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Beyond the Mentor-Mentee Model: A Case for Multi-Mentoring in Undergraduate Research

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Undergraduate research is widely regarded as a high-impact educational practice (Kuh, 2008; Lopatto, 2010). Students who participate in undergraduate research show gains in cognitive development (e.g., Hunter, Laursen, & Seymour, 2007), academic success and persistence (e.g., Hathaway, Nagda, & Gregerman, 2002), and personal identity and affective growth (e.g., Hu, Kuh, & Li, 2008). Furthermore, benefits can be compensatory, where women, first-generation students, and those from traditionally underserved populations exhibit more pronounced gains compared to non-minority groups (e.g., Gregerman, 2009; Osborn & Karukstis, 2009; Owerbach & Oyekan, 2015). What qualifies as undergraduate research? The Council on Undergraduate Research defines undergraduate research as “an inquiry of investigation conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline.” However, many educators prefer a broader definition that encompasses undergraduate research and scholarly and creative work, choosing to view the endeavor as “a continuum of knowledge production, from knowledge new to the learner to knowledge new to humankind, moving from the commonly known, to the commonly not known, to the totally unknown” (Willison & O’Regan, 2007, p. 394). Regardless of whether the research is original to the discipline or only to the student, a critical component that often determines whether the student actually recognizes the gains from the experience is the mentor (Aikens et al., 2016; Hartmann, Widner, & Carrick, 2013; Henne et al., 2008; Hunter et al., 2007, 2008; Kardash, Wallace, & Blockus, 2008; Laursen et al., 2010; Locks & Gregerman, 2008; Lopatto, 2004, 2010; Lundberg & Schreiner, 2004; Russell, 2008; Taraban & Logue, 2012; Thiry et al., 2010; Zydney et al., 2002).

The international higher education community has recently emphasized the importance of mentoring in undergraduate research (Healey & Jenkins, 2009). Reports by the Boyer Commission and the National Science Foundation recommend that undergraduate education should include research and scholarly inquiry conducted in association with a faculty mentor (Boyer Commission on Educating Undergraduates in the Research University, 1998; National Science Foundation, 2000). Results from the Survey of Undergraduate Research Experience (SURE) show that learning gains are directly correlated with the students’ evaluation of the mentor (Lopatto, 2010). The 2014 Gallup Purdue Index Report found that having a mentor and working on a long-term project were two of the most powerful factors connected to graduates having “great jobs” and “great lives” (Gallup, 2014). More than ever, there is a global call for educational institutions to find ways to engage students in

undergraduate research experiences that are well-mentored.

The term *mentoring* has been defined extensively and variably in the literature, but these definitions generally include reference to the experience levels of the people in the relationship, the manner in which those people are exchanging information, and the type of information they are exchanging (Higgins, Dobrow, & Roloff, 2010; Johnson, 2002; Kram, 1985; Thiry & Laursen, 2011). Johnson (2015) proposed an operational definition for mentoring within the context of the academe: “Mentoring is a personal and reciprocal relationship in which a more experienced (usually older) faculty member acts as a guide, role model, teacher, and sponsor of a less experienced (usually younger) faculty member or student. A mentor provides the mentee with knowledge, advice, counsel, challenge, and support in the mentee’s pursuit of becoming a full member of a particular profession” (p. 23).

Johnson’s (2015) definition focuses on the dyadic relationship between mentor and mentee, and most research on mentoring is conducted within the framework of the classic master-apprentice model (Allen, 2007; Wanberg, Welsh, & Hezlett, 2003). A significant body of work demonstrates the effectiveness of the intense personal relationship that develops between a faculty mentor and a student mentee who are mutually engaged in undergraduate research (e.g., Hartmann et al., 2013; Lopatto, 2004; Lundberg & Schreiner, 2004). However, many undergraduate researchers are not working with a single mentor alone (Bradley et al., 2017; Guberman et al., 2006; Lopatto, 2010; Lopatto & Tobias, 2010); instead, they surround themselves with a network of people who take an active interest in their work and provide developmental assistance and support (Higgins & Kram, 2001; Higgins, Chandler, & Kram, 2007; Higgins et al., 2010). The developmental network comprises individuals from a range of social spheres and can include both non-mentors and mentors (Higgins et al., 2010; Kram & Ragins, 2007). Thus, effective mentoring in undergraduate research also involves an understanding of the best practices in multi-mentoring.

