitioner, students may simultaneously develop a capacity to apply these same skills and attributes to their relationships with students (and future colleagues) from other health professions. This article draws on the concept of interprofessional cultural competence (CC; Pecukonis, E., Doyle, O. & Bliss, D.L. (2008). Reducing barriers to interprofessional training: promoting interprofessional cultural competence. J Interprofessional Care, 22(4), 417-428), noting that interdisciplinary CC training delivered early in undergraduate years may be an effective vehicle for meeting IPE aims and objectives, and examining an example of this in practice. This article suggests that interdisciplinary programmes developed to jointly meet CC and IPE aims and objectives may provide a platform for fostering interprofessional tolerance, promoting shared values and discouraging the formation of interprofessional barriers as students are socialised into their professional cultures.
Handron et al., 06-2001	Challenges of Providing Interdisciplinary	Journal of Family Social Work, 33, 4, e199-e203	2, 3	Recommendations and implications of the Pew Health Professions Commission's fourth and final report emphasized the importance of developing interdisciplinary competencies for health professionals (Bellack & O'Neil, 2000). Headrick and Moore (1999) reported to the Association of Academic Health Centers that interprofessional collaboration has

	Mental Health Education			not been easy, in part, because most health professional faculty are products of individual, discipline specific models for education. This article provides a conceptual foundation for interdisciplinary health care education at the graduate level based on findings from an interdisciplinary course in child/family mental health at East Carolina University. Classroom challenges affecting interdisciplinary offerings and specific problems that preclude integration of medical students are addressed. The article offers strategies to create a positive interdisciplinary learning climate for pre-professional education. Evidenced-based medicine is discussed as a mechanism to remove discipline specific barriers.
Holley, 2009	The challenge of an interdisciplinary curriculum: a cultural analysis of a doctoral-degree program in neuroscience	Higher Education, 5, 3, 49-62	2	Drawing on data collected through 45 interviews with faculty, doctoral students, and administrators affiliated with an interdisciplinary neuroscience program, I examine the structure of the interdisciplinary graduate curriculum. The data presented here highlight the challenge of such programs. I review the purpose, organization, and content of the interdisciplinary curriculum, noting those challenges that arise. Not only do such programs require collaboration among faculty who traditionally has been highly invested in their individual discipline or department, but they also require an active, deliberate process to foster interdisciplinary integration and student learning.
Jessen Condry et al., 2017	Design of a Lyme Disease Vaccine as an Active Learning Approach in a Novel Interdisciplinary Graduate-Level Course	Journal of Microbiology and Biology Education, 58, 2, 241-255	2, 3	A biomedical sciences graduate program needed an introductory class that would develop skills for students interested in a wide variety of disciplines, such as microbiology or cancer biology, and a diverse array of biomedical careers. Faculty created a year-long student-centered course, Scientific Discovery, to serve this need. The course was divided into four modules with progressive skill outcomes. Each module had a focus related to each of the major research areas of the collective faculty: molecular biology, biochemistry, neuroscience, and infectious disease. First-year graduate students enter the program with relevant college-level biology and chemistry coursework but not in-depth content knowledge of any of the focus areas. Each module features a biomedical problem for the students to gain specific content knowledge while developing skills outcomes, such as the ability to conduct scholarly inquiry. In 2015, the theme of the infectious disease module was to create an effective human vaccine to prevent Lyme disease. The module required students to learn fundamental concepts of microbiology and immunology and then apply that knowledge to design their own Lyme disease vaccine. The class culminated with students communicating their creative designs in the form of a "white paper" and a pitch to "potential investors." By the end of the module, students had developed fundamental knowledge, applied that knowledge with great creativity, and met the skills learning outcomes, as evidenced by their ability to conduct scholarly inquiry and apply knowledge gained during this module to a novel problem, as part of their final exam.
Kans and Gustafsson, 02-2020	Internal stakeholders' views on	Cogent Education, 18, 3, n/a	1, 2	Even though research exists on interdisciplinary education and interdisciplinary skills, the term "interdisciplinary" is ambiguous. Currently, studies on how different internal stakeholders in an education setting define and conceptualise interdisciplinarity are

	interdisciplinarity: An empirical study within an interdisciplinary master's program			lacking. Consequently, the purpose of this paper is to define and conceptualise interdisciplinarity in higher education. This is investigated by focus group interviews with 29 internal stakeholders representing students, teachers, and program managers at an interdisciplinary master's program. The conclusion provides a definition of interdisciplinarity; The integration of people possessing different competencies (knowledge, background, and skills) acting upon an identified need, challenge or opportunity that requires a holistic approach founded in synergies and thereby creating new knowledge. Interdisciplinary learning is mainly conceptualised to take place in open-ended and research-like innovation projects.
Kiley and Halliday, 09-2019	Candidate and supervisor experiences of doctoral study in a structured, interdisciplinary training environment	Innovations in Education and Teaching International, 7, 1, 1731221-1731240	2	This study aimed to understand doctoral candidates' and supervisors' positive and negative experiences of undertaking a doctorate in a structured interdisciplinary research training environment. Interviews were held with 16 candidates and eight supervisors involved in an interdisciplinary research centre. Most candidates were undertaking a disciplinary focussed doctorate while being active participants in the centre's doctoral education program. Our findings highlighted three themes that influence positive or negative experiences: the design of the interdisciplinary environment; the critical role of communication; and the qualities of candidates and supervisors deemed important to work effectively in such an environment. We conclude with suggestions that might help develop an effective interdisciplinary research environment.
Kluger and Bartzke, 12-2020	A practical guideline how to tackle interdisciplinarity—A synthesis from a post-graduate group project	Humanities and Social Sciences Communication, 56, 5, 663-674	2	The comprehensive understanding of increasingly complex global challenges, such as climate change induced sea level rise demands for interdisciplinary research groups. As a result, there is an increasing interest of funding bodies to support interdisciplinary research initiatives. Attempts for interdisciplinary research in such programs often end in research between closely linked disciplines. This is often due to a lack of understanding about how to work interdisciplinarily as a group. Useful practical guidelines have been provided to overcome existing barriers during interdisciplinary integration. Working as an interdisciplinary research group becomes particularly challenging at the doctoral student level. This study reports findings of an interdisciplinary group project in which a group of doctoral students and postdoctoral researchers from various disciplines faced the challenges of reconciling natural, social, and legal aspects of a fictional coastal environmental problem. The research group went through three phases of interdisciplinary integration: (1) comparing disciplines, (2) understanding disciplines, and (3) thinking between disciplines. These phases finally resulted in the development of a practical guideline, including five concepts of interactive integration. A reflective analysis with observations made in existing literature about interdisciplinary integration further supported the feasibility of the practical guideline. It is intended that this practical guideline may help others to leave out pitfalls and to gain a more successful application of interdisciplinarity in their training.
Knobloch et al., 01-2020	Developing interdisciplinary	Journal of Agricultural	1, 2, 3	Purpose: The purpose of this study was to describe faculty and graduate students' motivation and learning experiences in a multi-institutional, interdisciplinary graduate

	thinking in a food and nutritional security, hunger, and sustainability graduate course	Education and Extension, 7, 1, 1-11		course focused on the nexus of food and nutritional security, hunger, and sustainability. Design/Methodology/Approach: A one-group pre-experimental case study design was used. Faculty and students completed questionnaires, which included rating scales and open-ended questions. Data were analyzed and triangulated into key findings. Findings: Results indicated that faculty were interested and engaged in the development of the interdisciplinary course, and students were engaged in interdisciplinary learning and developed communication and education skills through experiential place-based learning. Practical Implications: Faculty developed a common understanding of their different disciplinary perspectives that helped provide a more cohesive and complementary interdisciplinary learning experience for students. Students learned about global challenges while identifying similar challenges in their local communities through the experiential learning assignments. Theoretical Implications: The design of the interdisciplinary course helped students think critically and creatively to learn complex issues. Advances in technology and active learning support a flipped classroom model to engage students. Place-based learning combined with interdisciplinary classroom experiences connected students to local real-world contexts and provided students with practical applications of problem-solving, critical thinking, and systems thinking skills. Originality/Value: Graduate students conducted an asset and needs assessment, which connected them to professionals in the community. Students think food and nutritional security, hunger, and sustainability are global challenges and seldom notice food insecurity in their local communities.
Knowlton et al., 2014	Teaching interdisciplinary sustainability science teamwork skills to graduate students using in-person and web-based interactions	Sustainability, 26, 1, 113-127	2	Interdisciplinary sustainability science teamwork skills are essential for addressing the world's most pressing and complex sustainability problems, which inherently have social, natural, and engineering science dimensions. Further, because sustainability science problems exist at global scales, interdisciplinary science teams will need to consist of international members who communicate and work together effectively. Students trained in international interdisciplinary science skills will be able to hit the ground running when they obtain jobs requiring them to tackle sustainability problems. While many universities now have sustainability science programs, few offer courses that are interdisciplinary and international in scope. In the fall semester of 2013, we piloted a course for graduate students entitled "Principles of Interdisciplinary Sustainability Research" at Michigan Technological University. This course was part of our United States National Science Foundation Partnerships in International Research and Education project on bioenergy development impacts across the Americas. In this case study, we describe the course development and implementation, share critical insights from our experience teaching the course and student learning outcomes, and give recommendations for future similar courses.
Lang et al., 06-2018	Implementation and Mixed-Methods	Pedagogy in Health	1, 2, 3	Master of Public Health (MPH) students must develop skills to work in collaborative, interdisciplinary, and interprofessional teams upon graduation. Teaching pedagogies that involve active learning and collaboration between students, such as team-based learning

