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Perspectives and Researcher Experiences of Undergraduate Research

Introduction

Undergraduate research is an interesting educational phenomenon because it is a variation on one of the oldest educational techniques, apprenticeship. Only recently has undergraduate research gained recognition as a valuable teaching tool. Despite taking so long to become an accepted educational tool, undergraduate research has a long, rich history as an effective teaching method that instills in students the desire to learn new things (Drinker, 1912; Kinkead, 2012; Ravitch, 2000). Because aviation is a relatively new academic discipline without the long educational history of other, more traditional academic disciplines like the traditional sciences or liberal arts, it is not surprising that undergraduate research is not commonly utilized in aviation education. Where it is used in education, students seem to flourish.

This research uses Kinkead's (2003) definition of undergraduate research that defines it as a process which can "include scientific inquiry, creative activity, and scholarship . . . The key is that the project produces some original work" (p. 6). Using a semi-structured interview, this study aims to understand the experiences of aviation students who voluntarily participated in research during their undergraduate educational experience. The coded interview responses help us deconstruct and grasp the realities of the undergraduate researchers so that we may improve this aspect of their education.

Literature Review

History

Insight into their experiences can be gained by understanding the history of undergraduate research within higher education and the changes that brought it to the forefront as

an educational technique. Undergraduate research can be viewed as a form of apprenticeship, which is an educational technique that dates back as far as recorded human history (Kardash, 2000). Apprenticeships were common in non-academic education in the 19th century but also played a role in the training of professionals such as doctors and lawyers (Ravitch, 2000). These professions did not often engage in research outside a classroom setting. Independent scholarly undergraduate research was viewed as an unnecessary expense of time and resources as institutions aimed to make practitioners, rather than researchers (Drinker, 1912). This began to change in the mid-20th century with the creation of undergraduate research programs at prestigious institutions such as the Massachusetts Institute of Technology (Kinhead, 2012; Merkel, 2003). The concept of undergraduate research evolved to an acceptable academic practice, and in 1998, encouragement of undergraduate research was proposed by the Boyer Commission as a new gold standard in undergraduate educational practices.

The encouragement of undergraduate research, on a large scale, is a relatively new phenomenon, which can trace its growth to the Boyer Commission on Educating Undergraduates in the Research University report to the U. S. Department of Education in 1998. This report was an inflection point about which undergraduate education has begun to pivot and change from a model that has students spending long hours in lectures and moving toward a more hands on, research based system. The commission formed to provide guidance on correcting what they saw as a broken undergraduate university system. They argued that academia was becoming less elite, more common, and parents and students were unwilling to accept what it meant to attend the academy. They also argued that undergraduate students were disserved in academia because they saw that undergraduate students would spend their entire first year taking remedial or high school level “introductory” courses but not progressing in their chosen field. By the time these

students graduated, they would have the required coursework complete, but they “still lack[ed] a coherent body of knowledge or any inkling as to how one sort of information might relate to others. And all too often they graduate[d] without knowing how to think logically, write clearly, or speak coherently” (Boyer Commission, 1998, p. 6). This is the university system that the Boyer Commission sought to change. They recommended inquiry-based learning be adopted as the standard at research universities beginning at the freshman year. They also recommended that support be given to those students to help them grow under the guidance of a faculty member. These recommendations were fairly radical to academia, and it has taken some time for the academy to respond (Boyer Commission, 1998). There is a growing body of research, both qualitative and quantitative, about undergraduate research and how it can influence students’ success (Desai et al., 2008; Lopatto, 2003; Lopatto, 2004; Nagda, Gregerman, Jonides, von Hippel, & Lerner, 1998; Silva et al., 2004; Wood, 2003).

Quantitative Studies about Undergraduate Research

The quantitative researchers focused on two broad areas related to the benefits to students who participate in undergraduate research. First, their effort was focused on analyzing the demographics of students willing to participate in undergraduate research, and second, they demonstrated how their participation in scholarly activities impacts their academic achievement and outcomes. Undergraduate researchers appear to be a cross section of all college students demographically, with respect to race, gender, and socioeconomic background but not necessarily academic discipline (Desai et al., 2008; Lopatto, 2004). Some students are engaged in undergraduate research as part of a program to improve retention in historically underserved demographic groups or to improve retention of first and second year students in academia (Nagda, Gregerman, Jonides, von Hippel, & Lerner, 1998). Others participate through capstone

or research independent studies as part of their last year of training (Desai et al., 2008; Lopatto, 2003; Silva et al., 2004). It is difficult to draw any general conclusions about the type of students that participate in undergraduate research because the data provided are too varied. The conclusion seems to be that there is no rhyme or reason to the type of students that are involved but that all students are equally capable of conducting undergraduate research. With respect to academic performance, the literature is far less ambiguous.

