

Title

Entry points when undergraduate research mentors reflect on their role: A qualitative case study

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Abstract

Graduate students and postdoctoral researchers are increasingly taking on mentoring roles in undergraduate research (UR). There is, however, a paucity of research focusing on how they conceptualize their mentoring role. In this qualitative interview study, we identified three entry points that mentors reflect on to define their role: (1) What are the goals of UR? (2) What do the students expect from me? and (3) How should I use my expert knowledge? We discuss how academic developers can use these entry points together with a set of reflective lenses in the future to stimulate critical reflection on the mentoring role.

Keywords: undergraduate research, mentoring role, partnership, critical reflection, entry points

Introduction

Undergraduate research (UR) is a particular type of *inquiry-based learning* (Lee, 2012; Prince & Felder, 2006), where students work on research projects that are coupled to ongoing research efforts at the university (Brew, 2003). It has been identified as a *high-impact practice* (Kuh, 2008), supporting a wide range of essential learning outcomes (Auchincloss et al., 2014; Hunter, Laursen, & Seymour, 2007; Lopatto, 2009). Hunter, Laursen, and Seymour (2007, p. 69) wrote: “Overwhelmingly, students define undergraduate research as a powerful affective, behavioral, and personal discovery experience whose dimensions have profound significance for their emergent adult identity, sense of career direction, and intellectual and professional development.”

Two different models for providing students with UR experiences have emerged: the internship or *summer undergraduate research experience* (SURE), with a long tradition in North America, and the *course-based undergraduate research experience* (CURE), that has started to become more widespread in recent years (Auchincloss et al., 2014). CUREs provide a larger number of students with research opportunities and use a broader set of teaching and learning activities than SUREs. Moreover, CUREs challenge the traditional apprenticeship model in SUREs by working with more diverse groups of students and using more democratic ways to mentor students (Brush, Cox, Harris, & Torda, 2010; Corwin, Graham, & Dolan, 2015). A key challenge, however, in CUREs is to retain a strong student-mentor relationship in larger groups. The student-mentor relationship and the role of the mentor are often highlighted as the most important factors for the success of UR experiences (Kuh, 2008; Linn, Palmer, Baranger, Gerard, & Stone, 2015; Palmer, Hunt, Neal, & Wuetherick, 2015).

Graduate students and postdoctoral researchers are increasingly acting as UR mentors. It is, in fact, more common that undergraduate students are mentored by graduate students and/or postdoctoral researchers than by faculty members (Thiry & Laursen, 2011). At the same time, graduate students and postdoctoral researchers seldom receive any formal training in how to effectively mentor UR projects (Ahn & Cox, 2016). These mentors are therefore often left on their own to critically reflect on and define their role.

Most previous research on effective UR mentoring has either focused on undergraduate students' perspectives (e.g. Hunter et al., 2007) or faculty members' perspectives (e.g. Behar-Horenstein, Roberts, & Dix, 2010), overlooking graduate students' and postdoctoral researchers' perspectives on UR mentoring (Ahn & Cox,

2016). One exception is the study by Dolan and Johanson (2009), which focused on the motives, gains, and challenges reported by graduate students and postdoctoral researchers. In a more recent study, Ahn and Cox (2016) examined the mentoring knowledge, skills and attributes of graduate students and postdoctoral researchers. Beyond these two studies, little attention has been paid to how graduate students or postdoctoral researchers conceptualize their mentoring role and the reasoning behind it.

In this qualitative case study (Merriam, 2009), we explore the reasoning behind how graduate students and postdoctoral researchers conceptualize their role as UR mentors. We focus, in particular, on what larger questions – or *entry points* – these novice UR mentors use to frame reflections on their mentoring role. When turning to implications for academic developers' practice, we discuss how the identified entry points can be used in conjunction with four reflective lenses proposed by Brookfield (1995) to stimulate and enhance critical reflection on the mentoring role in future UR mentor training and development.