	Evaluation of Team-Based Learning in a Graduate Public Health Research Methods Course	Promotion, 6, 12, 9428-9440		(TBL), may be helpful in preparing students to work in teams. To our knowledge, there is no literature examining TBL specifically in the context of graduate public health education to date. This study evaluated the implementation of TBL in a Behavioral Science Research Methods course on the following outcomes: (a) engagement with the course material, (b) perceived effectiveness of TBL components, (c) experience working in teams, and (d) perceived mastery of learning outcomes. We conducted a survey of first-year MPH students enrolled in the TBL research methods course (= 45 respondents) and three focus groups (= 17 total). Two focus groups were conducted with second-year MPH students who previously took a lecture-based version of the course (= 10 total). Overall, students in the TBL research methods course felt confident in their mastery of learning outcomes. Students appeared more engaged with the TBL course material than with material from lecture-based courses. They also perceived this instructional method to be effective in facilitating learning. Main themes that emerged around working in teams included the central role of teammates in students' learning, the logistic and procedural roles students took on within their teams, and team dynamics. The TBL format engages MPH students in course content and has strong potential for preparing students for collaborative work in diverse teams.
Larson et al., 2011	Interdisciplinary research training in a school of nursing	Nursing Outlook, 4, 2, 140-150	2	Although interdisciplinarity has become a favored model of scholarly inquiry, the assumption that interdisciplinary work is intuitive and can be performed without training is short-sighted. This article describes the implementation of an interdisciplinary research training program within a school of nursing. We describe the key elements of the program and the challenges we encountered. From 2007-2010, eleven trainees from 6 disciplines have been accepted into the program and 7 have completed the program; the trainees have published 12 manuscripts and presented at 10 regional or national meetings. The major challenge has been to sustain and 'push the envelope' toward interdisciplinary thinking among the trainees and their mentors, and to assure that they do not revert to their 'safer' disciplinary silos. This training program, funded by National Institute of Nursing Research (NINR), has become well-established within the school of nursing and across the entire University campus, and is recognized as a high quality research training program across disciplines, as exemplified by excellent applicants from a number of disciplines.
Lindvig et al., 02-2019	Creating interdisciplinary education within monodisciplinary structures: the art of managing interstitiality	Studies in Higher Education, 59, 1, 29-36	2	The literature on interdisciplinary higher education is influenced by two overall trends: one looks at the institutional level of specially designed interdisciplinary institutions, while the other assesses individual interdisciplinary educational activities. Much less attention is given to the processes of creating interdisciplinary education initiatives within traditional monodisciplinary universities. In this study, we thus explore how interdisciplinary education and teaching emerge and develop within universities that have little or no established infrastructure to support interdisciplinarity. Using qualitative data from a multi-part case study, we examine the development of diverse interdisciplinary educational efforts within a traditional faculty-structured university in

				order to map the ways in which interdisciplinary educational elements have been created, supported, challenged or even strengthened by pre-existing monodisciplinary structures. Drawing on theories from economics, literature studies and sociology of education, we conclude that creating interdisciplinary education in such settings demands skills that we define as the ‘art of managing interstitiality’.
Lindvig, 09-2018	The implied PhD student of interdisciplinary research projects within monodisciplinary structures	Higher Education Research and Development, 44, 2, 347-360	1	While the literature concerning doctoral students has looked at institutional setup and socialisation of students within higher education structures and across disciplinary boundaries, so far, little attention has been given to the socialisation of PhD students in the intersections between strategic interdisciplinary research projects and monodisciplinary institutional structures, which is the aim of this article. The study is based on interviews with 32 PhD students and principal investigators affiliated with five research projects in the Excellence Programme for Interdisciplinary Research at University of Copenhagen, Denmark. In analysing this empirical material, the analytical concept of the 'implied student' has worked as a sensitising concept, highlighting the expectations of PhD students, principal investigators, the institutions, the educational system, and the encounter between them. In the interviews, the PhD students emphasise the conundrum of having to fit into a confined disciplinary role, while simultaneously being expected to cross boundaries and deliver on predefined goals in the interdisciplinary research projects. The findings show that students cope with these expectations by limiting the scope for improvisation and experimentation; in other words, suppressing what MacLure points towards as education's 'other'. This calls for greater attention to be paid to the accumulation of expectations heaped upon such PhD students and how this affects the education of the future generation of researchers.
Lyall and Meagher, 08-2012	A Masterclass in interdisciplinarity: Research into practice in training the next generation of interdisciplinary researchers	Futures: The Journal of Policy, Planning and Future Studies, 37, 6, 1171-1185	2	This paper draws on evaluations of a number of interdisciplinary studentship and fellowship schemes to discuss some of the challenges of developing interdisciplinary research skills in early career researchers. It describes efforts to support such capacity-building in the UK through a series of Interdisciplinary Masterclasses which used workshop-based elicitation techniques to develop smallscale studies in order to synthesise experiential knowledge and foster mutual learning. This has enabled us to build important bridges between research and practice, thereby supporting and developing the interdisciplinary careers of early- and mid-career researchers, as well as research managers and leaders. This paper describes an approach to interdisciplinary capacity-building derived from actual practice. Based on learning from these activities, we offer some suggestions for improved supervision and mentoring of interdisciplinary graduate students and young postdoctoral researchers. If we are to develop effective, future interdisciplinary capacity, we advocate that supervisors/mentors need to focus, not just on the research, but on the particular forms of professional support and mentoring required by inexperienced interdisciplinary researchers in terms of career guidance, the development of publications strategies and network building.

Marbach-Ad and Marr, 2019	Enhancing graduate students' ability to conduct and communicate research through an interdisciplinary lens	Journal of Microbiology and Biology Education, 44, 6, 608-617	3	This research is a part of a longitudinal study of the Computation and Mathematics for Biological Networks (COMBINE) program at the University of Maryland. The mission of COMBINE is to train doctoral students from a wide range of fields to pursue interdisciplinary research. Here, we focus on one component of COMBINE, a semester-long course titled Data Practicum at the Intersection of the Physical, Computer, and Life Sciences. The goal of this study was to explore the effectiveness of the teaching practices that were used in the Data Practicum. We investigated their impact on graduate students' confidence to conduct research through an interdisciplinary lens and to communicate their research to diverse audiences. We used validated pre- and post-course online surveys, in-class observations, collection of artifacts, and interviews. Interviewed students and instructors highlighted the course's iterative process, peer review system, and unique incorporation of outside research already being conducted by students as the most impactful aspects of the course. Based on students' reports and artifacts, the Data Practicum was successful in helping them to communicate their research visually, orally, and in text to a wide and varied audience, to critically review others' work, inside and outside their discipline, and to develop awareness of research in other disciplines. We observed that it is possible to enhance interdisciplinary communication skills through an iterative teaching approach that gives students a chance to incorporate feedback from multiple sources. This course could serve as a model for other graduate programs wishing to increase training in interdisciplinary skills.
Millar, 06-2013	Interdisciplinary research and the early career: The effect of interdisciplinary dissertation research on career placement and publication productivity of doctoral graduates in the sciences	Research Policy, 19, 3, 20	3	This paper uses data from the 2008 Survey of Doctorate Recipients, with matched data from the Survey of Earned Doctorates, to explore how conducting interdisciplinary research for one's dissertation affects the first few years of graduates' careers. Using a sample of doctoral graduates from the years 2004 to 2007, this research assesses the relationship between interdisciplinary dissertation research and three career-related indicators. Results show that conducting interdisciplinary dissertation research increases individuals' likelihood of obtaining a position within academia. Secondly, among those employed within higher education, interdisciplinary research does not have a dramatic effect on the types of positions individuals hold. However, the effect of interdisciplinary dissertations on the type of academic employment graduates obtain is different for the two cohorts included in this study. Additionally, this paper finds that graduates who report interdisciplinary research have a higher number of publications than those who do not, but this is partly the result of the different types of jobs graduates hold.
Miller et al., 10-2019	Student Experiences Engaging in Interdisciplinary Research Collaborations: A Case Study for	Journal of Social Work Education, 42, 5, 1152-1164	2, 3	This article provides a case study of student experiences working as part of an interdisciplinary research team. A team of graduate-level students from social work, civil engineering, and computer science collaborated on the design of a mobile device application that captures data regarding how transportation disadvantage affects the lived experiences of community-dwelling older adults and single parents experiencing homelessness with dependent children. An online survey (N=5) was used to assess student experiences on the team. Findings from this case study have important

	Social Work Education			implications for engaging students in interdisciplinary applied research, including challenging them to expand their knowledge base beyond the traditional confines of their disciplines, encouraging critical and creative thinking skills, and harnessing technology for the greater social good.
Moreno and Danowitz, 07-2016	Becoming an interdisciplinary scientist: an analysis of students' experiences in three computer science doctoral programmes	Journal of Higher Education Policy and Management, 55, 4, 750-766	1, 2	The aim of this study was to identify how and why doctoral students do interdisciplinary research. A mixed-methods approach utilising bibliometric analysis of the publications of 195 students identified those who had published interdisciplinary research. This objective measurement of the interdisciplinarity, applying the Rao-Stirling index to Web of Science and Scopus citations, allowed for a comparison of students' interdisciplinary research outcomes from three different computer science programmes: a traditional programme, a multidisciplinary doctoral school and an interdisciplinary doctoral college. Applying a sociocultural approach, interviews with the 15 most interdisciplinary students were analysed to understand how dispositions and experiences of students and factors of the different programmes affect the circumstances and processes of becoming an interdisciplinary early career scientist. The data indicate that student motivations, previous skills and knowledge interacted with policies and programme structures including type of funding and supervisor expectations to play a crucial role in interdisciplinarity at the doctoral level. These factors can give rise to interdisciplinary research even in programmes without interdisciplinary focus and compromise the interdisciplinary goals of interdisciplinary programmes.
Mountford et al., 12-2020	Interdisciplinary doctoral research networks: enhancers and inhibitors of social capital development	Studies in Higher Education, 45, 12, 2558-2573	2, 3	Interdisciplinary research networks are increasing, with professionals encouraged to undertake research across disciplines to increase innovation, creativity and knowledge. More recently, this interdisciplinary focus is being mirrored by the establishment of interdisciplinary doctoral research networks. But do these networks work? And if so, how and why? We employ social capital theory to (a) understand the lived experiences of students in interdisciplinary doctoral programmes and (b) build programme design theory to support the development of social capital within such programmes. We present the results of 28 semi-structured interviews conducted with doctoral students from three European Union funded interdisciplinary research training networks to understand how they perceive the enhancers, inhibitors and manifestations of social capital within their networks. Key themes revolve around 'extracting value from the interdisciplinary process', 'motivating students throughout the interdisciplinary programme journey', and 'relating to others both within and external to the programme'. We propose a framework for interdisciplinary programme design.
Newswander and Borrego, 2009	Engagement in Two Interdisciplinary Graduate Programs	Higher Education, 58, 4, 551-562	2	This qualitative study examines two US interdisciplinary graduate programs which involve faculty and students from different disciplines. Haworth and Conrad's engagement theory of quality graduate education was applied. It was found that when interdisciplinary programs facilitate engagement by supporting diversity, participation, connections, and interactive teaching and learning, students report positive experiences. Engagement is particularly achievable when an interdisciplinary administrative unit (e.g.,