Multi-mentoring gained serious attention from scholars in the mentoring community in the late 1990s (e.g., Baugh & Scandura, 1999; Dansky, 1996). Recent work has attempted to describe the landscape of multi-mentoring by defining terms, characterizing mentoring structures, and exploring outcomes (Huizing, 2012; Kroll, 2016). In the undergraduate research community, multi-mentoring appears to be a common practice, particularly in the sciences (Bradley et al., 2017; Linn, Palmer, Baranger, Gerard, & Stone, 2015). However, much of literature on and practice of mentoring undergraduate researchers still contains an implicit assumption of the traditional one-on-one dyadic model (Dotterer, 2002; Hartmann et al., 2013; Thiry & Laursen, 2011). Here, we argue that multi-mentoring can be broadly applied in undergraduate research in a global context, across disciplines and institutions. We briefly review relevant examples of multi-mentoring models and the concept of co-mentoring from the professional development literature, discussing the opportunities and challenges associated with applying these concepts to undergraduate research. We provide suggestions for how research mentors and institutions can implement the structures and practices of multi- and co-mentoring to enhance the undergraduate research experience.

Models of Multi-Mentoring

Multi-mentoring structures describe the way mentoring roles are fulfilled in a group of at least three people. There is substantial literature on group mentoring in the workplace for professional development. The goal of this paper is to place some of these relevant structures in the context of undergraduate research and is not meant to be an exhaustive literature review. For a full review of team-based mentoring and developmental networks, we refer the readers to Dobrow, Chandler, Murphy, and Kram (2012), Huizing (2012), Kroll (2016), and references therein.

The types of multi-mentoring structures identified in extant literature that we review here include

one-to-many, peer-group mentoring, many-to-many, many-to-one, and mentoring mosaics. *One-to-many* mentoring involves several less experienced mentees mentored by a single, more experienced person (Huizing, 2012). Although one-to-many mentoring can comprise a collection of mostly unassociated, individual dyadic mentoring relationships (Baugh & Scandura, 1999), the strength of this type of structure over the dyadic model is the potential for increased connectedness among the mentees (Mezias & Scandura, 2005). Communication in this model is often networked, rather than linear, meaning that all mentees are communicating simultaneously with one another (Gareis & Nussbaum-Beach, 2007). Networked communication can lead to *peer-group mentoring* (Mullen, 2000), in which the role of mentor shifts within a group of mentees of similar experience levels. Peer-group mentoring is a widely cited team-based mentoring model with demonstrated benefits for professional and personal development (Huizing, 2012).

Peer-group mentoring is similar to many-to-many mentoring in that both can consist of large groups with multiple mentors and mentees. However, in the *many-to-many model*, the role of mentor is designated for the duration of the group (Huizing, 2012). Support is always provided in one direction, from the mentors to the mentees. The benefits of the two models are similar, but many-to-many mentoring can accommodate some of the deficiencies that occur in peer-group mentoring, such as limited mentor skills or time constraints (Levine, Hebert, & Wright, 2003).

Many-to-one mentoring has at least two mentors who are focused on a single mentee (Huizing, 2012), increasing the opportunities for the mentee to receive mentoring benefits (Packard, Walsh, & Seidenberg, 2004). However, the many-to-one model is less effective when the mentors do not interact (Crocitto, Sullivan, & Carraher, 2005; de Janasz & Sullivan, 2004; Higgins, 2000; Mezias & Scandura, 2005), requiring the mentee to integrate information and serve as the communicator between mentors.

The *mentoring mosaic* is a model that more broadly encompasses multi-mentoring structures (Ayers & Griffin, 2005; Dobrow et al., 2012; Mullen, 2000; 2009). This model is somewhat analogous to the developmental network (Dobrow et al., 2012; Higgins and Kram, 2001; Higgins et al., 2010; Kram & Ragins, 2007) or mentoring constellation (Kram, 1985) in that it recognizes that one mentor cannot fill all the necessary roles for a mentee all of the time, so it relies on multiple mentors that may change depending on the developmental stage of the mentees involved. According to Ayers and Griffin (2005), the mentoring mosaic recognizes the interconnected aspects of mentoring, “such as formal and informal situations, dyadic relationships, multiple mentors and changing roles from protégé to mentor across a professional career, and the spiraling nature of mentoring over time” (p. 373). Multi-mentoring is a critical component of the mentoring mosaic, which clearly plays a powerful role in the development of a mentee (Baugh & Scandura, 1999; Higgins & Thomas, 2001) and can have significant benefits for students and faculty when applied to undergraduate research.