Theoretical background

A commonly used theoretical framework in studies of UR experiences is Lave and Wenger's (1991) concept of *communities of practice* (e.g. Barab & Duffy, 2000; Hunter et al., 2007; John & Creighton, 2013; Lopatto, 2009). In these studies, the researcher/mentor is seen as an expert who helps students to be socialized into the research field or the community of practice. It is through the students' initial *legitimate peripheral participation* and their engagement in simpler tasks that they gradually become members of the community of practice (Lave & Wenger, 1991).

In their conceptual review of mentoring, undergraduate research, and identity development, Palmer et al. (2015) proposed an alternative approach to mentoring that

highlights the *partnership* component of the student-mentor relation. Their way of conceptualizing mentoring is more in line with what Zachary (2002, p. 28) described as a new mentoring paradigm:

Mentoring practice has shifted from a *product-oriented* model, characterized by transfer of knowledge, to a *process-oriented* relationship involving knowledge acquisition, application, and critical reflection. The hierarchical transfer of knowledge and information from an older, more experienced person to a younger, less experienced person is no longer the prevailing mentoring paradigm.

A partnership is based on a reciprocal relationship between the student and the mentor, where both benefit and accept certain risks by engaging in something that is not fully predictable (Healey, Flint, & Harrington, 2014; Marquis et al., 2016). A partnership positions students as knowledgeable partners that contribute and shape their learning experiences (Healey, O'Connor, & Broadfoot, 2010; Jensen & Bennett, 2016). Jensen and Bennett (2016, p. 42) pointed out that “the way that this occurs is through the use of dialogue to develop mutual understanding. This definition of partnership reflects the principles and values of authenticity, reciprocity, empowerment, and responsibility.” Dialogue should, however, not be understood as a mere technique, but as a part of the developmental progress in becoming human beings – “a moment where humans meet to reflect on their reality as they make and remake it” (Shor & Freire, 1987, p. 13).

This new mentoring paradigm emphasizes the importance of critical reflection and the need for mentors to think about their roles in UR, instead of simply being handed down guidelines and best practices (Zachary, 2002). Since mentors will constantly face new and challenging situations for which they have not been trained, reflection is an essential element of mentoring (Schön, 1983). Reflection involves

“assessment of what is in relation to what might or should be and includes feedback designed to reduce the gap” (Smith, 2001, p. 57). Reflection becomes critical when it questions assumptions and common practices, and when it focuses on power relations (Brookfield, 1995). To support critical reflection, Brookfield (1995) proposed four reflective lenses that practitioners can use: (1) their own experiences – the autobiographical lens; (2) their colleagues’ experiences – the peer lens; (3) the literature – the scholarship lens; and (4) their students’ experiences – the student lens.

Study context and design

The context for this study is a 15 ECTS-credits advanced level course in tissue engineering given at Chalmers University of Technology in Sweden. The aim of the course is for students to: (1) gain an overview of the tissue engineering field; (2) understand and critique the scientific and technical assumptions and approaches that form the building blocks of the field; and (3) develop research competencies. The course is part of the Biotechnology and Biomedical Engineering programs, and the majority of the students take the course in the first year of their master studies. In contrast to many other UR experiences, there is no highly competitive application or individual selection process (Auchincloss et al., 2014) beyond meeting the course prerequisites. The enrollment in the course is limited to 20 students due to the number of available projects and mentors, and the course budget. This is, however, a fairly high throughput compared to many SUREs (Desai et al., 2008; Harrison, Dunbar, Ratmansky, Boyd, & Lopatto, 2011).

As we have discussed in a previous paper (Wallin, Adawi, & Gold, 2017), the tissue engineering course can be seen as a hybrid between a CURE and a SURE, drawing on strengths of both models. With a strong focus on authentic research, the course also allows students to work in groups and uses a mix of different teaching and

learning activities. The three main activities in the course are lectures, article review sessions, and a research project. The lectures focus on fundamental aspects of tissue engineering and provide an overview of the field and insight into different areas of tissue engineering. In the article review sessions, the students learn how to read and critically evaluate scientific articles and they learn about the peer-review publication system. The projects allow students to address authentic scientific problems and contribute to the creation of new scientific knowledge. The students work on their research project in groups of five or six over the entire five-month period of the course. Each project is directly coupled to the mentor's on-going research and the students work on their project in close collaboration with their mentor.

