AC 2010-989: FACTORS INFLUENCING STUDENT SUCCESS IN A SUMMER RESEARCH PROGRAM: FORMAL VERSUS INFORMAL RELATIONAL STRUCTURES

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Factors influencing Student Success in Summer Research Programs: Formal versus Informal Relational Structures

Abstract

This research examines the differential impact of formal versus informal relational structures in determining student outcomes in summer research programs. In an effort to generate student responses and feedback regarding the success of the summer 2008 DAACI program, undergraduate participants were individually interviewed during the second-to-last week of the program. The interviews lasted an average of 45 minutes and ranged from about 20 minutes to 1hr 15 minutes. Students were asked a series of questions about themselves and their reactions to the program. Such information is useful in determining successful research program designs, and can be applied to future summer research programs. Overall, the main factor in ensuring the student has a positive summer research experience is their relationship with their mentors. Those who had helpful, involved mentors or graduate student mentors had better experiences than those who did not. Although interactions with fellow students were important to them, the formal social events were not beneficial, and were frequently completely unattended. Students much preferred the informal interactions they engaged in throughout the summer, as well as the formal weekly meetings and Monday lunches. Some students had professors who also met with them weekly, and found that to be helpful. A small group of students met weekly for a study group, and also found this to be much more beneficial than the golf and movie outings. Implications for how this information can be used in designing future programs are discussed.

Introduction

Terenzini[1] writes, "Learning is maximized when it is situated in a real and meaningful context, when real problems are encountered and students are afforded opportunities for active engagement with those problems." One way to achieve these active engagements is via inquiry-based or research based-learning.[2] Rather than working individually or statically, students involved in research-based learning engage in dialogues about research or discovery with faculty mentors throughout their undergraduate academic careers, thereby having the opportunity for "accidental collisions of ideas."[3] These research experiences differ greatly from the most common form of undergraduate teaching today—lecture.[4] To allow students more opportunities to engage in research-based learning, organizations such as the NSF recommend that research deliberately be included within undergraduate education curricula.[5]

We define undergraduate research as "undergraduate engagement in authentic research conducted in intensive summer long program under the direct supervision of faculty researchers."[6] In addition to allowing students to explore new ideas, undergraduate research experiences benefit students in numerous ways. These experiences can have positive effects upon students' heightened interests in post-graduate science, technology, engineering, and mathematics (STEM) careers,[7] students' decisions to pursue graduate studies,[8] and students' persistence to graduation.[9] Kardash[10] found that both students and faculty mentors thought that students had increased their research skills during their undergraduate research experiences. One

key distinction within these programs that is often touted is the direct supervision of faculty researchers—students gain research experience by working in a format that closely resembles an apprenticeship. Under the tutelage of their mentors, they gain hands-on experience with conducting research. We examine the ways in which students experience this mentoring aspect of their research program. What types of relational encounters contribute to a more positive mentoring experience? Are there certain mentoring approaches that better elicit student growth?

Our research contributes to the engineering education literature by identifying which aspects of mentor interactions best contribute to students' quality of their experience within a research program. Specifically, we investigate the role of formal and informal relational structures between student and mentor, connect these to learning (or other) student-derived benefits from participating in the program, discover enjoyable aspects of the program, and identify areas of the program that might be improved. Within this paper, informal relational structures relate to activities that were planned outside of those mandated by the program, and formal relational structures are activities that were experienced by all students in the program and were designed by program administrators.

Methods

Participants

Participants in this study were eleven undergraduate engineering students selected for the summer 2008 Design, Application, Analysis, and Control of Interfaces (DAACI) Research Experiences for Undergraduates program. These students represented seven universities. Six were female, and four were members of underrepresented groups.

Data Collection

In an effort to generate student responses and feedback regarding the success of the summer 2008 DAACI program, undergraduate participants were individually interviewed during the second-to-last week of the program. The interviews were structured and conducted in-person. They lasted an average of 45 minutes and ranged from about 20 minutes to 1hr 15 minutes. Each student was solicited via email and eleven out of twelve agreed to be interviewed, for a response rate of 92%. Students were asked a series of questions about themselves and their reactions to the program, including:

- What are your career goals? Why?
- How confident do you feel that you will become a ------ ?
- Why did you decide to participate in this program?
- How do you feel about the program so far? What's good? What could be improved?
- Do you think this program is helping you reach your career goals? How?
- Do you think your research skills have evolved since the beginning of the summer? Why or why not?
- Now that you've completed this summer of research, what do you think are your strengths and weaknesses as a researcher?
- What advice would you give other students conducting undergraduate research?

Data Analysis

Audio from all the interviews were transcribed, omitting utterances, background noises, and pauses in conversation. Transcripts were then read and organized into coding categories using an emergent theme system.

Results

General Student Responses to Program

When asked to identify positive aspects of the research experience, students identified several elements (Table 1). Responses given by the most students related to community (i.e., among students and faculty) and beginning the process of research. All but two students felt their research skills evolved during the summer. Students felt they gained valuable skills such as knowing how to work independently, to design and carry out a research project, and to think critically. One of the two students who did not particularly like his research experience attributed this to spending the majority of his time doing literature reviews and background research for a project rather than spending time in the lab doing research.

