

# The Graduate Student Role in Undergraduate Research Mentoring: Theoretical Perspectives

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**Abstract**—This full research paper expands on ongoing work in undergraduate research mentoring focusing on the relationships and power dynamics of mentoring triads that include a faculty member, graduate student, and undergraduate researcher through narrative analysis of the literature. **Background:** Graduate students have an important role in undergraduate research. They act as the bridge mentor in a mentoring triad, working with their faculty member and the undergraduate researcher. This mentoring relationship is typically considered either an open triad, where the PI does not engage with the undergraduate researcher, or a closed triad, where the undergraduate researcher has a mentoring relationship with both the graduate student and the PI. There is little literature related to the particular needs of graduate students in such relationships; a recent systematic review found only ten journal articles that focus on graduate students and explicitly use the term "mentor\* triad". Broadening the search found additional literature related to graduate students in undergraduate research mentoring triads, though only 63 articles in total. In working with graduate students and faculty to facilitate professional development workshops on undergraduate research mentoring, there seems to be some aspects missing in existing mentoring relationship models that are not clearly in the mentoring literature. Defining the graduate student's role, relationships to the faculty mentor and undergraduate mentee, and recognizing or developing appropriate boundaries are often confusing for graduate students. These areas require further inquiry to determine ways to better support graduate students in mentoring triads. **Purpose:** This study explores existing literature to understand the state of the literature related to graduate students' roles and relationships in undergraduate research triads. **Methodology/Approach:** This study presents an integrative literature review analyzing the triadic mentoring literature, building upon a previous systematic literature review conducted on this topic. **Findings/Conclusions:** Through a narrative and thematic analysis of this literature we gained a deeper understanding of what mentoring triads are and how they are enacted in

research mentoring context. We explored the history and development of current triadic mentoring models and identified some potential areas for expansion of these existing models. Findings from this narrative analysis of the mentoring triad literature will be used to inform phase two of the study, an in-depth thematic analysis of interviews of research mentoring triads. **Implications:** This study explores the relationships that graduate students engage in when acting as mentors for undergraduate researchers. In our current work, interactions with faculty and graduate students suggest that the existing models do not fully encompass the relationships they experience. The findings from this study will inform recommendations for navigating triad mentoring relationships that include graduate students, faculty, and undergraduate students.

**Keywords**—undergraduate research; mentoring triad; research mentoring; integrative literature review

## I. INTRODUCTION

Undergraduate research mentoring has traditionally been explored and described as a dyadic relationship. This relationship exists between a faculty member and an undergraduate student researcher for the benefit of enhancing the undergraduate research experience and providing an opportunity for faculty members to prepare students for future graduate research work. While carrying out these studies, researchers discovered that despite the common perception and conceptualization of undergraduate research mentoring as a dyadic relationship, there was often a third component, the graduate student, whose role was not considered nor explored. One study shows this reconceptualization in real time, where Abbott and colleagues changed their conceptualization of undergraduate research mentoring between two phases of their project, moving more towards studying the triadic nature of the research mentoring model including faculty member, graduate student, and undergraduate student researcher [1]. While the initial conception didn't consider the role of graduate students, these studies quickly demonstrated that graduate research students play an integral role in the development of undergraduate researchers. Faculty often ask or delegate this mentoring responsibility to graduate students within their labs.

Few studies focus on the graduate student role in undergraduate research mentoring, however those that do show that while faculty members may focus on bigger picture items with undergraduates, graduate student mentors are the ones who work alongside undergraduate researchers day to day answering many of their technical and procedural questions [2].