The mentors in the tissue engineering course are graduate students and postdoctoral researchers who are associated with one of the two professors who teach the tissue engineering course. The mentors do not receive any specific training or formal instructions regarding how to effectively supervise UR projects prior to the course. Due to the lack of formal guidelines and specific training, the mentors are put in a position where they need to reflect on and define their mentoring role.

In this paper, a qualitative case study approach (Merriam, 2009) was used to explore the reasoning behind how novice UR mentors conceptualize their mentoring role. We were specifically interested in what entry points, or larger questions, novice UR mentors use to frame their reflections. Individual, semi-structured interviews were carried out with three mentors at the beginning of the tissue engineering course and prior to their first mentoring experience. The mentors had been involved in the tissue engineering course before, either as students or assistants, but were now for the first time involved as mentors and responsible for a research project. The interviews explored how the mentors conceptualized their mentoring role and the reasoning behind

it by focusing on the nature of good mentoring, issues related to the specific project that the students will carry out, and the interaction with the students. The interviews lasted between 45 and 70 minutes and were all audio-recorded and transcribed soon after the event. The data was analyzed using a general inductive approach (Thomas, 2006). This means that the data was first broken up into segments, which were coded. The codes were then sorted and sifted in an iterative way until a number of themes emerged. These themes constitute the entry points that the novice UR mentors used to reflect on and define their mentoring role. We have strived to provide a sufficiently detailed description of both the results and the setting to allow for user generalizability, which “involves leaving the extent to which a study’s findings apply to other situations up to the people in those situations” (Merriam, 2009, p. 226).

Results and discussion

An inductive analysis of the interview transcripts led to the identification of three entry points that the novice UR mentors used to reflect on and define their own role. Formulated as questions, these were: (1) What are the goals of UR? (2) What do the students expect from me? and (3) How should I use my expert knowledge? While all three mentors raised these questions during the interviews, their answers to the questions differed in important ways, leading to different ways of conceptualizing their mentoring role. Below, we describe and discuss these three entry points, using illustrative quotes from the interviews and previous studies related to UR mentoring. The mentors are referred to by their pseudonyms: Clara, Peter, and Ella.

What are the goals of undergraduate research?

One entry point that influenced how the novice mentors conceptualized their own role is what they considered to be the goals of UR. When discussing the goals of UR, the mentors either focused on the project and the development of new knowledge or the

students and their learning. Balancing these two goals of UR was experienced as challenging by the mentors.

In emphasizing the project and the development of new knowledge as the goal of UR, the mentors saw their role mainly as experts in the field of their research and gatekeepers to the scientific community. Peter pointed out that the projects are opportunities for him to get help in testing ideas that he wants to investigate himself:

In the project with the labwork I hope I can try out some new things that I wanted to try myself anyway. So then I think it will be more of a benefit [to mentor students]. (Peter)

The focus here is on the professional benefit of combining teaching and research. As a mentor, he will provide the students with interesting projects to work on and in return he will get help from the students in advancing his own research. While this is partly what UR is about (Brew, 2013), we believe that it can become problematic when the mentor's focus is shifted entirely towards the project and the development of new knowledge, while ignoring the students' learning experience. The mentor then becomes the one who controls the direction of the project and creates clear boundary conditions within which the students work (Auchincloss et al., 2014).