Co-Mentoring

In all of these multi-mentoring structures, interaction among mentors allows for the creation of a collaborative environment that values interdependence, mutuality, and reciprocity (Fletcher, 1999; Kram & Ragins, 2007; Mullen, 2009). When mentors have an intentional relationship where there is reciprocity in teaching and learning, this is termed co-mentoring (Bona, Rinehart, & Volbrecht, 1995; Kram & Ragins, 2007; Mullen, 2000 & 2009). Co-mentoring values and promotes a culture of learning from and development of colleagues who may be at different ages and stages of their career, breaking down power structures and flattening the hierarchy (Kroll, 2016). It assumes that everyone has something to contribute and something to gain, which can be a powerful mechanism for professional development (Mullen, 2000). Additionally, co-mentoring functions as a catalyst for changing traditional practices and hierarchical systems (Mullen, 2009). The key activities needed in co-mentoring are power sharing, turn taking, co-leading, dialogue, constructive feedback,

transparency, and authenticity. These activities require co-mentors to be open to criticism and formative feedback and not fearful of evaluation and judgment. Co-mentoring values the characteristics, skills, and qualities of the individuals involved with a focus on professional development (Mullen, 2000).

Multi-Mentoring and Co-Mentoring in Undergraduate Research: Opportunities and Challenges

In the work environment, multi-mentoring can be more effective than dyadic mentoring because of the collaborative interactions among diverse, skilled people. When mentors comprise diverse individuals from a range of social spheres, mentees are exposed to a greater variety of ideas and information (Dobrow & Higgins, 2005; Higgins, 2001; Higgins et al., 2007; Ragins, 1997). Because mentors have varying skill sets and expertise, they bring different strengths to the mentoring relationship and can compensate for gaps in support, thereby ensuring that all of the mentees' needs are met (Baugh & Scandura, 1999; de Janasz & Sullivan, 2004; Eby, 1997; Higgins & Thomas, 2001; Higgins et al., 2007; Levine et al., 2003; McManus & Russell, 2007). Furthermore, having a range of mentors increases the potential for an identity match between the mentor and mentee (DeCastro et al., 2013).



“... multi-mentoring can be more effective than dyadic mentoring because of the collaborative interactions among diverse, skilled people.”

Undergraduate research presents students with the opportunity to develop relationships with multiple diverse mentors. Students report having mentors that range across academic levels (peers, graduate students, postdocs, and faculty) and organizations (academic, industry, government) (Bradley et al., 2017; Lopatto, 2010). In addition to their formally defined mentors, undergraduate research students often turn to other individuals for informational, logistical, or psychosocial support (Bradley et al., 2017; Pascarella & Terenzini, 2005). For example, undergraduate research students may seek out faculty mentors for big-picture questions about project goals but may turn to peers or postgraduates for technical advice (Dolan & Johnson, 2010). The increased diversity of role models offered through multi-mentoring may be especially important for students from underrepresented populations whose representation among faculty may be limited, leading to greater student retention and success (Huggins, Jenkins, & Scurry, 2007; Locks & Gregerman, 2008; Lundberg & Schreiner, 2004; Nelson & Rogers, 2003; Towns, 2010).

There are psychosocial benefits that are enhanced by the collaborative nature of co- and multi-mentoring. Many workplace studies demonstrate that the presence of multiple diverse mentors has been linked with higher job satisfaction and greater professional success (Arthur & Rosseau, 1996; de Janasz, Sullivan, & Whiting, 2003; Eby, 1997; Higgins, 2000; Higgins & Kram, 2001; Higgins et al., 2007; Peluchette & Jeanquart, 2000). Although not a requirement, many relationships in workplace multi-mentoring structures have been shown to develop informally and organically, leading to longer-term bonds (Allen & Eby, 2007; Ragins & Cotton, 1999). Compared to formal mentoring, informal mentoring can also lead to greater gains in the affective domain, such as self-confidence, satisfaction, and persistence (Mullen, 2016).

In undergraduate research, students who participate in collaborative mentoring relationships show gains in personal and professional growth (Hunter et al., 2007). The collaborative environment helps students take ownership of their work, learning independence and self-confidence, leading to gains in socialization in the field, networking, and adaptability (Lopatto, 2010; Shanahan et al., 2015; Wei & Woodin, 2011). Long-term bonds that develop through informal mentoring help ensure students'

needs are supported across their academic experiences (Barnett, 2011).