				a school or center) grants degrees and serves as a tenure home for faculty. Students earning degrees in traditional departments had more difficulty connecting interdisciplinary requirements to their disciplinary work, and were often faced with incompatible program requirements or advice from faculty members. Although they desire to do interdisciplinary work, the students and faculty in traditional departments are required to meet additional and often conflicting requirements. Engagement may further be complicated because these participants feel divided between collaborations, social networks, and expectations that pull them in different directions.
Noble et al., 11-2016	Promoting convergence: The integrated graduate program in physical and engineering biology at Yale University, a new model for graduate education	Biochemistry and Molecular Biology Education, 44, 6, 537-549	2	In 2008, we established the Integrated Graduate Program in Physical and Engineering Biology (IGPPEB) at Yale University. Our goal was to create a comprehensive graduate program to train a new generation of scientists who possess a sophisticated understanding of biology and who are capable of applying physical and quantitative methodologies to solve biological problems. Here we describe the framework of the training program, report on its effectiveness, and also share the insights we gained during its development and implementation. The program features co-teaching by faculty with complementary specializations, student peer learning, and novel hands-on courses that facilitate the seamless blending of interdisciplinary research and teaching. It also incorporates enrichment activities to improve communication skills, engage students in science outreach, and foster a cohesive program cohort, all of which promote the development of transferable skills applicable in a variety of careers. The curriculum of the graduate program is integrated with the curricular requirements of several Ph.D.-granting home programs in the physical, engineering, and biological sciences. Moreover, the wide-ranging recruiting activities of the IGPPEB serve to enhance the quality and diversity of students entering graduate school at Yale. We also discuss some of the challenges we encountered in establishing and optimizing the program, and describe the institution-level changes that were catalyzed by the introduction of the new graduate program. The goal of this article is to serve as both an inspiration and as a practical "how to" manual for those who seek to establish similar programs at their own institutions.
O'Meara and Culpepper, 2020	Fostering collisions in interdisciplinary graduate education	Studies in Graduate and Postdoctoral Education, 11, 2, 163-180	2, 3	Despite the benefits of collisions, many universities' structures and policies thwart interactions between students and faculty from different disciplinary backgrounds. Academic departments are siloed (Klein, 2010; Lattuca, 2001; National Academy of Science, Engineering and Medicine, 2018), leading to fewer opportunities for students and faculty from different departments to interact. Most graduate programs teach doctoral students how to become disciplinary experts, not interdisciplinary collaborators (Golde, 2005; Weidman et al., 2001). Such structural and cultural arrangements reduce the number of interdisciplinary collisions or meaningful interactions that graduate students experience during their doctoral training. With these barriers in mind, understanding how graduate training programs can foster interdisciplinary collisions is important for several reasons. Given funding agencies' increased emphasis on interdisciplinary approaches and the potential for interdisciplinary science to solve

				pressing global issues, interdisciplinary science has become an institutional imperative for many universities (Bozeman and Boardman, 2003; Klein, 2010; Lyall, 2019; Lyall et al., 2013). Explaining how graduate training programs give doctoral students the skills needed to do interdisciplinary research will help institutions better meet their interdisciplinary goals. Likewise, understanding how graduate training programs navigate academic silos and disciplinary divisions to promote student learning is important for facilitating organizational change (Holley, 2009a, 2009b; Sá, 2008). Thus, this study's purpose was to understand how, if at all, one graduate training program facilitated collisions or meaningful interactions, among doctoral students and faculty from different disciplinary backgrounds.
Rienties and Heiliot, 03-2018	Enhancing (in)formal learning ties in interdisciplinary management courses: a quasi-experimental social network study	Studies in Higher Education, 43, 3, 437-451	2	While interdisciplinary courses are regarded as a promising method for students to learn and apply knowledge from other disciplines, there is limited empirical evidence available whether interdisciplinary courses can effectively 'create' interdisciplinary students. In this innovative quasi-experimental study amongst 377 Master's students, in the control condition students were randomised by the teacher into groups, while in the experimental condition students were 'balanced' by the teacher into groups based upon their initial social network. Using social network analysis, learning ties after 11 weeks were significantly predicted by the friendship and learning ties established at the beginning of the course, as well as (same) discipline and group allocation. The effects were generally greater than group divisions, irrespective of the two conditions, but substantially smaller than initial social networks. These results indicate that interdisciplinary learning does not occur 'automatically' in an interdisciplinary module. This study contributes to effective learning in interdisciplinary learning environments.
Rissman and Barrow, 05-2019	Characteristics of collaborative, interdisciplinary, and engaged research among graduate students in environmental conservation	Journal of Environmental Studies and Sciences, 9, 3, 297-310	1	Research that is collaborative, interdisciplinary, and engaged with non-university partners has emerged as desirable for training graduate students to address complex issues in natural resource management. However, there is a lack of understanding regarding why researchers may participate in various forms of collaborative research, especially among graduate students in environmental conservation. We explored graduate students' research experiences and the characteristics and attitudes associated with collaborative research and two specific types of collaboration: interdisciplinary collaboration and engaged research. We surveyed 56 graduate students who were affiliated with University of Wisconsin-Madison's Integrative Graduate Education and Research Training (IGERT) program on biodiversity conservation under novel ecosystems. We investigated differences between the different categories of collaborative research with logistic regression and decision tree analysis using the classification and regression tree (CRT) algorithm. Students with more collaborators were more likely to feel supported by an intellectual community and view interdisciplinary research as vital for conservation practice. Students with an interdisciplinary collaboration were more likely to be comfortable collaborating with peers but less likely to view collaboration as contributing to their research. Students engaged with non-academics were less

				comfortable collaborating with faculty and more concerned that becoming engaged with conservation policy or practice may negatively impact them. Of the ten instances in which variables were significant across the three logistic regressions, eight were also identified in the CRT model. This suggests relatively high agreement between the two statistical approaches. The different forms of collaborative research had different predictors and should not be viewed as interchangeable. Further attention is needed on approaches for enhancing graduate students' training and experience with collaborative environmental research.
Ryan et al., 08-2012	Developing research capacity among graduate students in an interdisciplinary environment	Higher Education Research and Development, 31, 4, 557-569	2	A critical review of research to date suggests a need to explore the development of graduate student research capacity from the standpoint of graduate students. Six members of an interdisciplinary graduate student colloquium at the Centre for Youth and Society (Victoria, Canada) offer their perspective. Our research involved four phases, each illustrating the processes that refined our understanding of the components that contributed to the development of our graduate student research capacity. First, we engaged in several round-table discussions and created a conceptual map depicting components that were meaningful in developing our research capacity. Second, we examined previous work on graduate student research capacity development and compared this data to the conceptual map. Third, we conducted a thematic analysis of secondary data of graduated students with similar interdisciplinary training and involvement in the Centre. Finally, the data analysis was used to refine the conceptual map that may benefit educators and future graduate students. From the standpoint of students themselves, we discuss those components perceived as best contributing to the development of graduate student research capacity and highlight the importance of an interdisciplinary context and writing process.
Schmidt et al., 03-2012	A New Model for Training Graduate Students to Conduct Interdisciplinary, Interorganizational and International Research	Bioscience, 62, 3, 296-304	2	Environmental challenges are often global in scope and require solutions that integrate knowledge across disciplines, cultures, and organizations. Solutions to these challenges will come from diverse teams and not from individuals or single academic disciplines; therefore, graduate students must be trained to work in these diverse teams. In this article, we review the literature on training graduate students to cross these borders. We then present a National Science Foundation Integrative Graduate Education and Research Traineeship Program at the University of Washington as a model of border-crossing graduate training focused on interdisciplinary, international, and interorganizational collaborations on environmental challenges. Finally, we offer recommendations from this program to those considering similar training programs, including strategies for maintaining faculty buy-in, for scaffolding student training to cross borders, and for conducting focused group trips that give the students structured experience crossing all three borders simultaneously.
Secret et al., 07-2017	Teaching an interdisciplinary Graduate-Level	Journal of Educators	2	Our paper describes the design and delivery of an online interdisciplinary social science research methods course (ISRM) for graduate students in sociology, education, social work, and public administration. Collaborative activities and learning took place in two

	methods course in an openly-networked connected learning environment: A glass Half-Full	Online, 14, 2, 17 pages		types of computer-mediated learning environments: a closed Blackboard course management system and a public facing "openly-networked connected learning" environment designed to facilitate cross-discipline connections, student engagement, and digital fluency. A course formative assessment based on student feedback and instructors' reflections informed the lessons learned about the design and delivery of the course. Our assessment suggests that many of the connected learning goals can be met through the closed course management system rather than through the open platform.
Shanock et al., 08-2010	A View Into the Future of Organizational Psychology: Our Experiences With an Interdisciplinary Approach to Graduate Education	Industrial and Organizational Psychology, 3, 3, 272-276	2	Of the four possible “futures” for I-O psychology discussed by Ryan and Ford (2010), one (Scenario 2: Identity Merger) struck close to home. In fact, it is not the future for us, it is the present. The three of us are I-O psychologists with appointments in both a psychology department and a fully integrated interdisciplinary organizational science (OS) PhD program. The program, which is now 5 years old, spans two colleges (Liberal Arts & Sciences and Business) and includes individuals from four departments (Psychology, Management, Sociology, and Communication Studies). Although considerable thought was invested in how to structure and operate such an interdisciplinary program well before we accepted our first class of students, our collective thinking has evolved dramatically as we have experienced the program.
Spelt et al., 11-2017	A multidimensional approach to examine student interdisciplinary learning in science and engineering in higher education	European Journal of Engineering Education, 42, 6, 761-774	2	Preparing science and engineering students to work in interdisciplinary teams necessitates research on teaching and learning of interdisciplinary thinking. A multidimensional approach was taken to examine student interdisciplinary learning in a master course on food quality management. The collected 615 student experiences were analysed for the cognitive, emotional, and social learning dimensions using the learning theory of Illeris. Of these 615 experiences, the analysis showed that students reported 214, 194, and 207 times on, respectively, the emotional, the cognitive, and the social dimension. Per learning dimension, key learning experiences featuring interdisciplinary learning were identified such as "frustrations in selecting and matching disciplinary knowledge to complex problems" ("emotional"), "understanding how to apply theoretical models or concepts to real-world situations" ("cognitive"), and "socially engaging with peers to recognise similarities in perceptions and experiences" ("social"). Furthermore, the results showed that students appreciated the cognitive dimension relatively more than the emotional and social dimensions.
Tobi and Kampen, 2018	Research design: the methodology for interdisciplinary research framework	Quality and Quantity, 52, 3, 1209-1225	2	Many of today's global scientific challenges require the joint involvement of researchers from different disciplinary backgrounds (social sciences, environmental sciences, climatology, medicine, etc.). Such interdisciplinary research teams face many challenges resulting from differences in training and scientific culture. Interdisciplinary education programs are required to train truly interdisciplinary scientists with respect to the critical factor skills and competences. For that purpose this paper presents the Methodology for Interdisciplinary Research (MIR) framework. The MIR framework was developed to help cross disciplinary borders, especially those between the natural sciences and the social sciences. The framework has been specifically constructed to facilitate the design

