Session XXXX

What I Wish My PI Knew: Student Experiences in Undergraduate Research

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Introduction and Methods

In STEM education, educators and industry leaders alike emphasize hands-on laboratory research experience during undergraduate education as a way for students to gain skills as technicians and researchers[1,2]. Undergraduate research promotes retention in STEM fields and serves as a pathway to graduate school and science careers[2,3]. For some undergraduate students, however, the process of engaging in research can be chaotic, confusing, and discouraging, which limits the value of their experiences [2]. However, positive undergraduate research experiences can be a key to student growth and success. Effective mentorship and guidance can impact outcomes of undergraduate student research projects and experiences[1]. Despite the relatively uncontested importance of undergraduate research experience on engineering student success, little discussion has focused on how to integrate students into unfamiliar research settings. To shed light on effective mentorship practices, we report cases based on the experiences of the first three authors, who participated in undergraduate research and share insights from the fourth author, who directs an undergraduate research program. We share characteristics of mentorship that maximize student success.

Results and Discussion

Case 1. MWF worked in a laboratory that focused on nanoparticle synthesis for medical applications. She learned basic laboratory skills (e.g., pipetting, measuring). The graduate student mentor walked her through each step of his process and she became experienced at following directions, but did not know how to direct her own process. MWF next joined a lab focused on microfluidic fabrication, where she “did not suffer too much hand-holding,” received only rudimentary training, and when she had difficulties, there was no one to ask. “I grew a lot from this experience. But I wasted my time trying to reinvent the wheel.” The third graduate student MWF worked with demonstrated a method, asked MWF questions about the method and then allowed to her try it with the understanding that she would have questions. MWF made decisions with increasingly less oversight, resulting in eventual independence.

Case 2. The first laboratory CF entered focused on clean-room thin-films. While the graduate student he worked with explained the process, the equipment she used was too expensive and delicate for him to use, "It was never something I could contribute to in a meaningful way" and provided no hands-on opportunities. The second laboratory CF worked in focused on nanoparticle characterization. Here he taught his mentor a method, and this was eye-opening for him, "seeing a grad student having the same uncertainty I had but working through it and finding success is probably more valuable than I realized." CF then worked in a molecular logic lab, where he went from being the support to being the leader of his own project. He felt adrift, "I didn't know how to evaluate success, failure, and progress." This led him to doing busy work: "I didn't get a lot done, but I focused on looking like I was getting a lot done" like running simple experiments.

Case 3. BF started in a synthetic chemistry laboratory where the grad student he worked with helped him talk concepts over and think things through. "I slowly started doing larger and larger pieces by myself" until he was doing the entire process. However, high-stakes meetings made him less committed to progress. In his next research experience, focused on antibody purification, his mentor got BF working quickly and made him feel useful. BF then worked directly with the PI on instrumentation. He had little background in the area, "I don't know what forward progress looked like, and I don't have the ability to fix problems I run into," slowing down the work and making it less meaningful as an experience.

These cases highlight the importance of opportunities to develop not only basic skills, but also understanding, such that students learn to direct their own work. Mentors should allow students to see their uncertainty and provide support responsively but gradually transfer responsibility to the student. This fosters a sense of ownership, competency and belonging that allows students to grow further as they enter new research experiences.

References

1. Byars-Winston, A.M., Branchaw, J., Pfund, C., Leverett, P., and Newton, J., 2015, —"Culturally diverse undergraduate researchers' academic outcomes and perceptions of their research mentoring relationships." International Journal of Science Education, Vol. 37, No. 15, pp. 2533-2554.
2. Carpi, A., Ronan, D. M., Falconer, H. M., & Lents, N. H., 2017, —"Cultivating minority scientists: Undergraduate research increases self‐efficacy and career ambitions for underrepresented students in STEM," Journal of Research in Science Teaching, Vol. 54, No. 2, pp. 169-194.
3. Willis, D., Krueger, P., Kendrick, A., 2013, —"The influence of a research experiences for undergraduates program on student perceptions and desire to attend graduate school," Journal of STEM Education. Vol. 14, No. 2, pp. 22-28.