



Paper: Using Qualitative Techniques to Understand the Types of Undergraduate Research Mentorship

Karina Sylvia Sobieraj, The Ohio State University

I am a fourth-year biological engineering student pursuing a minor in biomedical engineering. I am active in many clubs on campus including Make a Wish and the Society of Women Engineers and I am also an undergraduate researcher for an engineering education research group.

Dr. Rachel Louis Kajfez, The Ohio State University

Dr. Rachel Louis Kajfez is an Assistant Professor in the Department of Engineering Education at The Ohio State University. She earned her B.S. and M.S. degrees in Civil Engineering from Ohio State and earned her Ph.D. in Engineering Education from Virginia Tech. Her research interests focus on the intersection between motivation and identity of undergraduate and graduate students, first-year engineering programs, mixed methods research, and innovative approaches to teaching.

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Introduction

Mentoring is a form of teaching and learning that can be optimized to further enhance the quality of education. A greater understanding of the benefits of mentoring could help create more mentorship programs or assist in the enhancement of existing programs. To gain a greater understanding of mentoring, a subset of interviews from the SPRITE (Student Perspective on Research Identity and Transformation of Epistemology) project, a larger research project about undergraduate students' experience in research, were analyzed and coded in relation to the topic of mentoring. The larger project focused on the identities and epistemologies of undergraduate researchers, but various data collection measures, allowed for information regarding mentorship in undergraduate research to also be collected. By reviewing the mentorship information collected in the large study, we were able to develop a deeper understanding of three pillars of mentorship, including individual mentoring, peer mentoring, and faculty/PI (principal investigator) mentoring which is the focus of this paper.

Conducting undergraduate research is one way undergraduates obtain a mentor in higher education. The time spent working on a research project creates a personal and professional connection within the research group, due to the student's reliance on the expertise from another individual [1]. Therefore, becoming a student researcher inherently involves mentorship. This experience can vary from individual to individual, as some students receive mentorship from one person or multiple individuals. There's also a great breadth of quality related to mentorship in the research setting. Our research considers the type of mentorship experienced during the research experience to determine its effect on a student.

Literature Review

The connection that a student has with his or her research mentor is often different than the connection between a student and their classroom professor or teaching assistant. Mentorship works in a way that combines the knowledge and capabilities of two or more individuals. Through mentorship, students may learn concepts and skills beyond those taught in traditional classroom environments [2]. Therefore, the foundation of our research study was chosen to be based on this concept.

Undergraduate research experiences tend to be selective and limited [3]. That said, there are many beneficial outcomes. Undergraduate researchers acquire many skills, techniques, and understanding of the research process that they would not normally encounter [4]. Not only can an undergraduate research experience (URE) benefit an undergraduate student related to knowledge acquisition, it can also provide a mentor at an early stage in a student's academic journey. Therefore, our study seeks to define the types of mentors and mentorship experiences available to students through UREs.

Effective mentorship requires an understanding of how to be an effective role model. The key to a successful mentoring experience is a mutual understanding of the expectations of both the

mentor and the mentee. This collective agreement assures the equal contribution of both parties. Equal amount of effort results in positive outcomes for both the student and the mentor [5]. This type of relationship does not happen by chance, and it takes “deliberate action” from both the supervisor and the student [6]. Nevertheless, before a mentor can beneficially take part in a mentoring experience, he or she should be educated on how to properly mentor a student. This topic was discussed by Rachelle Hollander, who signified the importance of faculty education of mentoring skills and practices [7]. There has been a significant mention in literature of good traits and qualities that a mentor should have to be successful, but there is a gap in literature in regard to the expectations, needs, and desires a mentee has for their mentor. Our study leads to a better understanding of what these expectations or necessities are by analyzing past student research experiences with a variety of mentor figures.