				of interdisciplinary scientific research, and can be applied in an educational program, as a reference for monitoring the phases of interdisciplinary research, and as a tool to design such research in a process approach. It is suitable for research projects of different sizes and levels of complexity, and it allows for a range of methods' combinations (case study, mixed methods, etc.). The different phases of designing interdisciplinary research in the MIR framework are described and illustrated by real-life applications in teaching and research. We further discuss the framework's utility in research design in landscape architecture, mixed methods research, and provide an outlook to the framework's potential in inclusive interdisciplinary research, and last but not least, research integrity.
Tucker, 09-2008	Interdisciplinary in Doctoral Social Work Education: Does It Make a Difference?	Journal of Social Work Education, 44, 3, 115-138	2, 3	Interdisciplinarity in doctoral education currently is strongly advocated by governments and universities as important in developing knowledge useful in addressing significant public problems. However, the efficacy of these claims has not been subject to empirical investigation. Using longitudinal data covering a 13-year period, this research addresses this limitation by examining how variation in interdisciplinary emphasis in social work doctoral programs affects the scholarly orientation and productivity of graduates. The findings suggest that interdisciplinary doctoral education makes a difference, with graduates from programs with higher levels of interdisciplinarity demonstrating more generalist scholarly orientations, and achieving higher levels of scholarly productivity.
van de Ven et al., 12-2014	Essential components of a successful doctoral program in nanomedicine	International Journal of Nanomedicine, 10, n/a, 23-30	2	The Nanomedicine program at Northeastern University provides a unique interdisciplinary graduate education that combines experiential research, didactic learning, networking, and outreach. Students are taught how to apply nanoscience and nanotechnology to problems in medicine, translate basic research to the development of marketable products, negotiate ethical and social issues related to nanomedicine, and develop a strong sense of community involvement within a global perspective. Since 2006, the program has recruited 50 doctoral students from ten traditional science, technology, and engineering disciplines to participate in the 2-year specialization program. Each trainee received mentoring from two or more individuals, including faculty members outside the student's home department and faculty members at other academic institutions, and/or clinicians. Both students and faculty members reported a significant increase in interdisciplinary scholarly activities, including publications, presentations, and funded research proposals, as a direct result of the program. Nearly 90% of students graduating with a specialization in nanomedicine have continued on to careers in the health care sector. Currently, 43% of graduates are performing research or developing products that directly involve nanomedicine. This article identifies some key elements of the Nanomedicine program, describes how they were implemented, and reports on the metrics of success.
Wagner and du Toit, 02-2019	A qualitative study of interdisciplinary near-peer	Training and Education in Professional	1, 2	Although literature on interdisciplinary training has shown some promise for enabling students to cross disciplinary barriers, little is known about how being mentors to near-peers in other disciplines could initiate psychology trainees into their future role in a multidisciplinary team. This article aims to describe the experiences of psychology and

	research mentoring in professional training.	Psychology, 13, 1, 29-36		urban planning students who participated in a near-peer interdisciplinary research mentoring program to understand how psychology trainees could benefit from interdisciplinary collaboration. Three focus group discussions were conducted with the students about their experiences of the program and a thematic analysis was performed on the data to distill themes focusing on the interdisciplinary aspects of the mentoring. Four themes regarding the students' experiences were generated: challenges regarding disciplinary roles, challenges regarding the clarity of interdisciplinary collaboration, the value of interdisciplinary collaboration for academic outcomes, and the value of interdisciplinary mentoring for professional identities. The findings indicate that, despite experiencing some challenges, students from different disciplines can benefit from guiding and being guided through the research and writing process. In particular the psychology students were able to see how their role as mentors contributed to the development of their personal and professional identities as future researchers. Interdisciplinary collaboration may present psychology trainees with an opportunity to demonstrate the unique contribution that psychology can make to a shared issue and assist them to develop a collective, multiple understanding of a research topic that could also model power sharing with clients.
Wagner et al., 02-2012	Developing an Interdisciplinary, Distributed Graduate Course for Twenty-First Century Scientists	Bioscience, 62, 2, 182-188	1, 2	Graduate programs have placed an increasing emphasis on the importance of interdisciplinary education, but barriers to interdisciplinary training still remain. We present a new model for interdisciplinary, cross-institution graduate teaching that combines the best of local teaching, distance learning, and experiential learning to provide students and faculty with a unique collaborative learning experience and interdisciplinary research skills. We summarize the lessons learned from a highly successful implementation of this course model in the new field of landscape genetics, which integrates concepts and methods from population genetics, landscape ecology, and spatial statistics. The distributed nature of the course allowed sections to be offered locally that would not have been offered otherwise because of the lack of complementary expertise at local institutions. Students gained hands-on experience in interdisciplinary, Web-based and international research collaboration with group projects. A final synthesis meeting was invaluable for course assessment, manuscript development for group projects, and professional networking.
Wallen et al., 06-2019	Integrating team science into interdisciplinary graduate education: an exploration of the SESYNC Graduate Pursuit	Journal of Environmental Studies and Sciences, 9, 2, 218-233	2, 3	Complex socio-environmental challenges require interdisciplinary, team-based research capacity. Graduate students are fundamental to building such capacity, yet formal opportunities for graduate students to develop these capacities and skills are uncommon. This paper presents an assessment of the Graduate Pursuit (GP) program, a formal interdisciplinary team science graduate research and training program administered by the National Socio-Environmental Synthesis Center (SESYNC). Quantitative and qualitative assessment of the program's first cohort revealed that participants became significantly more comfortable with interdisciplinary research and team science approaches, increased their capacity to work across disciplines, and were

				enabled to produce tangible research outcomes. Qualitative analysis of four themes—(1) discipline, specialization, and shared purpose, (2) interpersonal skills and personality, (3) communication and teamwork, and (4) perceived costs and benefits—encompass participants' positive and negative experiences and support findings from past assessments. The findings also identify challenges and benefits related to individual personality traits and team personality orientation, the importance of perceiving a sense of autonomy and independence, and the benefit of graduate training programs independent of the university and graduate program environment
Walrath, 2006	Interdisciplinary medical, nursing, and administrator education in practice: The Johns Hopkins experience	Academic Medicine, 81, 8, 744-748	2	Reforming graduate medical, nursing and health administrators' education to include the core competencies of interdisciplinary teamwork and quality improvement (QI) techniques is a key strategy to improve quality in hospital settings. Practicing clinicians are best positioned in these settings to understand systems issues and craft potential solutions. The authors describe how, in ten months during 2004 and 2005 the school of medicine, the school of nursing, and an administrative residency program, all at Johns Hopkins University, implemented and evaluated the Achieving Competency Today II Program (ACT II), a structured and interdisciplinary approach to learning QI that was piloted at various sites around the United States. Six teams of learners participated, each consisting of a medical, nursing, and administrative resident. The importance of interdisciplinary participation in planning QI projects, the value of the patient's perspective on systems issues, and the value of a system's perspective in crafting solutions to issues all proved to be valuable lessons. Challenges were encountered throughout the program, such as (1) participants' difficulties in balancing competing academic, personal and clinical responsibilities, (2) difficulties in achieving the intended goals of a broad curriculum, (3) barriers to openly discussing interdisciplinary team process and dynamics, and (4) the need to develop faculty expertise in systems thinking and QI. In spite of these challenges steps have been identified to further enhance and develop interdisciplinary education within this academic setting.
Welch-Devine et al., 06-2014	A pedagogical model for integrative training in conservation and sustainability	Ecology and Society, 19, 2, 10	2	The benefits and challenges of interdisciplinary training are well documented, and several reviews have discussed the particular importance of interdisciplinary training for conservation scholars and practitioners. We discuss the progress within one university program to implement specific training models, elements, and tools designed to move beyond remaining barriers to graduate-level, interdisciplinary conservation education.
Zhang and Shen, 10-2015	Disciplinary Foundations for Solving Interdisciplinary Scientific Problems	International Journal of Science Education, 37, 15, 2555-2576	1, 2	Problem-solving has been one of the major strands in science education research. But much of the problem-solving research has been conducted on discipline-based contexts; little research has been done on how students, especially individuals, solve interdisciplinary problems. To understand how individuals reason about interdisciplinary problems, we conducted an interview study with 16 graduate students coming from a variety of disciplinary backgrounds. During the interviews, we asked participants to solve two interdisciplinary science problems on the topic of osmosis. We investigated

				participants' problem reasoning processes and probed in their attitudes toward general interdisciplinary approach and specific interdisciplinary problems. Through a careful inductive content analysis of their responses, we studied how disciplinary, cognitive, and affective factors influenced their interdisciplinary problems-solving. We found that participants' prior discipline-based science learning experiences had both positive and negative influences on their interdisciplinary problem-solving. These influences were embodied in their conceptualization of the interdisciplinary problems, the strategies they used to integrate different disciplinary knowledge, and the attitudes they had toward interdisciplinary approach in general and specific interdisciplinary problems. This study sheds light on interdisciplinary science education by revealing the complex relationship between disciplinary learning and interdisciplinary problem-solving.

Appendix 2.A: Graduate Student IDE Interview Guide

Graduate Student Interdisciplinary Education Interview Guide

Key:

- *Italicized: Mainly directions on where to take conversation or additional information. Usually do not need to read aloud.*
- [Brackets]: These are situational changes in the interview guide. They may make some words plural or replace parts of sentences with the correct wording based on a participant's previous response.
- (Parentheses): Usually additional information.
- Underlined: Important information. Only used once, emphasizing need for participant consent.
- Notes for Interviewer: Feel free to delve deeper in a conversation when a participant wants to, or something stands out as interesting. Feel free to alter the script to best suit the participant, if they do not understand something, you can ask it in another way. Do not use the word, 'why.'

BEFORE INTERVIEWS START: Need to obtain consent before interview meetings start.:

Good morning [afternoon] [evening], we will be conducting an interview that will take between thirty and forty-five minutes to complete. Before we begin, I would like to share with you the definition of interdisciplinary understanding that we are using for the project. Whereas interdisciplinary understanding is "the capacity to integrate knowledge and modes of thinking in two or more disciplines or established areas of expertise to produce a cognitive advancement – such as explaining a phenomenon, solving a problem, or creating a product –in ways that would have been impossible or unlikely through a single disciplinary means." I will share this definition with you again at a later point in the interview to refresh your memory. Do you have any questions before we begin? (*Allow for response. If none: continue*) Do you consent to participate in this study and the recording? (Allow for response. If YES, continue) We will now begin the interview recording.

Thank you for participating in today's interview. We greatly appreciate your time and help with this project. This interview will focus on topics around interdisciplinary research and education. If you have any questions during this interview, if would like to return to a previous topic, or if you would like to end the interview, please feel free to let me know at any time. I would like to begin by asking you a few questions around your graduate program, about your education background, and about your previous professional experiences.

1. To start, I would like to know a little bit about you. What are your current research interests? (*Ice breaker question, let them talk about them*)
    a. *Probe:* What led to your interest in [*Use* participants research interest response] *(or)* [those topics]?
2. What year and program are you currently in?
    a. *If program not identified, ask for home department.*
3. What degrees have you obtained before your current degree program?
4. Have you had any professional work experience?
    a. *If No: proceed to transition into next question.*
    b. *If Yes:* Was this work experience in academia or outside of academia?
        i. How long were you working in academia [outside of academia] [in academia and outside of academia]?
    c. *Probe:* Could you briefly describe those experiences?

Transition: Thank you for the information on your educational and professional background. We are going to move on to some questions around your research involvement and graduate coursework.