In contrast, Ella conceptualized the goal of UR more in terms of student learning. The role of the mentor then involves taking a step back and considering where the students are at the moment, where they are coming from, and what they will need to move forward:

Tutoring is not just telling people what to do, it is also to see what they learn... It is to see people and try to take one step back and see what they are doing and what the difficulties are for this person. (Ella)

Here, a successful project is not necessarily defined by strong scientific results, as the main goal is to help the students to explore the field on their own, make their own mistakes, and support their learning. The risk, however, of focusing more on the students than on the project is that the UR project can lose its authenticity and therefore limit students' ability to become part of the research community (John & Creighton, 2013). It is the authentic nature of research projects that students value, as it shows them that they are respected and valued as contributors to the scientific field (Auchincloss et al., 2014; Lopatto, 2003, 2009). In other words, authentic projects help students to transition from their student role towards a researcher role.

What do the students expect from me?

Another entry point that influenced how the novice mentors conceptualized their role, is what they believed the students expected from them. Since the mentors had no previous experience of UR mentoring, some of them drew on previous teaching experiences from other contexts in higher education, such as the traditional lab exercise, to reflect on what the students might expect from them. This led Peter to believe:

I think they probably want me to do as much as possible, I would expect. I think they want more guidance on what they should do, since this [UR] is different from what they are used to. I guess they need more input from me. (Peter)

The idea that students want as much help as possible is closely linked to the idea that students do not value becoming self-regulated learners. Numerous studies have shown that this is not the case and that students, especially in UR, have a strong desire to learn and develop (Hunter et al., 2007; Linn et al., 2015; Lopatto, 2009). While acknowledging that comparing UR to other more familiar teaching contexts in higher education can help novice mentors and students at the beginning by making the transition to UR easier, we also believe that it limits the potential of UR and the

possibility for students to learn to deal with the complexity and uncertainty inherent in research.

Other mentors realized that UR is different from traditional teaching, where there is often a well-defined procedure for the students to follow and/or the teacher knows the answer to the problem. Focusing on what people might expect in situations similar to UR outside higher education, i.e. situations where no one knows the “answer”, Ella concluded from this situation that students expect to be able to trust her as a mentor to guide them through the project:

They trust me to guide them through this project and they trust me to also tell them if they are doing something that I think that they should not do. So, I think they trust me a lot. They are trying to find new ideas and work on the project, and they trust me to tell them what I think about their ideas and what they need to improve on...and not just let them go on the whole semester and try to figure out things on their own. (Ella)

According to this view, students do not want the mentors to resolve the challenges of engaging in UR, which may carry key opportunities for learning and development. Instead, the mentor trusts the students to be up for these kind of challenges – to want to learn – and the students trust the mentor to guide them through the challenges (Palmer et al., 2015).

How should I use my expert knowledge?

The third entry point that influenced how the novice mentors conceptualized their role is related to their expert knowledge. As the projects that the students work on are directly coupled to the mentor’s own research interest, the mentor will have certain expert knowledge about the research area and experience of working with similar

questions (Gonzalez, 2001). When reflecting on how they should use this expert knowledge, Clara pointed out a thorny dilemma:

I do not want to say: You should do this or that...I am trying to guide them and also give them space to think and analyze and have ideas by themselves...But it can be hard sometimes because you want them to do something and I think this is the best idea and then I do not want them to feel that. (Clara)

One way of dealing with this dilemma is to focus on the development of the project rather than the development of the students. Peter felt that his role was to provide the necessary expert knowledge for carrying out the project but not to support students to develop a broader set of generic skills:

To my understanding it is mostly the project knowledge that the tutor should provide. Since I have no pedagogical training myself I have not really thought about group dynamics or anything like that. (Peter)

When mainly building on their expert knowledge, mentors create a position of superiority for themselves (Brew, 2001). They decide the boundary conditions for student learning and inquiry, what Lee (2008) called “gatekeeping” in her empirical work on supervision styles in doctoral education. The desire to remain in control of the situation and being seen as an expert is likely to help mentors to limit risks, but leads to a certain type of UR experience. While this can still be a satisfying UR experience for the students, it is also limiting. When focusing on being an expert, mentoring risks being reduced to a transmission of knowledge from somebody who knows to somebody who does not know (Zachary, 2002). The following quote reflects such a transmission model of mentoring:

You cannot tell everything that you know to a person that is new in the field, so you need to go step-by-step. (Ella)

Ella is, however, aware of the importance of using her expert knowledge in a suitable way to help students to learn.