Some students may also be unaware of the benefits of having a mentor. To assist students in experiencing mentoring many universities have developed mentoring programs which tend to focus on students mentoring other students [5]. Some of the student benefits of such mentoring programs include an increase in confidence, learning, and motivation [8]. Providing a way for students to receive these benefits is often the priority of these designed programs. Mentor programs such as the one present at University of Colorado, Boulder details a mentorship program created specifically for college students to receive guidance from graduate student mentors [5]. Although there are many benefits to the programs, there are also setbacks such as an absence of mentor availability as well as the disinterest of students admitting they need help [9]. Important scholarship has proven that mentorship programs are ultimately beneficial to undergraduate students, yet the absence of knowledge of these programs makes undergraduate students less aware and therefore, less invested in mentorship. Our study is intended to analyze specific URE mentorship models to solidify student’s perspectives on mentors, which could further be used to help strengthen current programs and raise awareness for the creation and necessity of these programs in all undergraduate curricula.

A mentorship presence can push students to have greater interest in their education and research. A personal bond with an individual motivates them to become involved in what the other individual is pursuing. It was shown in a study that student participation in a research lab was greater when there was a mentor present in the lab as opposed their absence in the research lab [10]. Studies have also shown an increase in leadership and courage due to the presence of mentor-mentee relationships [11]. This shows a correlation between research participation and mentorship. Although many studies have shown what a mentor can provide to a mentee, there is a lack of understanding of how various types of mentors vary in their impact to a mentee, which is sought out in this research study.

Methods

For this project, 8 interviews were selected from a set of 24 available interviews to analyze the chosen topic of mentorship more specifically amongst a manageable size of interviews. The full set of interviews was from the SPRITE, Student Perspectives on Research Identity and Transformation of Epistemologies, research project. The goal of SPRITE, a 5 yearlong study, is to better understand undergraduate researchers’ identity and epistemic thinking development through research experiences. For the larger project, 24 interviews were conducted (20 with

undergraduates and 4 with graduate students). The interviews were conducted over the timeframe of two consecutive academic years. Each interviewee was chosen from an initial phase one survey, which lead to a semi-structured interview in the second phase of the project [12]. From the larger dataset, 8 interviews were chosen from the undergraduate portion of interviews. Those participants' genders and institutions are noted in Table 1. Four male participants were chosen with mentorship experience. Since there were more potential female participants, a different approach was taken in choosing the final four participants. First, the female participants were grouped in terms of institution and interview year (there were two years of interviews for the larger project with interviewees studying at 6 different institutions that were numbered 1 through 6 to make identification easier). The female participants were selected to ensure they were from the same interview year of 2017 (this ensured they were all interviewed with the same protocol) and a variety of institutions as seen in Table 1. The candidates were chosen from the first year interviews due to a greater breath of participating institutions.

Table 1

Participant Number	Participant	Gender	University
1	Logan	M	5
2	Peyton	M	2
3	Dana	M	1
4	Pat	M	1
5	Ari	F	3
6	Kelly	F	2
7	Riley	F	1
8	Sage	F	1

Following the selection of interviews, each interview was qualitatively analyzed to find all information related to mentorship. This approach was similar to that of the larger project, but in a simpler format [13]. Although the interviews were not geared toward the specific information sought out by this research study, the interviews still contained a substantial amount of information related to this topic. Dedoose, an online coding platform, was used to apply codes to the selected transcripts. A broad code titled “mentoring” was applied to each interview, the coded sections were then individually analyzed, to detect important information. This analysis lead to the creation of a codebook of key terms related to mentoring, which is located in the appendix. A few codes from this book are specifically mentioned in this research study analysis, but the entire codebook was included to show the detailed analysis that each interview underwent. A descriptive definition was applied to each code to signify the overall meaning of it. The interviews were coded once again with the new codebook. The interviews were analyzed again and specific codes (codes that incorporated more detail) were then create and applied to the interviews. An excel spreadsheet was made to showcase the key factors that were important to each individual interview. An example of this excel document can be seen in Table 2.