5. Have you had the opportunity to work on any research projects?
    a. *If No: proceed to next question.*
    b. *If Yes:* Did these research projects only include team members from your own discipline/department? (May need to ask question in opposite manner, Did any of these research projects include team members from outside of your own discipline/department?)
        i. *If yes:* Can you estimate how many projects you have been associated with?

ii. *If No:*

1. Could you estimate how many projects you have been associated with that only included team members from your discipline?
2. Could you estimate how many projects you have been associated with that included team members from your discipline and from outside your discipline?
3. During the research projects that included team members from outside your own discipline, can you think of any challenges or difficulties you face?

iii. *If Yes or No:* Among these research projects, did any standout to you as more enjoyable or a learning experience?

1. *If Yes:* What made that [those] project[s] [use participants response to previous question to complete this question]? *(ex.: What made that project a learning experience?)*

6. Have you taken any classes with students from other disciplines?
   a. *If Yes:* What aspects of these classes with students from other disciplines were different from departmental courses that only included students for your own department? (can rephrase question if needed)
      i. *If Response:* Were these aspects positive, negative, or neutral in your opinion?
         1. *If Response:* What made them positive [negative] [neutral]?
   b. *If Yes:* Are you working on, or have you completed any class projects or papers with graduate students from other disciplines in this class?
      i. *If Yes:* How is did that project go? (did it go smoothly? Were you all successful?)
      ii. *If No: continue to If Yes or No questions*
   c. *If Yes or No:* Would you be interested in taking [more] classes that involve graduate students from other disciplines?
      i. *If Yes or No:* What makes you [un]interested in taking classes like these?
   d. *If No: continue to next question (after If Yes or Now questions).*

Before we move to the next question, I would again like to share with you the definition of interdisciplinary understanding that we are using for the project, to refresh your memory. Whereas interdisciplinary understanding is "the capacity to integrate knowledge and modes of thinking in two or more disciplines or established areas of expertise to produce a cognitive advancement – such as explaining a phenomenon, solving a problem, or creating a product – in ways that would have been impossible or unlikely through a single disciplinary means."

For these following questions, imagine you have been given the opportunity to work on an interdisciplinary research project. This hypothetical project will include members from outside your own department.

7. Do you believe you have been adequately prepared to be ready to work on such an interdisciplinary project? (If participant asks for details about the project, specify that it would be a project that would personally interest them.)
    a. *If Yes or No:* What makes you believe you are [not] ready for this project?
8. Would you be willing to work on this interdisciplinary research project?
    a. *If Yes or No:* What makes you [not] willing to work on that project for this project? (i.e.: experience? research practice? chance for publication? curiosity?)
9. Do you believe you would be able to perform well while working on this interdisciplinary project?
    a. *If Yes or No:* What makes you believe you would [not] be able to perform well on this project?
10. Would you anticipate any challenges, or difficulties associated with this project?
    a. *Probe*: Could you think of anyway that your program could have prepared you for that challenge or difficulty?

Transition: We have one question related to demographics to help describe our participants. (Feel free to provide information before question, else if participant asks, please provide)

11. What gender do you identify as? (*If participant asks something like, 'why does this matter?'*: Females have been shown in previous research to have more participation in collaborative research and interdisciplinary research. (Van Rinjsoever and Hessels)

    If participant asks something like. 'Why only gender?': Previous research has only shown gender, more years of experience, number of previous academic institutions, and disciplinary field dynamics as related to increased collaborative research and interdisciplinary research. (Van Rinjsoever and Hessels) (Trying to get a glimpse at this to see if it holds up under repeated analysis.))

Before we conclude this interview, I would like to give you the chance to expand on any of your responses. (*Allow for response. If none: continue*) Or, if there was anything you wanted to talk about around interdisciplinary graduate education, I would be happy to hear your thoughts around them. (*Allow for response. If none: continue*) Were there any questions you anticipated that I would ask you around interdisciplinary graduate education, that I have not asked? (*Allow for response. If they don't answer their own question: ask the question they thought of. If none: continue*)

If you would like to discuss anything more about anything around interdisciplinary research or education, either now or in the future, I would be happy to hear your thoughts. (*Allow for response. If none: continue*)

Thank you again for your participation. We greatly appreciate you taking the time to complete this interview.

Appendix 2.B: Graduate Faculty IDE Interview Guide

Graduate Faculty Interdisciplinary Education Interview Guide

Key:

- *Italicized: Mainly directions on where to take conversation or additional information. Usually do not need to read aloud.*
- [Brackets]: These are situational changes in the interview guide. They may make some words plural or replace parts of sentences with the correct wording based on a participant's previous response.
- (Parentheses): Usually additional information.
- Underlined: Important information. Only used once, emphasizing need for participant consent.
- Notes for Interviewer: Feel free to delve deeper in a conversation when a participant wants to, or something stands out as interesting. Feel free to alter the script to best suit the participant, if they do not understand something, you can ask it in another way. Do not use the word, 'why.'

BEFORE INTERVIEWS START: Need to obtain consent before interview meetings start.:

Good morning [afternoon] [evening], we will be conducting an interview that will take between thirty and forty-five minutes to complete. Before we begin, I would like to share with you the definition of interdisciplinary understanding that we are using for the project. Whereas interdisciplinary understanding is "the capacity to integrate knowledge and modes of thinking in two or more disciplines or established areas of expertise to produce a cognitive advancement – such as explaining a phenomenon, solving a problem, or creating a product – in ways that would have been impossible or unlikely through a single disciplinary means." I will share this definition with you again at a later point in the interview to refresh your memory. Do you have any questions before we begin? (*Allow for response. If none: continue*) Do you consent to participate in this study and the recording? (Allow for response. If **YES**, continue) We will now begin the interview recording.

Thank you for participating in today's interview. We greatly appreciate your time and help with this project. This interview will focus on topics around interdisciplinary research and education. If you have any questions during this interview, if would like to return to a previous topic, or if you would like to end the interview, please feel free to let me know at any time. I would like to start by asking you a few questions around your background, your previous research experiences, and your professional experiences.

1. Before we begin, I would like to know a little bit about you. What are your current research interests? (*Ice breaker question, let them talk about them*)
    a. *Probe:* What led to your interest in [*Use* participants research interest response] (*or*) [those topics]?
2. What graduate and/or professional degrees have you earned?
    a. *Probe:* Did you experience any formal interdisciplinary training during graduate school? Such as: courses, coursework, projects, etc.
    b. *Probe:* During graduate school, did you have the opportunity to work on any interdisciplinary research projects?
    c. *Probe:* Do you have to complete continuing education courses as part of your discipline? *If yes->* During your continuing education courses, have you had the opportunity to learn about any topics around interdisciplinary research?
        i. *If No or extended response: continue to next question*
        ii. *If Yes:* What did you have the opportunity to learn about?
3. What is your current home department?
    a. What other department or departments do you currently work with? (This work can be team teaching, research projects, course development, etc. Anything where the faculty member works with members outside their department)
4. Have you only been associated with your current home department at the University of Mississippi?
    a. *If No:* Which other departments at the University of Mississippi have you been associated with as your home department?
    b. *If Yes: continue to next question*
5. How long have you worked as a faculty member in academia? *(if faculty member provides a start year, we can do the math later)*

6. Have you worked at other academic institutions as a faculty member before the University of Mississippi? (Some respondents may mention working for their graduate programs as graduate assistants, this is also fine)
    a. *If Yes:* How many other institutions have you previously worked at?
    b. *If No: continue to next question*
7. Have you worked professionally outside of academia?
    a. *If Yes:* How many institutions outside of academia have you previously worked at?
        i. *Probe:* Could you briefly describe these institutions?
    b. *If No: continue to transition into next questions.*

Transition: Thank you for the information on your educational and professional background. We are going to move on to some questions around your publications and teaching experiences. For these questions, it may help to have your CV ready in front of you.

8. Could you estimate how many publications you have been associated with that only included team members from your own discipline? (*This may take faculty members a few minutes, let them know that we are in no rush, and they can take their time*)
9. Could you estimate how many publications you have been associated with that included team members from your own discipline and at least one other discipline? (*Usually, total publications minus their disciplinary ones, excluding solo publications*)
    a. *If >0:* During these publications that included team members from outside your department, can you think of any challenges or difficulties you faced?
    b. *If =0: continue to next question*
10. Have you taught any courses that included graduate students from outside of your department?
    a. *If No:* Would you be willing to teach a class that included graduate students from outside your own department?
        i. *If Yes or no.* What makes you [un]willing to teach a class like this?
    b. *If Yes:* How do these courses compare to classes that only include graduate students from your department?

i. *Probe:* Were the conversations in these courses similar to conversations in classes that only include graduate students from your own department.
ii. *Probe:* Would you be willing to teach another course that included graduate students from outside your own department?

Before we move to the next question, I would like to share with you the definition of interdisciplinary understanding that we are using for the project. Whereas interdisciplinary understanding is "the capacity to integrate knowledge and modes of thinking in two or more disciplines or established areas of expertise to produce a cognitive advancement – such as explaining a phenomenon, solving a problem, or creating a product – in ways that would have been impossible or unlikely through a single disciplinary means." For the following questions, imagine you have been requested to teach a graduate course that focuses on developing interdisciplinary research skills. This hypothetical class will include graduate students from your own department and from outside your department. Outside of these main focuses, you can design the course and implement it in any way that works best for you.

11. Do you believe you are ready to instruct this interdisciplinary research graduate course?
    a. *If Yes or No:* What makes you believe you are [not] ready to instruct this course?
12. Would you be willing to instruct this interdisciplinary research graduate course?
    a. *If Yes or No:* What makes you [un]willing to instruct this course?
    b. If No to 11 and 12; Would you assist in instructing this course if it was team taught?
13. What tools or experiences do you believe have best equipped your ability to instruct this interdisciplinary research graduate course?
    a. *Probe:* What about those tools or experiences stand out to you?
        i. *Specific Probe:* Would you recommend those tools or experiences to others?
        ii. *Probe:* What tools or experiences would you recommend to others?

Transition: We have one last question related to demographics to help describe our participants. *(You can elect to provide additional information ahead of question, else if participant asks, please provide)*

14. What gender do you identify as? (*If participant asks something like, 'why does this matter?'*: Females have been shown in previous research to have more participation in collaborative research and interdisciplinary research. (Van Rinjsoever and Hessels)

    If participant asks something like. 'Why only gender?': Previous research has only shown gender, more years of experience, number of previous academic institutions, and disciplinary field dynamics as related to increased collaborative research and interdisciplinary research. (Van Rinjsoever and Hessels) Trying to get a glimpse at this to see if it holds up under repeated analysis.)

Before we conclude this interview, I would like to give you the chance to expand on any of your responses. Or, if there was anything you wanted to talk about around interdisciplinary graduate education, I would be happy to hear your thoughts around them. (*Allow for response. If none: continue*) Were there any questions you anticipated that I would ask you around interdisciplinary graduate education? (*Allow for response. If they don't answer their own question: ask the question they thought of. If none: continue*)

If you would like to talk about anything around interdisciplinary research or education, I would be happy to hear your thoughts. (*Allow for response. If none: continue*)

Thank you again for your participation. We greatly appreciate you taking the time to complete this interview. If you are interested in a follow up, I can send you any articles that result from this research. (*Allow for answer, before collecting email address stop recording*) I will now stop the recording.