In addition, Ella reflected on the limitations of her expert knowledge as well as the importance of discussing this with the students:

Be honest with [the students] from the start. Tell them that this is a study that we have never done before and we are not sure if this is going to work out, but we think it might do, but we are not sure... An open communication throughout the project. (Ella)

In this way, we believe that mentors can help students to gain a deeper understanding of the iterative and messy nature of research that is often invisible in reports and articles. It opens up for important discussions on the nature of research and knowledge, as well as the scientific method (John & Creighton, 2013).

Implications for academic development

From the interviews with the novice UR mentors, we identified three entry points that they used to reflect on and define their role: (1) What are the goals of UR? (2) What do the students expect from me? and (3) How should I use my expert knowledge? While all three mentors raised these questions during the interviews, there was considerable variation in how they conceptualized their own role. Previous studies have also found that novice UR mentors conceptualize their role in different ways (Dolan & Johanson, 2009; Ahn & Cox, 2016). One reason for this variation might be the lack of structured support or training for the mentors. Based on the empirical data from the interviews, we suggest that the three entry points can be used as a starting point to design more structured academic development support and training for novice UR mentors.

The entry points can be used to identify what questions to focus on in future training, whereas the literature on critical reflection can help to identify important

lenses for reflection. Critical reflection is recognized as an important process for helping mentors and teachers to define their own role (Beauchamp & Thomas, 2009). The reflections of the novice UR mentors participating in this study were, however, restricted to their own past experiences. While these reflections made the mentors' assumptions about mentoring explicit, the reflections often lacked a more critical component where underlying assumptions are questioned or supported beyond own experiences (the autobiographical lens). One way to overcome this limitation and enhance the reflective process is to encourage mentors to use the three additional lenses for reflection proposed by Brookfield (1995): the *peer* lens, the *scholarship* lens, and the *student* lens. Using the peer lens, mentors discuss their experiences with one another. This can help mentors to deconstruct hidden assumptions and beliefs, and broaden their perspective on being a mentor (Brookfield, 1995). For novice mentors who lack experience of UR mentoring, discussing with more experienced peers is particularly important. Using the scholarship lens, mentors engage with the literature on UR mentoring. Brookfield (1995, p. 36) wrote: "Studying theory can help us realise that what we thought were signs of our personal failings as teachers can actually be interpreted as the inevitable consequences of certain economic, social and political processes." Finally, Brookfield (1995, p. 35) emphasized the importance of the student perspective: "[T]he most fundamental metacriterion for judging whether or not good teaching is happening is the extent to which teachers deliberately and systematically try to get inside students' heads and see classrooms and learning from their point of view." Using the student lens, mentors discuss, for example, their own role and the students' role with the students. This has been referred to as the "negotiation stage" (Zachary, 2002), where the aim is to build a shared understanding of the mentor-student relationship.

UR requires mentors to carefully balance the roles of researcher and teacher. Malachowski (1996, p. 91) wrote: “It is as if two separate but related conversations are occurring concurrently; one pertaining to the research project itself, and one about the student’s life and personal development.” Balancing these two roles cannot be prescribed through guidelines and rules, but need to emerge from experience and reflection on experience using the four lenses for reflection described by Brookfield (1995). Furthermore, the notions of partnership and dialogue challenge common power relations and practices in higher education, such as those underpinning the traditional lecture. It is therefore important for novice UR mentors to engage in critical reflection to better understand their role and to be able to challenge power relations and common educational practices (Brookfield, 1995).

The three entry points offer academic developers a specific focus, specific questions to be addressed, when helping novice UR mentors to reflect on their own role. To further facilitate the reflective process, academic developers should provide a possibility for mentors to reflect on the three questions together with other mentors (the peer lens), provide relevant literature on mentoring (the scholarship lens), and encourage mentors to discuss their own and the students’ role with the students (the student lens).