Quantitative researchers have shown that undergraduate research is positively correlated to academic achievement (Lopatto, 2004; Wood, 2002). Undergraduate research can also be useful in assisting student career decision making. Participation in undergraduate research helped some students choose to continue their education to graduate school, while others turned away from their planned graduate school attendance (Lopatto, 2004; Russell, Hancock, & McCullough, 2007; Desai et al., 2008). The researchers in these studies found statistical significance, or at least hint at statistical significance, but rarely provided effect sizes, so there is no way to interpret the practical significance of some of their findings.

Qualitative Studies about Undergraduate Research

The body of qualitative research on undergraduate research is equally interesting because it suggests that student and faculty perceptions of undergraduate research are resoundingly positive, but the goals expressed by students and faculty for participation in the research are very different. Students use undergraduate research to learn the tools of the trade and engender themselves to their chosen industry, while faculty use undergraduate research to improve creative thinking and provide for monetary or curricular assistance to those who need it (Dolan & Johnson, 2010; Hunter, Laursen, & Seymour, 2007; Lee, 2012; Nagda, Gregerman, Jonides, von Hippel, & Lerner, 1998; Russell, Hancock, & McCullough, 2007). The fact that students

and faculty perceive the value of undergraduate research differently does not negate its use as a valuable pedagogical tool as long as both groups benefit from coordinated research efforts like those described by Desai et al. (2008).

Gaps in the Literature

The body of literature relating to undergraduate research is deficient in two broad categories. First, most of the studies conducted on undergraduate research focus on more traditional academic disciplines while ignoring more applied disciplines like aviation. Much of the existing body of research is focused on science, engineering, psychology, and education (Desai et al., 2008; Lopatto, 2004; Silva et al., 2004; Wood, 2002). Except for medicine, there is very little information about the use and role of undergraduate research in applied academic disciplines. This may be due to the perception that applied fields are not as academic as traditional fields. It could also be attributed to the idea that students in applied academic settings would not benefit from undergraduate research the way that students in traditional academic fields would. No matter the case, the fact that this area is underrepresented in the research is a gap addressed in this paper.

Most of the literature available on undergraduate research examines programs in which undergraduate researchers were compensated for their participation, whether it is monetarily or through course credit (Lopatto, 2004; Nagda, Gregerman, Jonides, von Hippel, & Lerner, 1998; Russell, Hancock, & McCullough, 2007; Silva et al., 2004), and this narrow focus represents the second gap in the body of research relating to undergraduate research. The experiences of those students who wish to participate in undergraduate research and cannot receive credit are missing from this body of literature, and this paper aims to begin satisfy that deficiency.

Conceptual and Theoretical Framework

Much of the theoretical framework for conducting research on undergraduate research experiences stems from the constructivist paradigm. This is, in part, due to the nature of original research, which, by its very nature, is constructed by the researcher. Specifically, one theoretical lens that explains the process of undergraduate research is cognitive apprenticeship, a constructivist concept rooted in situated cognition. According to Bates, Waynor, and Dolce (2012), Cognitive apprenticeships and situated cognition are situated learning theories that link knowing and doing. Basically, the theories are based on the notion that some skills are best learned when students actually perform the activities rather than just learn about them in a didactic classroom setting.

While studying the acquisition of different research skills among science undergraduate research participants, Kardash (2000) explained that apprenticeships can provide students in a field the opportunity to learn from experienced researchers in a safe environment in which the students can see how their work is helping the larger project. According to Kardash (2000), “Through these apprenticeships, novices learn not only how to perform the task, but also to think about the task in the same way as do experts in that domain” (p. 192).

This framework is appropriate to examine undergraduate research because of its underlying assumptions, namely the assumption that learning is constructed through experiences and needs to occur in a social environment. Undergraduate research is a process through which a student constructs their understanding of a topic with the guidance of a faculty mentor “who guides the novice researcher and initiates the student into the methods of a discipline,” (Kinhead, 2003, p. 6). In this way, undergraduate research is an epitome of this framework because the

only way to mentor-mentee relationship creates the social element while the act of conducting research gives them the hands-on experience necessary to improve their research abilities.

While undergraduate research fits well within situated cognition and cognitive apprenticeships, there is one important caveat to note. Cognitive apprenticeships are rooted in the concept of apprenticeship, which implies compensation for effort. Because the participants in the current study are all volunteers and not compensated with tangible rewards, it is reasonable to assume that there may be some inconsistencies between our population and those examined in previous cognitive apprenticeship inquiries.