If Yes: Can I confirm your email address to add it to a list of individuals interested in the results? We will delete your email address as soon as the results have been sent to you. (*Add email address to spreadsheet in Box Interviews folder*)

Appendix 2.C: Interview Consent Form

Consent to Participate in Research

Study Title: A Qualitative Interview Study Evaluating the Perceptions and Beliefs of Graduate Students and Graduate Faculty around Graduate Student Interdisciplinary Research Education and Training

Investigator
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Faculty Sponsor
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(XXX) XXX-XXXX
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The purpose of this study
We want to know about your perceptions, beliefs, and experiences around interdisciplinary education and research in graduate school.

What you will do for this study
You will be participating in an interview answering questions around your perceptions, beliefs, and experiences around interdisciplinary education and research.

1. You must currently be at least 18 years of age to participate in this study.
2. You must currently be enrolled as a graduate student or employed as a graduate faculty member at the University of Mississippi.
3. **Interview**
    a. You will be asked your preference if you would prefer the interview be done by Zoom or by phone. If no preference is stated, the interview will be carried out in Zoom.
    b. All interviews will be recorded to create transcripts for response analysis. Zoom interviews will be video recorded and the participant may turn off their camera during the recording. Phone interviews will be audio recorded.

Time required for this study
This study will take about thirty (30) to forty-five (45) minutes to complete at a time of your choosing.

Possible risks from your participation
There are no known risks associated with this study.

Benefits from your participation
There are no benefits associated with this study. However, you might experience satisfaction from contributing to the scientific knowledge on and around graduate student interdisciplinary education.

Incentives
There are no incentives associated with this study.

Confidentiality
All recordings associated with interviews will be held in password locked accounts (Zoom), or on password locked computers (Phone). Aside from the recordings, no personally identifiable information will be collected, and all interviews will be identified under pseudonyms. All recordings will be deleted upon results publication. All created transcripts will be kept under pseudonyms and given to the Department of Pharmacy Administration, University of Mississippi.

Members of the Institutional Review Board (IRB) – the committee responsible for reviewing the ethics of, approving, and monitoring all research with humans – have authority to access all records. However, the IRB will request identifiers only when necessary. We will not release identifiable results of the study to anyone else without your written consent unless required by law.

Right to Withdraw
You do not have to volunteer for this study, and there is no penalty if you refuse. If you start the study interview and decide that you do not want to finish, please notify your interviewer and the interview will be stopped. If stopped, the interview recordings will be deleted as soon as possible. Whether or not you participate or withdraw will not affect your current or future relationship with the Department of Pharmacy Administration, or with the University, and it will not cause you to lose any benefits to which you are entitled.

The researchers may stop your participation in the study without your consent and for any reason, such as protecting your safety or protecting the integrity of the research data. If the researcher terminates your participation, any recordings will be deleted to further protect the identity of the participant.

IRB Approval
This study [WILL NEED TO BE] reviewed and approved by The University of Mississippi's Institutional Review Board (IRB). The IRB [WILL NEED TO] determine[d] that this study fulfills the human research subject protections obligations required by state and federal law and University policies. If you have any questions or concerns regarding your rights as a research participant, please contact the IRB at (662) 915-7482 or irb@olemiss.edu.

Please email, or call the principal researcher, David D. Allen III, if there is anything that is not clear or if you need more information. When all your questions have been answered, you can then decide if you want to be in the study or not.

Statement of Consent
I have read the above information. I have been given an unsigned copy of this form. I have had an opportunity to ask questions, and I have received answers. I am at least 18 years of age. I consent to participate in the study interview and the recording with a verbal affirmation of consent.

Appendix 3.A: SEIEL Scale, and SEIdET Scale

SEIEL Scale [8,9]	Subscale	SEIdET Scale
1. Working with other students from different professions to form a team.	1	1. Working with other students from different disciplines to form a team.
2. Working with other students from different professions to resolve problems in the team.	1	2. Working with other students from different disciplines to resolve problems in the team.
3. Working with other students from different professions to develop a realistic appropriate patient care plan.	1	3. Working with other students from different disciplines to develop a research project plan or proposal.
4. Working with other students from different professions to understand our respective roles in an interprofessional team.	1	4. Working with other students from different disciplines to understand our respective roles in an interdisciplinary team.
5. Working with other students from different professions to understand the benefits to patients of team care.	1	5. Working with other students from different disciplines to understand the benefits to the quality of research.
6. Understanding and discussing the objectives of interprofessional learning.	2	6. Understanding and discussing the objectives of interdisciplinary learning.
7. Interacting with students from other professions and disciplines than my own.	1	7. Interacting with students from other departments and disciplines than my own.
8. Providing feedback to an interprofessional team on our function and work as a team.	2	8. Providing feedback to an interdisciplinary team on our function and work as a team.
9. Providing feedback to individual team members of an interprofessional team on their function and work on the team.	2	9. Providing feedback to individual team members of an interdisciplinary team on their function and work on the team.
10. Helping clinical sites understand an interprofessional team’s role in a clinical setting.	2	10. Helping the university community understand an interdisciplinary team's role in a research setting.
11. Helping the patient understand the objectives of the interprofessional learning.	2	11. Helping the public understand the objectives of the interdisciplinary learning.
12. Evaluating the quality of work as an interprofessional team.	2	12. Evaluating the quality of work as an interdisciplinary team.
13. Evaluating the degree to which an interprofessional team has achieved its goals.	2	13. Evaluating the degree to which an interdisciplinary team has achieved its goals.
14. Learning together cooperatively with students from other professions.	1	14. Learning together cooperatively with students from other disciplines.
15. Communicating effectively with other members of an interprofessional team.	1	15. Communicating effectively with other members of an interdisciplinary team.
16. Interacting with teachers and preceptors from other professions and disciplines than my own.	2	16. Interacting with teachers and faculty members from other departments and disciplines than my own.

Appendix 3.B: Interdisciplinary Graduate Education and Training Survey

Start of Block: Demographic Questions

Q1 What is the highest level of education you have completed?

- Bachelor's Degree
- Master's Degree
- Professional Degree
- Doctoral Degree
- Other/ Not listed here

Q2 Not including graduate assistantships or assistant positions related to graduate school, how many years of professional experience do you have? (Please consider internships as professional experience. If you have worked professionally for less than 1 whole year, please write "1" year. Please write a numeric whole number of years, ex. "0", "1", "6", or "23")

_____

Q3 What level of degree(s) are you currently pursuing? (Please select all that apply)

- [ ] Master of Arts Degree
- [ ] Master of Science Degree
- [ ] Professional Degree
- [ ] Doctoral Degree

Q4 Is your degree program online only?

- ○ Yes
- ○ No
- ○ N/A / Prefer not to answer

Q5 What year is this for you in your graduate program?

- ○ 1st year
- ○ 2nd year
- ○ 3rd year
- ○ 4th year
- ○ 5th year or greater

Q6 Which academic department is associated with your current degree course?

- ○ Accountancy
- ○ Communication Science and Disorders
- ○ Criminal Justice and Legal Studies
- ○ Economics
- ○ Finance
- ○ Health, Exercise Science, and Recreation Management
- ○ Higher Education
- ○ Leadership and Councilor Education
- ○ Management
- ○ Marketing
- ○ Nutrition and Hospitality Management
- ○ Pharmacy Administration
- ○ Political Science
- ○ Psychology
- ○ Social Work
- ○ Sociology and Anthropology
- ○ Teacher Education

Q7 What gender do you identify as?

- ○ Female
- ○ Male
- ○ Non-binary / third gender
- ○ Prefer not to say

Q8 What race or races do you identify as? (please select at least one, or all that apply)

- ☐ Amerindian/ American Indian/ Alaskan Native
- ☐ Asian/ Asian American
- ☐ Black/ African American/ African
- ☐ Middle Eastern/ Middle Eastern American
- ☐ Native Hawaiian/ Pacific Islander
- ☐ White/ Caucasian
- ☐ Other

Q9 Are you Hispanic or Latino/Latina?

- ○ No
- ○ Yes, I am Hispanic and/or Latino/Latina

End of Block: Demographic Questions

Start of Block: Research and Training Experiences

Q10 How many classes have you had in graduate school that included graduate students from departments outside of your own department?

- ○ Zero or N/A
- ○ 1
- ○ 2
- ○ 3
- ○ 4 or more

Q11 How many class projects or papers have you been involved with where at least one of your teammates/groupmates was a graduate student from a department outside your own department?

- Zero or N/A
- 1
- 2
- 3
- 4 or more

Q12 While in graduate school, how many research projects have you been associated with only your own discipline involved? (ex. only Social Work, only Marketing, or only Nutrition and Hospitality Management)

- Zero or N/A
- 1
- 2
- 3
- 4 or more

Q13 While in graduate school, how many research projects have you been associated with that include your own discipline and at least one other discipline? (ex. Economics and Psychology, Pharmacy Administration and Sociology/Anthropology, or Criminal Justice and Political Science)

- ○ Zero or N/A
- ○ 1
- ○ 2
- ○ 3
- ○ 4 or more

Q14 How many research projects have you been associated with, outside of graduate school, that only involved your own discipline. (please estimate to the best of your ability)

- ○ Zero or N/A
- ○ 1
- ○ 2
- ○ 3
- ○ 4 or more

Q15 How many research projects have you been associated with, outside of graduate school, that included your own discipline and at least one other discipline? (please estimate to the best of your ability)

- ○ Zero or N/A
- ○ 1
- ○ 2
- ○ 3
- ○ 4 or more

End of Block: Research and Training Experiences

Start of Block: Interdisciplinary Interest

Q16 Please respond with your level of importance to the following statements.

	Not important at all 0	1	2	3	4	5	6	7	8	9	Extremely important 10
Intra-disciplinary research is important. (Intra: within your own discipline)	○	○	○	○	○	○	○	○	○	○	○
Inter-disciplinary research is important. (Inter: including one or more disciplines with your own discipline)	○	○	○	○	○	○	○	○	○	○	○

Q17 Please respond to the following statements with your level of agreement from strongly disagree to strongly agree. For these statements, please assume that all classes offered by your own department or another department provide the same credit towards your degree.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I am interested in taking graduate classes offered by faculty from other departments.	○	○	○	○	○	○	○
I am interested in working on research projects with faculty members outside my own department.	○	○	○	○	○	○	○
I am interested in working with graduate students from outside my own department on class group projects or papers.	○	○	○	○	○	○	○
If given the choice between a class in my department or a class outside my department on the same topic, I would select my department's class.	○	○	○	○	○	○	○

Working with graduate students from other departments would be challenging.	○	○	○	○	○	○	○
I think I could learn new concepts or methods while working with graduate students from another department.	○	○	○	○	○	○	○
If I could complete my degree entirely within my own department, I would choose to take all my classes taught by my department's faculty.	○	○	○	○	○	○	○

End of Block: Interdisciplinary Interest

Start of Block: Self-Efficacy

Q18 Please rate your level of confidence on the following statements.