Table 2

Participant	Positive Mentorship	Negative Mentorship	Independent/Group	Future Participant Endeavors	Benefits
Logan	Yes- Logan had a professor who was present throughout his research experience as well as group members who were always willing to help and contribute to his needs.	N/A	Logan worked both in a group setting and in an individual setting. When he was in the group setting, he had more interaction with other students and seemed to enjoy his experience more.	Logan wants to work at a university and help mentor freshman. His future was based off the research he has done in college. Logan is moving onto grad school and has just received a fellowship.	Logan shows that he has true knowledge about the things he has learned throughout this research and he shows desire to want to spread that knowledge to other people.

A word document was created as a tool used for interpreting the written information in the excel document. This document included brief and concise statements that made connections between participants and elaborated on the findings within the excel document.

Furthermore, a graphic (a Venn diagram) was created for each interviewee to segregate the three sections of mentoring. These sections included individual mentoring, peer/group mentoring, and faculty/PI mentoring. Key aspects from each interview were categorized into each specified section to showcase the various mentoring experiences of each participant. With the use of the concept map, a document was created that expanded upon the connections that were seen between the interviews. Final thoughts about the research question were put together with the use of the created documents.

Throughout the research project, there were various limitations that became present. First, it was difficult to showcase each participant's feelings and experiences in relation to mentoring based on the initial reasoning behind the interviews. These interviews were created to showcase researcher identity and epistemology, making it difficult to analyze the effects of mentoring on a researcher. Furthermore, analyzing more than 8 interviews could have led to a more solidified conclusion to the research question, but a smaller sample allowed for a closer understanding of the researcher experiences.

Results and Discussion

The results from the analysis have shown various interesting notions about mentoring and what it provides to a student. Each research experience is different, and therefore, each mentoring experience differs as well. Nonetheless, mentorship provides both the mentor and mentee with the opportunity to gain knowledge from one another.

Mentoring is a foundational aspect of research, that directly affects the participant's overall thoughts on research. After the interview analysis, themes and conclusions were drawn from the data. The positive aspects related to mentorship within the interviews were mainly observed, due to less consecutive information being found about the negative aspects of mentorship. Three general mentor types were found to be present throughout the analyzed research experiences. These were found to be the researcher himself or herself (the participant), the research team or any group that is part of the research lab, and the person that is in charge of the research. Four specific mentorship experiences were pinpointed within the analyzed interviews, that consisted of a combination of these mentor figures.

No Mentorship

The first mentorship possibility is one in which the student does not receive any mentorship at all. This was due to a lack of a mentors figure in the URE or the researcher not needing a mentor due to the capability of doing the research without anyone's help. Furthermore, it is possible for a student to have a mentor and then not need one once all the necessary skills and information are gained that are necessary within the research experience. At this point, he or she has the capability to take on the role of a mentor for another student. This specific situation can be exemplified by participant 1, who became a mentor by learning all that was needed from the consult of their previous mentor. Participant 1 stated,

“When I started it was one of the grad students actually started the same day that I did. We were learning on our own and asking our professor a lot of questions. Now, undergrad students come to me because I'm one of the older people in the group now.”

This shows that a mentorship experience provides the qualities that a student needs to become a mentor themselves. When a mentor is absent from a student's research experience the student lacks guidance and support which negatively impacts the student. The student only has their prior knowledge and experiences to fall back on. Participant 4 lacked a mentor and therefore, exemplifies this type of research experience. The participant made it clear that many professors do not have the time to mentor students properly, yet they are necessary for completion of a research project. Pat (participant 4) states that,

” The ones that do want to do that already have six, seven projects going on. They're just the ones that are focusing on their own research and there are ones that are focusing so much on helping students grow but they're too busy to accept more work which makes sense. That's always been the biggest struggle is finding that professor.”

Therefore, the presence of a mentor is necessary to conduct a research project, especially when the student is seeking this type of help. The absence of a mentor negatively impacts the work of a researcher, solely based on their inexperience, yet the presence of a mentor can prepare a student to have the ability to conduct individual work eliminating the need for a mentor.