Context of Undergraduate Research.

While the cognitive apprenticeships provide a conceptual or theoretical framework for this research, it is also important to establish the context in which undergraduate research activities take place within cognitive apprenticeships. First, an apprenticeship is a relationship between a person with more skill training another, less-skilled person, and cognitive apprenticeships that occur in undergraduate research settings are no different. In a university setting, many of these include the relationship between the faculty member and the undergraduate researcher (Dolan & Johnson, 2010).

A second factor to consider in the context of undergraduate research is the tendency for the participants to have generally positive perceptions of the research process and the effects of research on educational outcomes by undergraduate students (Hunter, Laursen, & Seymour, 2007; Russell, Hancock, & McCullough, 2007; Silva et al., 2004). A third concept that is helpful to understand the undergraduate research context is that of research being extracurricular. This research can be compensated or not, but the classroom environment seems to be too constraining

for students to produce truly original works as undergraduates (Drinker, 1912, Kinhead, 2003, Merkel, 2003).

These concepts provide a framework for understanding the experiences of undergraduate students who engage in extracurricular research. The relationship between the student and faculty member, the generally positive impressions of the activity, and the fact that most undergraduate research is extracurricular describe the context of the undergraduate researchers that were part of this project.

It is important to provide a note of caution when using the cognitive apprenticeships to facilitate student learning through undergraduate research. There must be adequate balance between the needs of the faculty-mentor and the student-mentee. The activity can yield benefit for both parties involved in undergraduate research, and caution must be employed to ensure both the mentor and the mentee realize value from the activity. These can be competing concepts if not managed properly. Merkel (2003) claimed that the focus of the research needs to be on the student's success and not the advancement of the faculty mentor's agenda, while Desai et al. (2008) claimed that a mutually beneficial working relationship can be established through communities of research between faculty, graduate students, and undergraduate students.

Research Questions

If properly managed, undergraduate research can be a means toward student success that more academic institutions could use to enhance undergraduate students' learning experiences. This research examines the perceptions and experiences of undergraduate aviation students who engaged in extracurricular research at the undergraduate level. Aside from the benefits described in the literature on undergraduate research and cognitive apprenticeships, we noticed the impact that undergraduate research activities had on students from different institutions. Our

observations of the apparent benefit of early academic research prompted the line of inquiry that shaped this research project. These conferences led us to wonder how those who had engaged in extracurricular research would describe their experiences and how those experiences would shape their education. The following three research questions guided this inquiry:

- 1) What are the experiences of undergraduate aviation students who engage in extracurricular research?
- 2) What is the perceived educational value in engaging in extracurricular research to undergraduate aviation students?
- 3) What support or hindrances from the university, the department, or faculty, are perceived by undergraduate aviation students engaging in extracurricular undergraduate research?

The research questions helped develop an understanding of the experiences of extracurricular, undergraduate researchers. Undergraduate research is not part of the curriculum in many aviation programs. Cognitive apprenticeships through undergraduate research activities have the potential to prepare future aviation professional more effectively than simply staying with a strictly didactic academic structure. Institutions falling under the Carnegie Classification of Research University (high research activity) should implement undergraduate research activities to better prepare their students for the expectations of their profession.

This research aims to understand the experience of undergraduate researchers within an aviation department to help develop undergraduate research activities that yield benefits for the students. If this research is successful, it could be used to help students succeed in their coursework and improve how connected students feel to their education. Further research could be conducted to see the effect of participation in extracurricular undergraduate research on student involvement and later employment or pursuit of graduate education.

Methodology

This phenomenological case study examined the shared experiences of a small group of students who engaged in extracurricular, undergraduate research (Creswell, 2013). Given the limited number of extracurricular, undergraduate researchers within the aviation department, only a small number of students were eligible for this project. All five students who previously participated in extracurricular, undergraduate research were contacted via email to request their participation in interviews that were part of our inquiry. The solicitation for participation clearly stated that participation in this study can have no effect on their grades in any course or practicum, their standing as students with the university, or their standing within the department. All reasonable efforts were made to ensure participants' confidentiality was maintained. The interviews, with the permission of the participants, were recorded, transcribed, and de-identified. The original audio files were kept securely on the researcher's computer with a separate password known only to the researcher, and all audio files and identified files were destroyed at the completion of the study.