Conclusions

The novice UR mentors in this study used three entry points to reflect on and define their own role: (1) What are the goals of UR? (2) What do the students expect from me? and (3) How should I use my expert knowledge? These entry points can be used as a starting point to stimulate reflection on the mentoring role in future UR mentor training and development. However, as the novice UR mentors’ reflections were limited to their own past experiences, and often lacked a more critical component, we argue that future

academic identity development for UR mentors should emphasize the use of three additional lenses for reflection: the peer lens, the scholarship lens, and the student lens. Juxtaposing reflections using these three lenses with reflections on past experiences may help novice mentors to better define their role and engage in meaningful partnerships with the students.

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References

- Ahn, B., & Cox, M. F. (2016). Knowledge, Skills, and Attributes of Graduate Student and Postdoctoral Mentors in Undergraduate Research Settings. *Journal of Engineering Education*, 105(4), 605–629.
- Auchincloss, L. C., Laursen, S. L., Branchaw, J. L., Eagan, K., Graham, M., Hanauer, D. I., ... Dolan, E. L. (2014). Assessment of course-based undergraduate research experiences: a meeting report. *CBE Life Sciences Education*, 13(1), 29–40.
- Barab, S. A., & Duffy, T. M. (2000). From Practice Fields to Communities of Practice. In D. Jonassen & S. Land (Eds.), *Theoretical Foundations of Learning Environments* (pp. 25–55). Mahwah, NJ: Erlbaum.
- Beauchamp, C., & Thomas, L. (2009). Understanding teacher identity: an overview of issues in the literature and implications for teacher education. *Cambridge Journal of Education*, 39(2), 175–189.
- Behar - Horenstein, L. S., Roberts, K. W., & Dix, A. C. (2010). Mentoring Undergraduate Researchers: An Exploratory Study of Students' and Professors' Perceptions. *Mentoring & Tutoring: Partnership in Learning*, 18(3), 269–291.
- Brew, A. (2001). Conceptions of Research: A phenomenographic study. *Studies in Higher Education*, 26(3), 271–285.
- Brew, A. (2003). Teaching and Research: New relationships and their implications for inquiry-based teaching and learning in higher education. *Higher Education Research & Development*, 22(1), 3–18.
- Brew, A. (2013). Understanding the scope of undergraduate research: A framework for curricular and pedagogical decision-making. *Higher Education*, 66(5), 603–618.
- Brookfield, S. (1995). *Becoming a Critically Reflective Teacher*. San Francisco, CA: Jossey-Bass.