Professional Mentorship

Another general research experience involves solely a professor or principal investigator (PI). The participant mostly receives time and guidance from one individual and only a small fraction of peer mentoring or group collaboration. By limiting the mentorship experience to solely one person, the participant's views on research groups is compromised. The participant is lead to believe that only professors or principal investigators can be good mentors. This scenario blocks the student's perception of the knowledge a network of mentees can provide them. Participant 5 had a research experience that embodied this type of research experience. The participant worked one-on-one with the professor of their research group and was taught key aspects about the research project. When asked what her thoughts were on one-on-one learning she stated,

“I think it's important because if you are doing it for the first time then you won't be able to learn, or there will be a lot of things that you don't really know how to do, and that person can give you a lot of knowledge and teach you how things are done.”

When asked about potentially incorporating research in a classroom she states,

“When there is a lot of people, I don't think research can be done that well all in the same classroom.”

This shows that when a participant is not introduced to the various types of mentoring categories, it leads them to believe that they would not benefit from other mentorship experiences. On the other hand, being advised directly by a qualified individual such as a principal investigator, could benefit a student by providing them with direct knowledge about their research project that the other mentees may not have. This ties back to the information released from a study [1] that showed the values and guidance that professional mentors can convey to their mentees throughout a research experience.

Group Mentorship

The next specified mentorship experience was identified as receiving mentorship from a group of mentees within the research group. Due to the absence of a PI or professor in the research experience, this figure can be replaced by a peer or a group of students in the research lab. Once a student lacks this figure in the research lab, they feel intimidation and separation from this type of mentor. Comfort and relation is found within the group of researchers that are in the same situation as them. Not only can a professor or PI be absent from the research project, they can also act in a way that pushes the student towards the comfort of the environment created by peers in the research lab. This scenario was found present in the research experience of participant 6. The participant's professor was not present throughout her experience in the research lab, which caused her to have trouble during the research experience as she stated,

“In retrospect, also, no one actually taught me that. I think my advisor just assumed that I would be familiar with that stuff from before. But it wasn't in any of the literature reviews or anything like that. I don't know.”

The participant lacked group/peer mentorship at the beginning of her experience, but received this guidance at the end. The participant felt comfort in seeking help from her research team members as she explained the following,

“It's a little intimidating when you don't know something to have to go to the advisor who, like, for sure knows the answer at least, like, whatever. Now there's a PhD student in my lab, on my project, so I felt much more comfortable asking him questions first before I brought it up to [my advisor].”

Less stress is involved in asking peers a question rather than asking an older member of the research team. Having two different mediums to receiving knowledge or guidance gives the participant a greater opportunity to have a successful research experience. When a researcher lacks a certain mentoring figure, it makes his or her research experience more challenging, and ultimately not as beneficial. This drives the student to the realization that success in research should not have an individual connotation to it, yet success relies on collaboration and teamwork.

Group and Professional Mentorship

The final identified experience represents the mentorship of both an advisor and a group of peer mentees. The combination of the two mentorship opportunities gives the student an equal amount of group collaboration and teamwork along with guidance from an experienced individual. This environment is the most beneficial when it comes to the ideal research experience. This was shown from the participant interview analysis along with literature regarding outcomes of mentorship programs [5]. The student has a glimpse of what it is like to work with an older,

knowledgeable individual as well as other people that can provide their input. The participant does individual work, yet still has other options when needing to reach out to for help. This experience is the most fulfilling. It structures the student in ways that the other three scenarios may not be capable of. This serves as the greatest body of knowledge and therefore benefits the overall research experience. Many of the participants had undergone this type of research experience. For example, participant 7 worked directly with a PI and a professor on the research project and could also consult peers to receive feedback on their work. Individuals in the research lab that were not a part of her research project were also available for help. Participant 8 outlined a similar experience when she stated,

“It's also helpful that I'm working kind of underneath a PhD student so I ask her, ‘These are the results that I've been getting. What direction do you think I should head in? Is there something I should add? Something I should not do? What will be most helpful for your results?’ That kind of thing. Our PI is also very present. He's in lab every day and always walking around asking if you know what you're doing and that kind of thing.”