Graduate students play an important role in undergraduate research, often acting as a bridge mentor in a mentoring triad, working with both their faculty member and the undergraduate researcher. A recent systematic literature review of the mentoring triad literature found a limited number of articles that discuss research mentoring triads within the context of undergraduate research [3]. Furthermore, less than ten of these articles explicitly used the word “triad” when describing research mentoring relationships. To gain a greater understanding of this triadic type of research mentoring relationships, we conducted an in-depth review of this limited body of literature. In this paper, we describe findings from this holistic thematic analysis of the ten articles. This paper provides a synthesis of findings across those studies, helping us gain a greater understanding of mentoring triads, how they are formed, and describing the common characteristics of these types of relationships. Furthermore, because the studies reviewed in this paper were the first to coin and utilize the term triad explicitly in undergraduate research mentoring, we sought to understand what these seminal articles had to say about two topics of interest: 1) What mentoring models exist (and how did they evolve)? and 2) What are some common characteristics and tensions observed in triadic mentoring relationships? In the following sections we expand on these topics of interest and then conclude with our recommendations and next steps to advance the existing body of research mentoring literature, particularly pertaining to the triadic relationships and models commonly seen between faculty, graduate students, and undergraduates in undergraduate research experiences.

## II. METHODOLOGY

To understand the current state of the literature regarding undergraduate research mentoring triads, this paper focuses on an in-depth synthesis across papers that explicitly use the term “triad” when describing mentoring models and exploring undergraduate mentoring relationships.

### A. Article Selection: Systematic Literature Review

This work builds upon and expands findings from our larger systematic literature review on mentoring triads [3]. For this systematic literature review we searched for peer-reviewed journal articles across five databases including: Scopus, OneSearch, ERIC, PsychInfo, Academic Search Complete. Due to the limited number of articles identified, and the desire to understand the newest developments within the content area, we further expanded our search to include peer-reviewed conference proceedings, including ASEE PEER and IEEE Xplore - Frontiers in Education. We conducted our search using the terms "mentor\* triad"; "mentor\* triad" AND "graduate

student"; "mentor\*" AND "undergraduate research" AND "graduate student"; and "mentor\*" AND "relationship" AND "undergraduate research" AND "graduate student". After our initial search we further restricted articles to those that upon full article review met our screening criteria: 1) Triad Discussion - about mentor triads explicitly or implicitly, 2) Relationship - graduate/ undergraduate/ faculty, 3) Context - undergraduate research, 4) Media - peer reviewed journal articles and conference papers. After removing duplicates and screening against this criteria, the search returned only 63 articles. Of those 63, only ten explicitly used the term “triad”. These ten articles are considered the extent of the literature that explicitly describes mentoring relationships in undergraduate research contexts using the term “triad”. Therefore, these ten articles are the basis for our integrative review.

### B. Integrative Literature Review

In this paper, we conduct an integrative literature review of the ten chosen articles found from a prior systematic literature review [3]. Integrative literature reviews (ILRs) can be found in medical literature in order to go beyond basic synthesis of articles and to provide new insights into what can be found through a thorough examination of systematically selected literature. This method is not commonly used and is still somewhat under development, with a number of authors, providing guidance. Lubbe and colleagues [4] provided a synthesis of past guidelines, converging on a five-step process including: composing a review question, sampling of the literature, critical appraisal of the sample, data extraction and synthesis, and presentation of findings and discussion. In the next paragraph we describe how we conducted these steps to complete this review.

*Step 1. Composing a review question.* Our overarching question is: What is the state of the literature related to graduate students’ roles and relationships in undergraduate research triads? For this existing paper, we also sought to answer to two sub-questions: 1) What mentoring models exist and how did they evolve? and 2) What are some common characteristics and tensions of mentoring relationships? *Step 2. Sampling of the literature (searching, screening, selection).* Our prior systematic literature review provided the sample for this integrative literature review. To answer the research questions for this paper, we focused more narrowly on the ten articles that explicitly used the term “triad” when describing mentoring relationships in undergraduate research settings. *Step 3. Critical appraisal (CA) of the sample (data collection).* This step was completed within the systematic literature review to remove low quality articles, those that did not fit the expectations of research such as not describing methods. Additional details of literature sampling and critical appraisal steps are described in the larger systematic review [3]. *Step 4. Data extraction and synthesis of extracted data and thematic analysis.* This step pertains to the work that was done for this paper. The ten articles were thoroughly read and notes were taken regarding the overarching question and the two sub-questions regarding mentor models and their evolution and the relationships seen within undergraduate research mentoring triads. Given the small number of articles, rather than a thematic analysis with