- Brush, E., Cox, M., Harris, A., & Torda, L. (2010). Undergraduate Research as Faculty Development. *CUR Quarterly*, 31(1), 11–15.
- Corwin, L. A., Graham, M. J., & Dolan, E. L. (2015). Modeling course-based undergraduate research experiences: An agenda for future research and evaluation. *CBE Life Sciences Education*, 14(1), 1–13.
- Desai, K. V., Gatson, S. N., Stiles, T. W., Stewart, R. H., Laine, G. a, & Quick, C. M. (2008). Integrating research and education at research-extensive universities with research-intensive communities. *AJP: Advances in Physiology Education*, 32(2), 136–141.
- Dolan, E., & Johnson, D. (2009). Toward a holistic view of undergraduate research experiences: An exploratory study of impact on graduate/postdoctoral mentors. *Journal of Science Education and Technology*, 18(6), 487–500.
- Gonzalez, C. (2001). Undergraduate research, graduate mentoring, and the university's mission. *Science (New York, N.Y.)*, 293(5535), 1624–1626.
- Harrison, M., Dunbar, D., Ratmansky, L., Boyd, K., & Lopatto, D. (2011). Classroom-Based Science Research at the Introductory Level: Changes in Career Choices and Attitude. *Cell Biology Education*, 10(3), 279–286.
- Healey, M., Flint, A., & Harrington, K. (2014). Engagement through partnership : students as partners in learning and teaching in higher education. *The Higher Education Academy Report*, (July), 1–76.
- Healey, M., O'Connor, K. M., & Broadfoot, P. (2010). Reflections on engaging students in the process of learning teaching and assessment: an institutional case study. *International Journal for Academic Developers*, 15(1), 19–32.
- Hunter, A.-B., Laursen, S. L., & Seymour, E. (2007). Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Science Education*, 91(1), 36–74.
- Jensen, K., & Bennett, L. (2016). Enhancing teaching and learning through dialogue : a student and staff partnership model. *International Journal for Academic Development*, 21(1), 41–53.
- John, J., & Creighton, J. (2013). "In practice it doesn't always work out like that." Undergraduate experiences in a research community of practice. *Journal of Further and Higher Education*, 37(6), 750–768.
- Kuh, G. D. (2008). *High-Impact Educational Practices*. Washington, DC: Association of American Colleges and Universities.
- Lee, A. (2008). How are doctoral students supervised? Concepts of doctoral research supervision. *Studies in Higher Education*, 33(3), 267–281.
- Lee, V. S. (2012). What is inquiry-guided learning? *New Directions for Teaching and Learning*, 2012(129), 5–14.
- Linn, M. C., Palmer, E., Baranger, A., Gerard, E., & Stone, E. (2015). Undergraduate research experiences: Impacts and opportunities. *Science*, 347(6222), 1–6.
- Lopatto, D. (2003). The Essential Features of Undergraduate Research. *Council on Undergraduate Research Quarterly*, (March), 139–142.
- Lopatto, D. (2009). *Science in Solution: The impact of undergraduate research on student learning*. Tucson, AZ: Research Corporation for Science Advancement.
- Malachowski, M. (1996). The mentoring role in undergraduate research projects. *Council on Undergraduate Research Quarterly*, 12, 91–94.
- Marquis, E., Puri, V., Wan, S., Ahmad, A., Goff, L., Knorr, K., ... Woo, J. (2016). Navigating the threshold of student–staff partnerships: a case study from an Ontario teaching and learning institute. *International Journal for Academic Development*, 21(1), 4–15.
- Merriam, S. B. (2009). *Qualitative Research: A Guide to Design and Implementation*. San Francisco, CA: Jossey-Bass.
- Palmer, R. J., Hunt, A. N., Neal, M., & Wuetherick, B. (2015). Mentoring, Undergraduate Research,

- and Identity Development: A Conceptual Review and Research Agenda. *Mentoring & Tutoring: Partnership in Learning*, 1267(April 2016), 1–16.
- Prince, M., & Felder, R. (2006). Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases. *Journal of Engineering Education*, 95(2), 123–138.
- Schön, D. A. (1983). *The Reflective Practitioner: How Professionals Think In Action*. London, UK: Temple Smith.
- Shor, I., & Freire, P. (1987). What is the “dialogical method” of teaching? *Journal of Education*, 169(3), 11–31.
- Smith, R. A. (2001). Formative Evaluation and the Scholarship of Teaching and Learning. *New Directions for Teaching and Learning*, 2001(88), 51–62.
- Thiry, H., & Laursen, S. L. (2011). The Role of Student-Advisor Interactions in Apprenticing Undergraduate Researchers into a Scientific Community of Practice. *Journal of Science Education and Technology*, 20(6), 771–784.
- Thomas, D. R. (2006). A General Inductive Approach for Analyzing Qualitative Evaluation Data. *American Journal of Evaluation*, 27(2), 237–246.
- Wallin, P., Adawi, T., & Gold, J. (2017). Linking teaching and research in an undergraduate course and exploring student learning experiences. *European Journal of Engineering Education*, 42(1), 58–74.
- Zachary, L. J. (2002). The role of teacher as mentor. *New Directions for Adult and Continuing Education*, (93), 27–38.