	Low Confidence 1	2	3	4	5	6	7	8	9	High Confidence 10
Working with other students from different disciplines to form a team.	○	○	○	○	○	○	○	○	○	○
Working with other students from different disciplines to resolve problems in the team.	○	○	○	○	○	○	○	○	○	○
Working with other students from different disciplines to develop a research project plan or proposal.	○	○	○	○	○	○	○	○	○	○
Working with other students from different disciplines to understand our respective roles in an interdisciplinary team.	○	○	○	○	○	○	○	○	○	○
Working with other students from different disciplines to understand the benefits to the quality of research.	○	○	○	○	○	○	○	○	○	○
Understanding and discussing the objectives of interdisciplinary learning.	○	○	○	○	○	○	○	○	○	○

Interacting with students from other departments and disciplines than my own.	○	C	C	C	C	C	C	C	C	○
Providing feedback to an interdisciplinary team on our function and work as a team.	○	C	C	C	C	C	C	C	C	○
Providing feedback to individual team members of an interdisciplinary team on their function and work on the team.	○	C	C	C	C	C	C	C	C	○
Helping the university community understand an interdisciplinary team's role in a research setting.	○	C	C	C	C	C	C	C	C	○
Helping the public understand the objectives of the interdisciplinary learning.	○	C	C	C	C	C	C	C	C	○
Evaluating the quality of work as an interdisciplinary team.	○	C	C	C	C	C	C	C	C	○
Evaluating the degree to which an interdisciplinary team has achieved its goals.	○	C	C	C	C	C	C	C	C	○

Learning together cooperatively with students from other disciplines.	○	○	○	○	○	○	○	○	○	○
Communicating effectively with other members of an interdisciplinary team.	○	○	○	○	○	○	○	○	○	○
Interacting with teachers and faculty members from other departments and disciplines than my own.	○	○	○	○	○	○	○	○	○	○

End of Block: Self-Efficacy

Start of Block: Readiness, Willingness, and Ableness

Q19 Please respond to the following statement around graduate education.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I am ready to take a class with another department.	○	○	○	○	○	○	○
I am willing to take a class in another department.	○	○	○	○	○	○	○
I believe I would be able to perform well in a class with another department.	○	○	○	○	○	○	○
I am ready to work on a class project/paper with a graduate student from outside my own department	○	○	○	○	○	○	○
I am willing to work on a class project/paper with a graduate student from outside my own department.	○	○	○	○	○	○	○

I believe I would be able to perform well on a class project/paper with a graduate student from outside my own department.	○	○	○	○	○	○	○
I am ready to work on a research project with a faculty member from outside my own department.	○	○	○	○	○	○	○
I am willing to work on a research project with a faculty member from outside my own department.	○	○	○	○	○	○	○
I believe I would be able to perform well on a research project with a faculty member from outside my own department.	○	○	○	○	○	○	○

End of Block: Readiness, Willingness, and Ableness

Appendix 3.C: Sample Survey Consent Form

Consent to Participate in Research
Study Title: An Exploratory Survey Study of Social Science Focused Graduate Student Readiness, Willingness, and Ableness for Interdisciplinary Research Training

Investigator
David D. Allen III, M.S.
Department of Pharmacy Administration
225 Faser Hall
University of Mississippi
University, MS 38677
(XXX) XXX-XXXX
XXXXXXXXX@go.olemiss.edu

Faculty Sponsor
Alicia Bouldin, B.S.Ph., M.S., Ph.D.
Department of Pharmacy Administration
225 Faser Hall
University of Mississippi
University, MS 38677
(XXX) XXX-XXXX
XXXXXXXXX@olemiss.edu

The purpose of this study
We want to know about your perceptions, beliefs, and experiences around interdisciplinary education and research in graduate school.
What you will do for this study
You will be participating in a survey answering questions around your perceptions, beliefs, and experiences around interdisciplinary education and research.

1. You must currently be at least 18 years of age to participate in this study.
2. You must currently be enrolled as a graduate student at the University of Mississippi.
3. You must have internet access to complete the survey on a computer or a mobile device.
4. Survey
    a. The survey consists of nineteen (19) questions that cover your demographics, interdisciplinary experiences, perceptions around interdisciplinary research, interest in interdisciplinary research training and education.
    b. You may take as long as you need on the survey

Time required for this study
This study's survey is estimated to take about fifteen (15) to twenty (20) minutes to complete at a time of your choosing.
Possible risks from your participation
There are no known risks associated with this study.
Benefits from your participation
There are no benefits associated with this study. However, you might experience satisfaction from

contributing to the scientific knowledge on and around graduate student interdisciplinary education.

Incentives

There are no incentives associated with this study.

Confidentiality

All results will be kept on a password secured Qualtrics account or on a password secured computer. All respondents will be referred to by a pseudonym for any direct quotes used from survey responses. No personally identifiable information will be collected during this study to protect the identity of the individual respondents. At publication of the results from this study, all deidentified data will be turned over to the Department of Pharmacy Administration, University of Mississippi.

Members of the Institutional Review Board (IRB) – the committee responsible for reviewing the ethics of, approving, and monitoring all research with humans – have authority to access all records. However, the IRB will request identifiers only when necessary. We will not release identifiable results of the study to anyone else without your written consent unless required by law.

Right to Withdraw

You do not have to volunteer for this study, and there is no penalty if you refuse. If you start the study survey and decide not to continue, please close the browser to end the survey. Your responses will be deleted as soon as possible. Whether or not you participate or withdraw will not affect your current or future relationship with the Department of Pharmacy Administration, or with the University, and it will not cause you to lose any benefits to which you are entitled.

The researchers may stop your participation in the study without your consent and for any reason, such as protecting your safety or protecting the integrity of the research data. If the researcher terminates your participation, any recordings will be deleted to further protect the identity of the participant.

IRB Approval

This study has been reviewed and approved by The University of Mississippi's Institutional Review Board (IRB). The IRB has determined that this study fulfills the human research subject protections obligations required by state and federal law and University policies. If you have any questions or concerns regarding your rights as a research participant, please contact the IRB at (662) 915-7482 or irb@olemiss.edu.

Please email, or call the principal researcher, David D. Allen III, if there is anything that is not clear or if you need more information. When all your questions have been answered, you can then decide if you want to be in the study or not.

Statement of Consent

I have read the above information. I have been given an unsigned copy of this form. I have had an opportunity to ask questions, and I have received answers. I am at least 18 years of age. I consent to participate in the study survey by continuing the survey.

If you do not consent to participate, please exit the survey now.

VITA

Born in 1992, David D. Allen III has had a wide variety of experiences during his upbringing. While born in Kentucky, he was raised primarily in the Panhandle of Texas and northeast Ohio. David has been exposed to a plethora of lifestyles in different settings throughout his lifetime, seeing the ups and downs of individual and societal issues. This Dissertation focused on something close to his passion, the development and implementation of interdisciplinary education in pursuit of improving the already high quality of graduate education, and interdisciplinary research practices.

David completed his Master of Science degree in Pharmaceutical Sciences with emphasis in Pharmacy Administration at the University of Mississippi in Oxford, MS, and his Bachelor of Arts degree in Political Science at the University of North Texas in Denton, TX. During and after the completion of his master's degree, he worked to complete his PhD in Pharmaceutical Sciences with an emphasis in Pharmacy Administration. His experiences around interdisciplinary research, and graduate education informed and enabled this Doctoral Dissertation to come to light with the support and guidance of a phenomenal Dissertation Committee Chair and Committee, fellow graduate student colleagues, and other university faculty members.

David has been associated with a modest number of publications at this time but aims to grow his peer-reviewed repertoire after the dissemination of these Dissertation publications. He maintains an interest in research examining interdisciplinary education, interdisciplinary research training, and interdisciplinary research practices. Furthermore, he hopes to utilize his future

research as an interdisciplinary research training opportunity for graduate and professional students.

NAME: **David Donald Allen III, MS**

EDUCATION:

University of Mississippi — Anticipated Graduation: December 2022
Dissertation Defense: October 27th, 2022
Doctor of Philosophy in Pharmaceutical Sciences
Emphasis in Pharmacy Administration with focus in Outcomes Research
University, Mississippi
Dissertation: "An Exploration of Interdisciplinary Graduate Education and Training: Currently Available Information, Perspectives, and Beliefs"

University of Mississippi — Graduation: May 11, 2019
Master of Science in Pharmaceutical Sciences
Emphasis in Pharmacy Administration
University, Mississippi
Thesis: "Electronic Nicotine Delivery System (ENDS): Reasons for Use and Associated Factors in Self-Selected Nicotine Concentrations"

University of North Texas — Graduation: May 16, 2015
Bachelor of Arts in Political Science
Denton, Texas

ARTICLES:

2021 Kara Beth Coward, Anne Cafer, Meagen Rosenthal, **David Allen III**, Queenie Paltanwale. "An exploration of key barriers to healthcare providers' use of food prescription (FRx) interventions in the rural South." Public Health Nutrition, 24(5) 1095-1103. January 11, 2021.

2019 **David D. Allen III**, Yi Yang, John P. Bentley, Meagen M. Rosenthal, Sandra I. Bentley. "Electronic Nicotine Delivery System (ENDS): Reasons for Use and Associated Factors in Self-Selected Nicotine Concentrations." ProQuest. Accepted: May 28, 2019.

2018 Andrew Notebaert, Marie Barnard, Edgar Meyer, Erin Dehon, Caroline Compretta, **David D. Allen III**, Stephen Stray, Juanyce Taylor, Donna Sullivan, and Rob Rockhold. "Science Teaching Excites Medical Interest: A Teacher Professional Development Program in Mississippi." Journal of STEM Outreach 1, no. 1: 1–8. October 26, 2018.

INVITED PRESENTATIONS:

2018 **David D. Allen III**. June 2018. " Electronic Nicotine Delivery Systems." Science Teaching Excites Medical Interest (STEMI) Summer Institute, 2018. Jackson, MS.

POSTER PRESENTATIONS:

2018 Yiran Rong, **David D. Allen III**, Yi Yang. July 2018 "Cost-Effectiveness Analysis of Umeclidinium/Vilanterol for the Management of Patients with Chronic Obstructive Pulmonary Disease (COPD)." 2018 Annual Meeting of the American Association of Colleges of Pharmacy. Boston, MA.

2018 Yiran Rong, **David D. Allen III**, Yi Yang. June 2018 "Cost-Effectiveness Analysis of Umeclidinium/Vilanterol for the Management of Patients with Chronic Obstructive Pulmonary Disease (COPD)." Southern Pharmacy Administration Conference 2018. Auburn, AL.