coding, this analysis was more holistic in nature, integrating quotes and ideas from the papers directly into the narratives found in the Findings section. *Step 5. Presentation of the findings and discussion.* The remaining sections of this paper fall under this step. While the themes and findings are insightful, it is important to note that an integrative review should also include a summarization, such as what we have provided in the Discussion section below. Before providing this summarization, we discuss the key narrative findings from this integrative review.

### III. FINDINGS

#### A. Mentor Models

Several models have been used to describe the relationships between members of a mentoring triad (faculty, graduate student, undergraduate researcher) in undergraduate research settings. In this section, we describe the development of existing models that refer to “mentoring triads” explicitly to better understand how others conceptualize and use these terms when describing mentoring relationships. For our study, we specifically explore mentoring in undergraduate research settings, and define triads in this context as a “multi-level approach to mentoring” in which graduate students serve as a bridge mentor, mentoring undergraduates while also being mentored by faculty. Furthermore, we classify these triads as either an open triad, where the PI does not engage with the undergraduate student, or a closed triad in which the PI interacts directly with both the graduate and undergraduate student (adapted from [5 p. 102, 6]). In conducting this narrative review of the “triad” explicit literature, we seek to develop a greater understanding of how these terms are defined and used across the literature, specifically in developing models to describe mentoring relationships. Moving towards a common language and understanding of these terms will strengthen existing findings in the literature and pave the way for further refinements of existing models.

Mentoring models are useful in helping both researchers and practitioners gain a better understanding of mentoring relationships, including how relationships form initially and develop over time. Most mentors and mentees organize and enact their mentoring program without thinking about what mentoring model they will follow. Given that many mentoring approaches are learned tacitly, through observing and repeating what others have modeled to us, it is not surprising that mentor models are not more widely discussed and referred to by practitioners as noted by studies outside of our review [7,8]. Bringing these models to the forefront, can be beneficial as, lack of familiarity with various mentoring models and approaches can contribute to a common challenge described in the literature, ambiguity in mentoring relationships. With ambiguity, the door is left over for misunderstandings and miscommunication between mentor and mentee. This lack of clear communication of goals and expectations for the mentoring relationship can be unproductive, and even detrimental to the health and productivity of members of the triad [9,10]. Using models to describe mentoring triad

relationships creates a common language between researchers and practitioners, helping both groups make sense of, and learn ways to intentionally improve these relationships.

In 2009, Dolan & Johnson first used the term “triad” in the context of studying undergraduate research mentoring relationships, stating “we propose that mentorship research and theory-building should include examination of the undergraduate-graduate/postdoctoral student dyad as well as the triadic relationship that includes their faculty member” [9, p. 488]. Interestingly, this exploratory case study focused on understanding research experiences from the perspective of graduate/ postdoctoral mentors, whereas many previous studies examined these same experiences from the undergraduate student’s perspective [9]. By exploring the perspectives of graduate students, Dolan & Johnson sought to address existing gaps in the literature and provided key insight into the gains and challenges experienced by graduate student mentors. Mentors in the particular lab studied, reported deciding to mentor undergraduates primarily due to expectations of increased productivity and implicit expectations of their faculty member. Additionally, they described mentoring challenges such as balancing the mentee’s needs and their own and gauging the mentee’s knowledge and abilities [9]. Furthermore, some participants described challenges of co-mentoring, stating, “She’s [faculty member] been doing it a lot longer. I’ll do it one way and then she’ll meet with the student later and turn around and do it a totally different way. And then I’m kind of like oh.. [laughs].” [9, p. 495]. Findings such as these and others, such as frustrations associated with “the ambiguity of the mentoring structure”, prompted an in-depth study of research mentoring triads, one of the earliest studies located on this topic [11]. This study used a qualitative approach to understanding how and why triads form. Seventeen participants were interviewed including 8 graduate students, 8 undergraduate students, and the faculty head of the research group. While this study involved only participants in one research lab, it provides insight into some typical tensions experienced between members of the undergraduate research triad. We will elaborate more on these tensions in the Mentoring Relationships sub-section below. With these two studies providing background and a basis for understanding mentoring relationships, particularly triads, with the help of Dolan, Aikens et al. (2016) developed a triad mentoring model.