In addition to the psychosocial and career benefits, other aspects of multi-mentoring have potential positive outcomes for the research project itself. From the beginning, multiple perspectives are integrated into the question, methodology, analysis, and interpretation of results. This essentially begins the peer-review process early and generates opportunities for cross-disciplinary work (Bradley et al., 2017; Dotterer, 2002). Co-mentoring can also be an effective faculty development tool, where observing other people mentoring may lead to enhanced mentoring across the faculty or among postgraduates (Dolan & Johnson, 2010; Thomas & Gillespie, 2008).

A potential challenge to multi- and co-mentoring in undergraduate research is the perception that it is a resource-intensive and expensive model. However, multi-mentoring can distribute some of the faculty mentoring responsibilities to non-faculty members, expanding student research opportunities at institutions that are limited by the number of available faculty (Wei & Woodin, 2011). Faculty members who are concerned about the financial and time resources required to effectively mentor research students may find some of these commitments can be spread across several mentors through multi-mentoring (Hakim, 1998; Zydney et al., 2002). Distributing mentoring responsibilities may allow faculty to remain engaged in their research while balancing other workload pressures, particularly at U.S. and international institutions that demand high-level research from their academic staff (Healey & Jenkins, 2009; Thomas & Gillespie, 2008).


Another potential challenge of applying multi- and co-mentoring to undergraduate research relates primarily to the quality of the relationships among mentors and mentees. Quality mentoring relationships require time to mature and the short time frame of many undergraduate research projects may not allow for strong ties to develop between students and multiple mentors (Hartmann et al., 2013). Mentoring abilities may vary across mentors and may even have negative effects on students. For example, postgraduate mentors, like graduate students and postdoctoral researchers, may have a negative influence on undergraduate researchers by enhancing academic hierarchies and imposing expectations that are unrealistic (Dolan & Johnson, 2010). Multiple mentors also enhance the potential for increased role and interpersonal conflict (Baugh & Scandura, 1999). In the following section, we discuss strategies for minimizing these challenges.

Suggestions for Implementing Multi-Mentoring and Co-Mentoring in Undergraduate Research

Our suggestions for implementing multi- and co-mentoring in undergraduate focus on the structure of the undergraduate research experience and the development of relational skills. Some readers may be employing these strategies with great success.

Those who are starting an undergraduate research program or are interested in transitioning to a multi-mentor model may find these suggestions a useful starting point.

Multi- and co-mentoring are most effective in environments that exhibit a culture of collegiality, where all members of the network show care and respect for one another (Higgins & Thomas, 2001; Johnson et al., 2014). We assume that the members of a multi-mentor network are willing to work toward collegiality. This includes openness to differing views, experiences, and styles. It requires members to trust and be trusted, to have integrity, be honest, take pride and responsibility in their work, and communicate when there are conflicts or concerns



“We assume that the members of a multi-mentor network are willing to work toward collegiality. This includes openness to differing views, experiences, and styles.”

(Johnson et al., 2012; Johnson et al., 2014). If relationships are dysfunctional and conflict extends beyond interpersonal are philosophical approaches, it may be that those members should not be involved in the multi-mentoring group.

Relational skills require practice and are most effectively learned when actions and values are taught and modeled (Johnson et al., 2014). For example, it is very effective for undergraduate students to see co-mentors discussing varying perspectives and learning technical skills from one another; students observe that both mentors respect and value the experience and expertise of each other and are willing to learn and be taught (McKendree et al., 1998). To enhance communication and limit interpersonal conflict, the group members should discuss roles early in the research process and return to the discussion as the project progresses. An undergraduate research syllabus could be used to initiate the discussions and clarify expectations and roles for the mentees and mentors (Scisney-Matlock & Matlock, 2001; Whiteside et al., 2007).

The quality of mentoring relationships can be enhanced by increasing the frequency of interactions (Aikens et al., 2017). Although meeting several times throughout a semester can be beneficial for a research group, weekly meetings are even more beneficial (Aikens et al., 2017; Whiteside et al., 2007). Logistically, weekly meetings can be helpful for keeping track of project progress, especially when meeting notes and research deadlines are recorded and distributed to the research group (Whiteside et al., 2007). Regular meetings also offer opportunities for communication, reflection, and rapport development (Aikens et al., 2017; Whiteside et al., 2007). Mentors can provide students with support while getting to know them as people (Handelsman et al., 2005; Schlosser et al., 2003). When undergraduates perceive their mentors as taking a genuine interest in their experiences, students report that the meetings with mentors are highly influential and effective (Hartmann et al., 2013; Thiry & Laursen, 2011; Whiteside et al., 2007).