2018 Sushmitha Inguva, **David D. Allen III**, Sujith Ramachandran, Eric Pittman, Benjamin F. Banahan III, Terri R. Kirby, Sara L. Noble. May 2018. "Opioid Overdose Risk Factors: A Nested Case-Control Study in Mississippi Medicaid." 23rd Annual International Meeting of the International Society of Pharmacoeconomics and Outcomes Research.
Baltimore, MD.

2018 Caroline Canarios, **David D. Allen III**, John Green, Sandy Snell, & Mobolaji Famuyide. 2018. "Factors influencing breastfeeding for mothers in the Mississippi Delta Region." 49th Annual Meeting of the Southern Rural Sociological Association and Southern Association of Agricultural Scientists. Jacksonville, FL.

2017 Sabrina V. White, **David D. Allen III**, Sujith Ramachandran, Kristen B. Callahan, Dustin E. Sarver, Robert D. Annett. September 2017. Characterization of Autism Spectrum Disorders in Mississippi School-Aged Children. 2017 Mississippi Psychological Association Convention.

2017 Patricia O'Sullivan, Manasi Suryavanshi, **David D. Allen III**. April 2017. Pharmacy Ethics: hybrid, flipped, personalized, and collaborative learning groups using Google Apps and Adaptive Courseware. Show Your SoTL Stuff Poster Session. (SoTL: Scholarship of Teaching and Learning). Oxford, MS.

ACCEPTED PRESENTATION, NOT PRESENTED (COVID-19 Pandemic):

2020 **David D. Allen III**, Queenie Paltanwale, Monika Salkar, Yi Yang, John P. Bentley, Meagen M. Rosenthal, Sandra I. Bentley. May 2020. Electronic Cigarette User Utilization, Preferences, and Beliefs Regarding Electronic Cigarette Nicotine Solution Flavoring. 25th Annual International Meeting of the International Society of Pharmacoeconomics and Outcomes Research.
Orlando, FL.

ASSOCIATED RESEARCH GRANTS:

March 2022 to February 2025
Dr. Yi Yang, Principal Investigator
"*Safety and Effectiveness of Opioid Tapering Among Older Adults"*
NIH, National Institute on Drug Abuse (NIDA)
ID: 2R15DA046036-02

Position: Graduate Research Assistant
May 2020 to
July 2020

EVALUATION REPORTS:

2022 Marie Barnard, Saara Nasruddin, Wesley P. Sparkmon, Hyllore Imeri, **David D. Allen III**, Melissa Presley, Ashley Crumby. *Science Teaching Excites Medical Interest (STEMI) (R25OD020215) Final Evaluation Report.* June 2022.

2018 Caroline Canarios, **David D. Allen III**, & John Green. 2018. "Right! From the Start NICU Breastfeeding Program 2017-2018 Evaluation Report." University, MS: The University of Mississippi Center for Population Studies for the Community Foundation of Northwest Mississippi and W.K. Kellogg Foundation.

2017 Marie Barnard, Emma Tkachuck, **David D. Allen III**. Good Food for Oxford Schools Program Evaluation Report. December 2017.

2017 Marie Barnard, and **David D. Allen III**. STEMI Fall 2017 Interim Evaluation Report. September 2017.

PROFESSIONAL WORK EXPERIENCE:

August 2016 to March 2022
University of Mississippi, School of Pharmacy
University, Mississippi
Graduate Assistant

August 2021 to March 2022 Dr. Manvi Sharma
Research Assistant
Project on Drug-Drug Interactions for Chronic Myeloid Leukemia Patients

May 2021 to August 2021 Dr. Yi Yang
Graduate Research Assistant
Project on Cannabis and Prescription Opioid Use in Older Adults

August 2020 to May 2021 Dr. Ashley Crumby
'Flex' Graduate Teaching Assistant
PHCY 601: Multisystem Complex Patient Care Hybrid 1
PHCY 608: Multisystem Complex Patient Care Hybrid 2
PHCY 501: Infectious Disease Intensive Hybrid 1
PHCY 502: Integrated Systems: Cardiovascular Hybrid 1
PHCY 503: Integrated Systems: Respiratory
PHCY 504: Integrated Sustems: Renal
PHCY 505: Integrated Systems: Neuromuscular
PHCY 509: Integrated Systems: DERM/EENT

July 2020 to August 2020 Dr. Marie Barnard
Graduate Research Assistant
Science Teaching Excited Medical Interest (STEMI) Project

May 2020 to July 2020 Dr. Yi Yang
Graduate Research Assistant
NIH R15 Renewal, *"Safety and Effectiveness of Opioid Tapering Among Older Adults"*

August 2016 to December 2016 Mrs. Patricia O'Sullivan
August 2018 to May 2019
August 2019 to May 2020
Graduate Teaching Assistant
PHAD 395: Pharmacy Ethics

August 2017 to August 2018 Dr. Marie Barnard
Graduate Research Assistant
STEMI Project
Good Food for Oxford Schools Project

August 2017 to August 2018 Dr. John Green
Graduate Research Assistant
Right! From the Start, Project (R!FTS)

June 2017 to August 2017 Dr. Sujith Ramachandran
Graduate Research Assistant

January 2017 to May 2017 Dr. Yi Yang
Graduate Teaching Assistant
PHAD 494: Pharmacoeconomics, Pharmacoepidemiology, Medication Safety

July 2011 to May 2012 CVS Caremark Corporation

Dec 2011 to May 2012
Pharmacy Technician Trainee
Denton, Texas

Dec 27, 2011 to Jan 6, 2011
Pharmacy Technician
Tupelo, Mississippi

Nov 2011 to Dec 2011
Cashier
Denton, Texas

Jul 2011 to Aug 2011
Pharmacy Service Associate
Twinsburg, Ohio

PEER TEACHING:

April 2021 Pharmacy Administration Seminar
Causal Inference: Directed Acyclic Graphs Presentation

May 2019 Patient Reported Outcomes
An Examination of Response Shift in Nicotine Dependence

April 2019 Patient Reported Outcomes
An Examination of Recall Bias in the Fagerström Test for Nicotine Dependence

November 2019 Introduction to Epidemiology
Discrete Choice Analysis Presentation

May 2018 Pharmacy Administration Seminar
Elixhauser Comorbidity Index Presentation

May 2018 Pharmaceutical and Healthcare Policy
A Review of Arizona House Bill 2382, The Free Speech in Medicine Act Presentation

November 2017 Pharmacy Administration Seminar
National Health Interview Survey (NHIS) Presentation

October 2017 Pharmacy Administration Seminar
Healthcare Cost and Utilization Project (H-CUP) Presentation

April 2017 Pharmacy Administration Seminar

An Examination of a State Level Policy Raising the Minimum Age for Tobacco Purchases Presentation

November 2016 Pharmacy Administration Seminar
Affordable Care Act, Section 3008: Hospital-Acquired Condition Reduction Program Presentation

October 2016 Health Economics
Affordable Care Act: Smoking Premiums and Cessation Coverage Presentation

INTERNSHIPS:

January 2015 to May 2015	Denton County Sheriff's Offices (DCSO) Denton, Texas
April 2015	Denton County District Attorney (DCDA) Office Denton, Texas

OTHER PROFESSIONAL EXPERIENCE:

August 2011 to December 2012	Air Force Reserve Officer Training Corps, Detachment 835 Denton, Texas

VOLUNTEER EXPERIENCE:

October 22, 2019	University of Mississippi Graduate School 3 Minute Thesis University, Mississippi Participant Registration Volunteer
March 20, 2019	University of Mississippi Upper Science Fair University, Mississippi Judge for Behavior and Social Sciences
August 2018 to December 2018 March 21, 2018	Graduate Statistics Tutor University of Mississippi University of Mississippi Upper Science Fair University, Mississippi Judge for Best in Class, and Behavior and Social Sciences
January 2007 to August 2011	Open M Free Clinic Akron, Ohio Pharmacy Volunteer: Pharmacy Technician

ASSOCIATED ORGANIZATIONS:

2018 – Cur. The Rho Chi Society, Pharmacy Honor Society
2018 – Cur. Mississippi Public Health Association

2018 – Cur.	American Association of Colleges of Pharmacy	
2017 – 2020	University of Mississippi Graduate Student Council	
	2019 – 2020	Alternate Senator
	2018 – 2019	Social and Philanthropic Affairs Committee Member
	2018 – 2019	Professional Development Committee Member
	2017 – 2018	Student Affairs Committee Member
	2017 – 2019	Senator
2017 – 2018	University of Mississippi Center for Populations Studies	
2016 – Cur.	International Society of Pharmacoeconomics and Outcomes Research (ISPOR)	
2016 – Cur.	University of Mississippi ISPOR Student Chapter	
	2019 – 2021	Treasurer
	2018 – 2019	Secretary
2014 – 2015	Phi Alpha Delta, Pre-Law Professional Fraternity	
2011 – 2013	University of North Texas, Engineering R.E.A.L. Community	
2011 – 2012	Air Force Reserve Officer Training Corps, Detachment 835	

HONORS:

2018	Rho Chi, Pharmacy Academic Achievement

CERTIFICATIONS:

2015 – 2020	Safe Serv Certification
2015 – 2017	Certification in CPR/AED
2014 – 2016	Texas Food Handler Certification, Denton
2011 – 2013	Texas Pharmacy Technician Trainee
2008 – 2012	Certification in First Aid
2008 – 2010	Certification in CPR/AED

AWARDS:

2022	2021-2022 ISPOR Outstanding Chapter Award, 1st place
2021	2020-2021 ISPOR Outstanding Chapter Award, 3rd place
2012	U.S. Air Force Reserve Officer Training Corps Academics Ribbon
2012	U.S. Air Force Reserve Officer Training Corps Honor Flight Ribbon
2012	U.S. Air Force Reserve Officer Training Corps Honor Guard Ribbon
2012	U.S. Air Force Reserve Officer Training Corps Recruiting Ribbon
2012	U.S. Air Force Reserve Officer Training Corps Rifle Team Cord
2012	U.S. Air Force Reserve Officer Training Corps Warrior Flight Ribbon
2011	U.S. Air Force Reserve Officer Training Corps Honor Guard Cord

RESEARCH INTERESTS:

- Graduate Education
- Interdisciplinary Education
- Pharmacy Education
- Electronic Nicotine Delivery Systems
- Smoking Cessation

- Tobacco and Nicotine Dependence
- Substance Dependence, Abuse, Trends, and Treatments
- Quality of Life
- Public Health
- Healthcare Policy

GRADUATE COURSE WORK:

- Pharmacoeconomics
- Health Economics
- Pharmaceutical and Healthcare Policy
- Theories in Health Promotion
- Advanced Pharmaceutical Marketing and Patient Behavior
- Patient Reported Outcomes
- Primary Data Research
- Secondary Data Techniques
- Research Methods
- Introduction to Epidemiology
- Pharmacoepidemiology
- Quantitative Methods in Psychology I
- Quantitative Methods in Psychology II
- General Linear Models
- Generalized Linear Models
- Applied Longitudinal Modeling
- Drug Development and Marketing
- Marketing Theory
- Pharmacy Administration Seminar: 1 through 10