The mentoring model developed by Aikens and colleagues is one of the earliest models that explicitly describes mentoring relationships as triads [6]. This study is also the first empirical study of mentoring triads found in the literature. It is a highly-cited article that examines mentoring through a social capital perspective. All but one article included in our review that was published after 2016 cites Aikens and colleagues [6]. Initially their paper proposed a model including eight different possible mentoring relationship structures between an undergraduate researcher, postgraduate (graduate student or postdoctoral scholar), and a faculty member. After collecting data and analyzing survey data from 842 undergraduates and their post-

graduate mentors, Aikens and colleagues further reduced the model down to the five types of triads shown in Figure 1 below [6]. The majority of participants (85%) reported their mentoring structures most closely resembled Models 4 and 5, the open and closed triads. Findings from this study suggest that “closed triads” with undergraduates, postgraduates, and faculty members interacting directly provide the most beneficial undergraduate research experiences when compared with other types of triads. Undergraduates who were mentored by postgraduates alone (Model 4) also benefited, but the gains were not as high, thus suggesting interactions with faculty contribute something to the research experience that postgraduates alone cannot provide [6]. The research suggests that this may be related to differences in social capital though they do not report any related outcomes directly linking back to this theory.

Several studies have built upon the findings of the empirical study of mentoring triads [6]. Though no revisions of these models to date have been proposed in the literature reviewed for this study, findings of these additional studies have contributed to our understanding of mentoring triadic relationships. For example, a follow up article by Aikens and colleagues used the open and closed triad models (Models 4 and 5), to explore race and gender differences in research mentoring structures and outcomes [12]. They found mentoring structures and outcomes differed based on gender and race/ethnicity [12]. In particular, they noted that men and underrepresented minority students were more likely to report a closed triad structure than women, white, and Asian students. Furthermore, differences in scientific identity, intentions to pursue a STEM PhD, and scholarly productivity were associated with specific mentoring structures. Based on these findings, they suggest that research mentoring networks differ in ways associated with genders and race.

Similar to Aikens et al. [12], Margherio [5] defined triads using the open and closed models (Model 4 and 5) previously identified by Aikens and colleagues [6]. This theory paper provided a conceptual model of ethical issues faced by members of the triad using a review of the triad literature, and building upon the tensions described by Dolan & Johnson [11]. Contrary to the frameworks used by Aikens et al. [12] and Margherio [5], Ceyhand & Tillotson [13] used the original eight structure model provided by Aikens et al. [6] to study the relationship between mentoring structures and support provided to undergraduate researchers. Similar to Aikens et al. [6], the majority of participants in the Ceyhand & Tillotson [13] study described their mentoring relationship as a closed triad, in which they interacted with both faculty and postgraduates.

One interesting finding with useful potential implications is that participants who were in closed triads continued their research experiences for a longer duration than participants who reported open triads, faculty-only, or postgraduate only. The majority of participants in closed triads continued their research experience for three or more semesters, whereas less than half

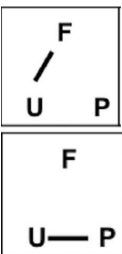
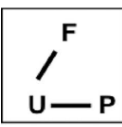

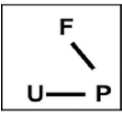
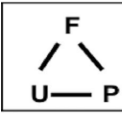
	Mentor Model	Description
1		Undergraduate mentored by postgraduate or faculty with no involvement from the other triad member.
2		Undergraduate mentored by both faculty and postgraduate. No interaction between faculty and postgraduate.
3		Undergraduate and postgraduate mentored by faculty member. No interaction between undergraduate and postgraduate
4		Open triad. Faculty member mentors postgraduate and postgraduate mentors undergraduate. No interaction between faculty and undergraduate.
5		Closed triad. Faculty member and postgraduate communicate regularly with the undergraduate mentee and with each other.