In addition to relational skills, the size of the mentor network should be considered. Ideal group size depends on several factors, such as the nature of the research, the personalities of the members, and the resources available to support the research, but the literature suggests that developmental networks comprising three to five close relationships are most satisfying to individuals (Higgins et al., 2010; Kram & Ragins, 2007; van Emmerick, 2004). A multi- and co-mentoring structure that can be commonly utilized in undergraduate research is the mentoring triad, where an undergraduate student is mentored by a postgraduate, who is mentored by a faculty member (Aikens et al., 2016; Thiry & Laursen, 2011; Whiteside et al., 2007). Research suggests that undergraduates experience the most positive outcomes in *closed* triads, in which ties are strong among *all* of the triad members (Aikens et al., 2016). It is the combination of multi- and co-mentoring that leads to the success of closed triads, as undergraduates whose mentors do not interact experience worse outcomes than undergraduates who have only a single faculty mentor (Aikens et al., 2016). Strong ties among members of the mentoring network enhance communication, mutual trust, and group rapport (Aikens et al., 2016; Coleman, 1988)

Research projects should be specifically designed for a mentoring network involving multiple mentors and students. Projects should focus on a common goal (Wei & Woodin, 2011). Depending on group size, the larger research problem can be subdivided into smaller student projects (Wei & Woodin, 2011). When undergraduate students are responsible for a specific aspect of the research, they develop a greater mastery of the skills and own the part of the project that they bring to the collaboration (Whiteside et al., 2007). It may even help to assign specific titles to the individual students or small research groups to more clearly define roles and responsibilities (Whiteside et al., 2007). This approach appears to be more common in the natural sciences, as demonstrated by the greater number of mentors, including peer mentors, in science mentor networks (Bradley et al., 2017). However, this aspect of multi-mentoring could be applied to other disciplines and

intentionally developed with appropriate project design (Bradley et al., 2017). In particular, interdisciplinary projects that involve knowledge and techniques from several disciplines naturally tend toward multiple mentors and subdivided student projects (Bradley et al., 2017).

At the institutional level, an awareness of multiple mentors beyond the formally-defined institutional faculty mentor should be increased through incentives and support structures (Bradley et al., 2017). Undergraduate research programs should be structured to promote the best experiences for all students, including online tools that facilitate communication and mentoring syllabi so that expectations among mentors and mentees are clear (Aikens et al., 2017). Institutions that already require an undergraduate thesis for graduation could structure the program to require weekly meetings for academic credit, similar to the Independent Study Program at the College of Wooster, in which students and all faculty advising students, including those serving as co-mentors, receive credit (Pollock et al., 2013). A formalized thesis committee could serve as the students' mentor network if the committee members developed strong ties and true co-mentoring relationships (Ketcham et al., in press). Mentors should participate in professional development programs that provide training on mentoring and distinguish between mentoring and supervising, as students do not always perceive faculty supporters as mentors (Bradley et al., 2017; Kardash et al., 2008; Russell, 2008; Taraban & Logue, 2012; Thiry & Laursen, 2011). Professional development programs should also train mentors to identify individual biases and provide strategies for reducing biases (Aikens et al., 2017).

These strategies will help students and mentors navigate through some of the difficulties of multiple complex relationships. For additional suggestions, we refer the readers to Shanahan et al. (2015), who wrote an extensive literature review on the salient practices of undergraduate research mentors, and Ketcham et al. (in press), who have articulated the practical application of co-mentoring in undergraduate research.

Closing Thoughts

Mentored undergraduate research is a widely recognized high-impact educational practice. There is a growing awareness that the landscape of mentoring has, and likely should, move beyond one-to-one mentoring. Multi-mentoring structures and the practice of co-mentoring can be applied successfully to undergraduate research, leading to greater positive outcomes for the research project and enhanced psychosocial and career benefits for the mentors and mentees. Multi-mentoring does not necessarily mark a shift in practice in the field of undergraduate research as a whole, but there is a need for institutions to provide support to overcome some of the challenges of developing quality mentoring relationships that are unique to multi-mentoring. Strategies for implementing multi- and co-mentoring in undergraduate research consider the development of relational skills among group members and the structure of the undergraduate research experience. Success with multi-mentor models will likely lead to a change in faculty development strategies and an intentionality of mentors to engage with each other in the endeavor of undergraduate research.

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