The interviews were semi-structured so that there was room for follow-on questioning and improvisational lines of questioning as dictated by the conversation, but still followed a protocol found in the Appendix. While the potential population of this study was not large, these few students explained their experiences and added to the conversation surrounding undergraduate research. Citing Duke (1984), Creswell (2013) claimed that three to ten subjects are appropriate for studying a phenomenon like the experiences of our undergraduate students who participated in extracurricular research activities.

Delimitations

Interviews and focus groups are the standard tools for a phenomenological case study. Semi-structured interviews were conducted of all participants because the small participant pool and required confidentiality offered to the participants made focus groups unusable in this study (Creswell, 2013).

Threats and Solutions

A key to this research was ensuring that the participants' experiences were accurately portrayed, so respondent validation or member checking was utilized. This ensured that the research report accurately represents the voices of the participants and their experiences and perceptions of extracurricular undergraduate research.

To improve the trustworthiness of the data analysis, de-identified transcripts were coded independently by three separate researchers to produce an inter-coder reliability. De-identification of the transcripts helped ensure the confidentiality of the participants.

Lead researcher positionality.

The greatest threat to trustworthiness in this study was researcher bias. As the researchers, we cannot hide the fact that we were studying our own students and that we wanted them to be as successful as possible. We were as transparent as possible with this bias and with our positions with respect to the research, and we hope that the use of respondent validation will suffice to improve the trustworthiness of the study.

As the lead researcher, I had a bit of a unique perspective on this because two undergraduate students conduct independent research under my guidance. This was the impetus for this research; I wanted to see what the students thought of the experience and whether they

found it worthwhile in their education. Part of my evaluation of positionality was to examine if I was fair to those students and if I provided the best possible advice and mentorship.

All three evaluators had previous relationships with the researchers, but the interviewer was the only researcher to actually interact with the participants, which reduces the threats associated with the interview protocol and results. Having worked with the participants before, the researchers could easily decipher which respondents provided the responses. Although the previous relationships may be perceived as a threat to the validity of this research, the results of their interviews provide insight into the experiences of undergraduate aviation students who participate in extracurricular research activities.

Data Analysis

Coding of Interview Transcripts

The interview transcripts were de-identified and then coded using several coding strategies, as recommended by Maxwell (2005) and Creswell (2013). These included topical codes, established before the data analysis begins. These codes were based on the literature and on the research goals. These topical codes acted as guides for the basic categorization of data, but it could have caused some valuable information to be missed if they were used on their own. The rigor of the study benefitted from an open coding strategy as well. Open coding strategies are inductive in nature. Codes are not ascertained before data analysis begins, but rather during the process of data analysis. It is through open coding that new ideas can emerge from the data that were not foreseen.

Topical and open codes were further organized into hierarchies of common codes. These hierarchical codes provided the basic understanding of the themes which emerged from the various interviews. These themes were then traced through the different interviews to look for

commonality among the data. In this way, coding strategies are not simply deconstructive tools to find themes but also served as the foundation for comparing and connecting information across the different interviews.

Results and Discussion

The purpose of the study was to understand the experiences of aviation students who participated in undergraduate research. The three student respondents were all students in a collegiate aviation program. There were three research questions posed to understand the phenomenon of undergraduate research and focused in three areas including, student experience, perceived value, and support.

Student Experiences

Research question one asked, “What are the experiences of undergraduate aviation students who engage in extracurricular research?” The students reported having an overall positive experience with undergraduate research. One student stated that, “I am loving what I am researching and that makes all the difference in the world.” Another student commented regarding the research that, “It was very worthwhile. Even if we didn’t gain anything, it was very exciting.”

While all the students generally reported having positive experiences, they all brought up significant challenges. One significant challenge that was common among the participants was idea of time management. College students often have a full course load and extracurricular activities. Flight students typically have less time for extra activities due to the number of hours spent flight training. One of the students commented that it was difficult to find the time to work on research every week, “given the fact that I’m still in the flight program and trying to get ahead on flights and ground lessons.”

Another student stated,

I found it very difficult, at the end of the day, you know, when you’re running out of hours at the end of the day and there’s something to work on, I found it very difficult to say...I’m going to stay up and do this now instead of, you know, it’ll get done tomorrow or I’ll do it this weekend.

Another challenge that was mentioned by the students was in regards to the lack of knowledge on how to conduct research. The reasoning for this was either that they had just not had the exposure in their coursework, or that they had missed out on previous research opportunities before.

Educational Value

The second research question asked, “What is the perceived educational value in engaging in extracurricular research to undergraduate aviation students?” There were several areas that the students mentioned regarding educational value. The students found that engagement in undergraduate research will help them prepare for graduate school similar to the findings of Russell et al. (2007) and Desai et al., (2008). One student commented,

I think eventually, I definitely want another degree, a master’s degree, and so I saw it as an opportunity to get a head start, or get a preview into what that would look like, to see if that’s something I really want to do.