Fig. 1. Mentor model triads with a faculty member (F), postgraduate (P), and undergraduate researcher (U) [6].

of participants who reported other types of mentoring structures continued their research experience for 3 semesters.

### B. Mentoring Relationships

Mentoring triads are complex, yet often provide a mutually beneficial structure for research mentoring [5]. Inherently these relationships can be more complex than dyads, because they involve three people instead of two [9]. Given this complexity, triadic mentoring relationships may be more time consuming and require more advanced levels of communication and problem solving [14]. Studying the challenges that mentor triad members experience provides a greater understanding of how mentoring triad members interact with and relate to each other. The existing literature frequently focuses on the perspectives of faculty and undergraduate students, leaving little room for a comprehensive understanding of triadic mentoring

relationships [5, 9, 13, 15]. To contribute toward addressing this gap, we focused on the graduate student perspective as experienced by graduate students within these mentoring triads. Adding this perspective provides a more holistic view of mentoring triads, and thus provides a useful springboard for advancing existing mentoring models. Graduate students experience several challenges in their triad mentoring relationships including the following: 1) balancing their desire for increased productivity with the time and effort required to train mentees [5, 9, 11], 2) ambiguous or unclear goals and expectations for the mentoring relationship [9], and 3) hierarchical tension vs. agency and control in the relationships [9, 11, 16]. A discussion of these challenges is the focus of the remainder of this section.

Research productivity is of utmost importance to graduate students. Many novice mentors assume adding an undergraduate researcher to their study will allow them to accomplish more in a given time frame [11]. However, graduate/ postdoctoral research mentors report a reduction in productivity, especially during the first few weeks after their undergraduate mentee came on board [9]. As mentees further developed their research skills, they can make more significant contributions, thus enhancing research productivity [9]. While ultimately triads can reach a level of increased productivity, it is important that mentors consider up front the skill and developmental nature of mentoring less knowledgeable others, so as to have more accurate expectations of the relationship. For new mentors, assessing the capabilities of another individual is not an easy task. Bringing inexperienced researchers up to speed to make significant contributions takes time. For graduate students (and faculty) the time-consuming nature of the mentoring relationship is undesirable [5]. They must therefore learn how to spend the optimal amount of time in training their mentees so as to receive the largest return [5]. Furthermore, creating a research environment that promotes and rewards returning students could allow mentors to maximize gains on their time investments. Improvements to existing mentor models should consider the developmental nature of mentoring undergraduate researchers [9].

Another challenge graduate student mentors face pertains to ambiguity. Without an understanding of mentor triad models and structures, most mentors have difficulty defining and describing to their mentees what their mentoring relationship will look like and how it will work. Furthermore, when triads are concerned, all three parties of the triad have needs and expectations to consider [9]. Often in research mentor-mentee relationships, there is an emphasis to hit the ground running to accomplish the goals and objectives of the lab, leaving little time upfront for planning and discussions around the goals and expectations of the relationship. While these things take some time, neglecting to establish a clear set of guidelines and plans up front can result in challenges and issues down the road that are particularly difficult to address and can be a great source of stress and tension among lab members.