This aspect of her research project allowed for several mediums to which she could seek help and guidance from. The participant had a positive outlook on the research experience based on these circumstances. This concludes that a well-rounded mentoring experience can impact a research experience in a positive way and introduce a greater amount of knowledge to the student. Multiple research experiences entail multiple mentorship experiences that come along with it. The different experiences add more depth to a student's overall research experience. Whether the participant decides to choose a career within research or decides to become a mentor himself or herself is all affected by the way the participant was mentored at the start and throughout their entire research experience

Conclusion

Mentorship plays a significant role in URE's, especially because it can take on a variety of forms. Specific research about the types of mentorship an undergraduate researcher can encounter is not present in many studies that have been conducted in relation to this topic. Our study intends to fill this gap in research to further provide evidence for the benefits of research and the necessity of continuing to study mentorship in order to better structure mentorship programs.

This study on mentorship found that a mentor could be a peer, a faculty member or a PI, or even a group of individuals in a research lab. By analyzing interviews of undergraduate researcher experiences, it was determined how each type of mentor can impact a student's research experience. Overall, it was determined that having a mentor positively impacted the URE. The lack of a mentor in a URE negatively affected the student, or meant that the student had the knowledge and skills to conduct research without the guidance of another person. Ultimately the type of mentor that is most beneficial, depends on the student himself or herself and the needs

that they possess within the realm of each specific research experience. No two research experiences are the same, therefore it is important for there to be a strong mentor-mentee relationship, in order to accurately relay expectations and desires amongst one another. Ultimately having the option of more than one mentor in a research setting showed to have the most positive URE outcomes. Having more than one option to seek help and clarification gives the researcher flexibility in determining which route is best suited for his or her needs.

Looking further into this topic, there is still much to discover about how various mentors can affect a research experience. Understanding mentoring as a whole is critical for the future due to its profound influence on the student research experience. By understanding the concept of mentorship, and that it comes in various forms, is a key step in making sure that mentoring is implemented into undergraduate curricula effectively. Mentorship programs can rely on this base structure to give students the options and resources to find a mentor that is best suited for their academic and research needs.

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Appendix

Codebook

Code Name	Definition	Example
Absence of Mentorship	Lack of guidance by a research team member of any sector of the hierarchy	“We totally just researched the crap out of that thing. You don't always see it getting into it and you really need to have that kind of mentorship and I didn't have the mentorship. I had mentorship from an entrepreneurial perspective, that kind of thing, but not really in an engineering setting.” (Pat)
Adult Mentorship	The participant receives mentorship from an older, more knowledgeable person who has expertise in the field of research that the participant is working in.	“It's also helpful that I'm working kind of underneath a PhD student so I ask her, "These are the results that I've been getting. What direction do you think I should head in? Is there something I should add? Something I should not do? What will be most helpful for your results?" That kind of thing. Our PI is also very present. He's in lab every day and always walking around asking if you know what you're doing and that kind of thing.” (Sage)

<p>Bad Experience</p>	<p>The participant mentions a bad experience in the realm of mentoring.</p>	<p>“I guess ... Well, it would probably be this semester. I spent most of the summer that I worked with them just being like, I don't know what's going on. Or just feeling constantly behind because my advisor can be pretty critical too. There's a lot of times where you don't necessarily feel built up or whatever.”</p>
<p>Career/Future</p>	<p>The participant mentions their future aspirations and why he or she chose to go down that path.</p>	<p>“In my eyes, my future that I want to have is to do research but also to teach incoming undergraduate students. Students who are in their freshman year, coming from high school.” (Logan)</p>
<p>Environment</p>	<p>The research space or the feel/atmosphere of the research group.</p>	<p>“But, before that I would do analysis with people. I would be in those spaces where we were working together. For the most part, I mean, I work better alone, quiet, secluded in these headphones and things, but, when I wasn't wearing those I was interacting, helping them with their research questions. Asking for help with my research questions and stuff like that.” (Logan)</p>