Positive Aspects of the DAACI Program	Number of Responses
Feeling of community among students	3
Free lunch on Mondays	3
Learning what it's like to be a grad student	3
Doing the faculty interviews in the beginning	3
Opportunity to do research	3
Being given independence	3
Having a professor that is readily available	2
Being connected to the SURF program	2
Students treated professionally	2
Having a good grad student mentor	2
Getting paid	1

Table 1. Positive Aspects of the Program Identified by Students

Though students felt that they gained independence and critical thinking skills during their experience, they also identified these to be weaknesses at the end of the program. In essence, before the program they felt they had absolutely no ability to design an experiment, to think critically, to work independently, or to make decisions in the lab. After the summer, they still felt that they weren't very good at such things, since this summer was often the first opportunity to test these skills. Most felt confident that their skills would further improve with practice, however, and were grateful for the opportunity to exercise those skills over the summer.

Informal Relational Structures

The key to positive feelings about the program seemed to be based on personal experiences within the program, such as whether the student had a good experience with their mentors or felt they were treated professionally. Those who had the most positive comments also had good things to say about their mentor, and vice versa. One student said:

> *I really liked the first week, how we got to do faculty interviews and just talk to a professor one on one. Because as an undergrad, especially, you feel like professors kind of neglect you, so it was kind of cool that they would set aside time where the professors would talk to you. So, I like that part, and my graduate mentor has been really, really good as far as scheduling, and being there when I needed advisement and my graduate mentor and my professor we all have weekly meetings. And I understand that's kind of uncommon. So I really liked that about my particular professor, I guess, is, it was nice that we need every Friday at 10 a.m. task and stuff and he's usually there anyways. So I can pop in and ask questions so really like that aspect as well but that might be just with my professor. I don't know if other students have had similar experiences.*

Overall, students were pleased with the informal interactions they had with their mentors—both faculty and graduate students. All but two students had mainly positive things to say about their mentor relations. Complaints about interactions related mainly to the characteristics of the mentors themselves in the form of absenteeism and a lack of structure given by the faculty mentor. One self-professed lazy student purposely connected to a laid-back mentor because he did not "want someone who was tight on me all the time."

Formal Relational Structures

Regarding what students liked about the structure of the program, students enjoyed the scheduled lunches and meetings, the faculty interviews they conducted before selecting their project, the general opportunity to do research, having the program connected to SURF, and getting paid.

> *I think just the best part is being assigned to a graduate student because there you get to see what he does every day. At the beginning I was concerned that the professor wouldn't be around too much, I probably see my professor about once a week, so I wasn't really sure how I was going to get direction. But I think the graduate student is more important, because he's in the lab every day, and besides if you come here for graduate school, that's the way it's going to be. The professor's not going to be there every day helping you out so I kind of understand now it's kind of whatever direction I want to go. You have to sit down and figure out what I want to do and the professor is just there for guidance. So I think being assigned a graduate student really helped me understand exactly what grad school is going to be like.*

They felt these scheduled opportunities to interact with other students and with faculty and graduate student mentors helped them feel more integrated into the program, and gave them a sense of belonging. Many also felt that the program treated them like professionals, fostered independence, and gave them a good idea what grad school was like. Many students also hoped

that they would make contacts with professors that would continue to be beneficial as they progress in school, later leading to positive letters of recommendation for when they apply to graduate school or industry jobs. Though many students cited extrinsic reasons for participating in the program, like getting a line on their resume, students also citied intrinsic benefits such as seeing what it was like to be in grad school and do research. One student came specifically to work on a particular project listed on the webpage.

Formal aspects of the program that students identified to be important included the connection to good mentors and very early notification about their acceptance to the program. Students also were not very comfortable with ambiguity and not knowing almost every detail about their experience before arriving on campus.

Discussion

Our research indicates that a one-size fits all model should not be implemented for undergraduate research experiences. Just as there are a variety of student approaches to learning, there are student preferences for mentoring levels and for formal versus informal relational structures within their mentoring and research experiences. Some students are more proactive and others need more structure. If information about this level of comfort can be explored in some way prior to the experience, experiences might improve for both mentors and students.

Also, students must understand that research is a process that requires patience. Understanding this process before they begin their experiences might impact their perceptions of their experiences positively before they begin the program. Summer research programs need to provide students with such information early- perhaps in the form of a wiki, website, or listserv. One of these might even provide a space for students to ask questions prior to arriving on campus.

Pascarella and Terenzini[11] report that information interactions between students and individual faculty members can positively impact students' career choices. For this reason, informal interactions such as those within an undergraduate research program can be important for undergraduate engineering students. Research programs should convey this information to their mentors, and, if possible, only select mentors that will be around during the program. Mentoring from a distance is generally not perceived by the students to be beneficial.

Conclusion

Overall, the main factor in ensuring the student has a positive summer research experience seems to be their relationship with their mentors. Those who had helpful, involved mentors or graduate student mentors had better experiences than those who did not. Although interactions with fellow students were important to them, the formal social events did not go over well, and were frequently completely unattended. Students much preferred the informal interactions they engaged in throughout the summer, as well as the formal weekly meetings and Monday lunches. Some students had professors who also met with them weekly, and found that to be helpful. A small group of students met weekly for a study group, and also found this to be much more beneficial than the golf and movie outings. Students generally preferred a structured set of

activities in which they can interact with other students—planned lunches, organized outings, study groups, etc. However, when it comes to their mentors, students are more inclined to favor informal interactions. They thrive under mentors who reach out, talk to the students, engage with their learning, and take an active role in their research experience, rather than just mentor from afar.

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