Our final topic for this section centers around power dynamics within the triadic relationships. Undergraduate research mentoring that includes interactions between all three members of the triad (faculty, postgraduate, and undergraduate researcher) is by nature hierarchical. Of the ten studies examined in this review, more than half (6/10) considered the impact of power dynamics on mentoring relationships. Several of these studies discuss power dynamics issues from the perspective of the undergraduate's interactions with the postdoctoral researcher and/or faculty member. Whereas Dolan & Johnson and Stuchiner et al. suggest undergraduates may feel more comfortable with graduate students due to their closeness in age and thus fewer perceived power dynamics [9, 16], others such as Dolan & Johnson [11] describe the hierarchical challenges some undergraduate students report. Interestingly, we also see this range of perspectives within a case study of a single research lab (8 undergraduates; 8 graduate students; 1 faculty member) [9, 11]. Some students within this lab viewed the layered structure (undergraduates, postgraduates, and faculty) of their group in a positive way. For example, one participant reported that these layers "made the pathway from novice to expert more concrete" [11, p. 551]. However, others in that same research lab commented about the tensions created by the hierarchical structure. For example, one participant described the dysfunction that resulted from these layers, stating, "When stuff goes wrong, it's 'Oh, the undergrads did this, the undergrads did that...'" [11, p. 548]. Another undergraduate mentioned that some postgraduates who are more experienced "wanted to make sure [he] knew that" [9, p. 548]. Perhaps we see both positive and negative perceptions of the hierarchical nature of triads because the power differential itself is not the issue, rather the abuse of that power. According to Margherio "a negative sense of hierarchy arises when [the] power differential is abused" [5, p. 106].

Power dynamics also impact the relationships between graduate students and faculty. In some closed triads, graduate students report challenges in co-mentoring undergraduates with their faculty advisor [9]. For example, one participant described her frustration when giving a student direction only to find out later the faculty asked the student to do it another way [9]. Similarly, Abbott and colleagues describe the power differential between faculty and graduate students as a frequent challenge reported by graduate students [1]. Findings from Dolan & Johnson echo this same sentiment [11]. When describing the postgraduate experiences, they commented how some participants felt "powerless" and went on to describe that "postgraduates were expected to work side-by-side with undergraduates and thus could not escape even temporarily, an undergraduate who was a particular frustration" [11, p. 549].

We can see from the examples above that power dynamics are real and do have an impact on the decision-making and nature of relationships within mentoring triads. It is interesting to note that while most of the articles that describe triads explicitly also discuss power dynamics, it is equally interesting that the existing mentoring models do not refer to or describe

these aspects of the mentoring relationship [6, 12]. Consideration of the impact of these power dynamics on formation and characteristics of mentoring triadic relationships would significantly enhance existing mentoring models. It is not enough to show a relationship link between two members of the triad. To better understand the dynamics and complexity of mentoring relationships, it would be useful to view the mentoring triad models from within a power dynamics framework.

#### IV. DISCUSSION

Mentoring triads involving a faculty member, graduate student, and undergraduate researcher, are common in undergraduate research contexts. While there can be dyadic relationships where the faculty member does not mentor the graduate student regarding the undergraduate research project, often these relationships are either in a closed or open triad, where the undergraduate engages with the graduate student and may or may not be mentored by the faculty member. In many of these situations, the graduate student does not have a pure dyadic mentoring relationship, working directly with the undergraduate; instead, their mentoring relationship is mediated by expectations both explicit and implicit from the faculty member, the highest ranking member of this hierarchical triad. At present, there are few studies that acknowledge or explore the mentoring triads in undergraduate research. Further exploration could shed light on how to better support undergraduate research opportunities and provide mentoring education and support for graduate students. A more nuanced understanding of these hierarchical mentoring triads will allow for necessary discussions and boundary setting between graduate students, their undergraduate mentees, and their faculty mentors, creating a better environment and experience for all involved in the undergraduate research experiences.

#### V. CONCLUSIONS & IMPLICATIONS

In this integrative literature review we described the development of mentoring models that explicitly refer to triads and identified some aspects of these mentoring relationships that are not described by existing models. Whereas existing models show the interactions between all three members of a triad (faculty, postgraduate, and undergraduate researcher), other aspects like the power dynamics of these relationships, including who makes the decisions and how these decisions are made, are not explicitly described. Findings from this review help us better understand triadic mentoring relationships and the associated power dynamics. This information is useful for researchers in further model development and mentors and mentees as they better understand and navigate the often complex, triadic research mentoring relationships.

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