<p>Excessive Mentorship</p>	<p>A mentor who puts too much effort into advising his or her mentees. The student lacks the capability to do little to any work.</p>	<p>“I can’t think of a time that I haven’t felt like a researcher except like a few points during my [international summer research experience], my postdoc didn’t like give me like full trust on my research project I felt like ... And so at that point I just was like..., I felt like a researcher, but also, I just felt like I was doing exactly what she told me, and I wasn’t like getting to come up with my own things.” (Riley)</p>
<p>Feeling</p>	<p>The mood that the participant is in while doing research or in the research environment.</p>	<p>“To see her see something in the project and figure it out on her own, like I just learned something and it makes sense and this is valuable towards the project, that is awesome to see. I wish everybody could have that kind of experience. To be able to mentor that team to that point, I didn't think that was going to happen honestly, that that's cool.” (Pat)</p>
<p>Hierarchy</p>	<p>The establishment of a research group based on seniority or experience.</p>	<p>“It's also helpful that I'm working kind of underneath a PhD student so I ask her, "These are the results that I've been getting. What direction do you think I should head in? Is there something I should add? Something I should not do? What will be most helpful for your results?"” (Sage)</p>

<p>Mentoring</p>	<p>Guidance and outside knowledge from another individual.</p>	<p>“I get to make a lot of my own. I really make choices on everything. It's sometimes I'll be led down a path, though. Like for example one of my old studies I had pre and post data and I needed to do comparative analysis. My professor gave me all these different ideas of ways I could go and I had to go through the literature and find out what might be best.” (Logan)</p>
<p>Mentoring Benefits</p>	<p>The impacts of adult or peer mentoring on a student.</p>	<p>“I think it's important because if you are doing it for the first time then you won't be able to learn, or there will be a lot of things that you don't really know how to do, and that person can give you a lot of knowledge and teach you how things are done” (Ari)</p>
<p>Mentorship Disadvantage</p>	<p>The negative impacts of adult or peer mentoring on a student.</p>	<p>“I guess ... Well, it would probably be this semester. I spent most of the summer that I worked with them just being like, I don't know what's going on. Or just feeling constantly behind because my advisor can be pretty critical too. There's a lot of times where you don't necessarily feel built up or whatever.” (Kelly)</p>

<p>Negative Mentorship</p>	<p>A relationship between a student and his or her superior that has impacted student in an unfavorable way. The participant expresses unfavorable details about his or her experience with conducting research with a professor or a teacher. The participant expresses that having a mentor specifically has had a negative effect on his or her research experience. The researcher mentions the insufficiency fulfilled by the mentor.</p>	<p>“She was not planning to have an undergraduate student come work under her, so she just like wasn’t very thrilled about it at the beginning, and I was just doing all of the like really meaningless chores. Um... so at that point it was like, I’m in a lab, but I’m not really doing research” (Riley)</p>
<p>Positive Mentorship</p>	<p>A relationship between a student and his or her superior that has impacted the student in a beneficial way. The participant expresses affirmative details about their experience with a professor or a teacher.</p>	<p>“So I had a really long talk with my professor, my PI, and he basically helped me figure out what were my skillsets and what I could offer to the lab, and I did ask him if there were any biologically related, more medical wet lab kind of bench top work, and he said there were, but he wanted me to learn something new” (Peyton)</p>
<p>Role Model</p>	<p>The participant looks up to his or her mentor and tries to embody their qualities and work ethic.</p>	<p>“My advisor is super good at technical stuff. He’s just the most smart person ever.” (Kelly)</p>
<p>Student Mentorship</p>	<p>The participant himself or herself takes on the role of a mentor throughout his or her research process.</p>	<p>“They’re awesome. I really enjoy my current lab. Um I have like weekly meetings with my PI, can stop in more if I needed that. Um, the grad students in my lab are pretty good at being totally okay with me doing an independent project, but also, they’re fine with me like coming and asking them questions, or helping like if I need anything.” (Riley)</p>