Another student also noted, “That it’s definitely going to look good when applying for a Master’s for grad school.”

All of the students felt that participating in undergraduate research would give them a better understanding of the aviation industry as a whole as well as help them learn subject matter at a deeper level. One student stated, “I’ve learned a significant amount about fatigue in aviation...I’d say what I’ve gathered is a significant amount of knowledge that I wouldn’t have otherwise had.” Another student focused the value towards writing, they noted, “I think that forcing yourself to write and forcing yourself to read and thinking about things in a research way can help you... you know, I’m probably a better writer because of it.”

Overall the students felt that they all benefited from the overall experience and experienced some self-improvement after the experience. While mentioned earlier that time management was a challenge, one student felt that the research process helped their time management skills by the end of the project.

There's a lot of self-accountability, like I said. The work needs to be done and you need to find the time to do it, and that's something that, again, certainly improved my time-management skills because I had a lot on my plate to start with.

University Support

The third question asked, "What support or hindrances from the university, the department, or faculty, are perceived by undergraduate aviation students engaging in extracurricular undergraduate research?" The student respondents overall all felt supported by the department. One student stated, "I think this is the environment that has encouraged me the most and supported me the most."

The students also mentioned that there was a lot of support from individual faculty members.

One student noted,

Just the support and to know that the faculty members are on my team. That is what really keeps me going with this research... I know that every professor cares about what I'm doing as a student, how I'm doing as a flight student, and how I'm doing as a person.

Another student commented,

Once I decided on the project and other faculty members became aware of the project, it gave me a lot of motivation that they thought it was something worth, you know, worth doing and worthwhile. And they provided good advice on it that, you know... the person I initially decided to work with only had a one track view on it. Once I started to pull from a couple different people, that helped a lot. But I think interdepartmentally, the faculty really helped.

The students' main theme regarding institutional support was the time management previously mentioned. From the perspective of a challenge or a hindrance from the department or University, it seemed that the students could have benefited from having an undergraduate research class. "I don't have an undergraduate research class, so I had no idea how to do any of it, so just the ambiguity of going through the process is proving significantly challenging." This seemed to be a common theme among the student respondents.

Conclusions and Recommendations

The students that participated in this study overall had a positive experience. The general struggle appeared to be their ability to manage their time around the project. All the students mentioned that they gained knowledge from their research projects and felt like it was a valuable educational experience. Generally, they felt supported by the department and faculty but really had no interaction with the University beyond the department level. Recommendations for further research would include similar studies with a greater population as well as recruiting participants from a broader cross section of institutions. In addition, the participants from this study were flight and maintenance undergraduate students in an aviation program at a four-year institution. Including a greater variety of aviation students, such as air traffic control or airport management focused students could shed more light on how aviation students interact with, understand, and benefit from extracurricular research. Departments and faculty seeking to engage their students in extracurricular research may, based on this research, find it useful to provide basic research training as part of the curriculum and to provide oversight and guidance to faculty who are mentoring undergraduate researchers.

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Appendix

Interview Protocol

Thank you for agreeing to participate in this research. For the record, do you consent to have this interview recorded (participant will have already agreed with the informed consent document, but this is another opportunity for them to cease participation if they would like)

We're going to talk for a bit about extracurricular undergraduate research and your experiences with it. If at any time you are not comfortable with a question or the interview, you are free to refuse to answer anything or even cease your participation at any time.

What are the experiences of undergraduate aviation students at SIUC who engage in extracurricular research?

- 1) What got you interested in conducting extracurricular research?
- 2) What was your research topic?
- 3) What led you to choose your topic for your research?
- 4) What did you hope to gain from participating in extracurricular research?
- 5) What challenges did you face (in the research process? needing help? time commitments? etc?)?
- 6) What successes did you have?
- 7) What failures did you experience?

What is the perceived educational value in engaging in extracurricular research to undergraduate aviation students at SIUC?

- 8) What is the value of this type of research for an undergraduate?
- 9) Do you feel like your research experience has helped you or hindered you in your coursework and beyond? Why or why not?
- 10) Was the experience worthwhile enough that you would recommend extracurricular research to your peers? In what ways?

What support or hindrances from the university, the department, or faculty, are perceived by undergraduate aviation students at SIUC engaging in extracurricular undergraduate research?

- 11) How did you feel supported by the university, department, or faculty members?
- 12) How did you feel hindered by the university, department, or faculty members?

Wrap-Up

- 13) What else would you like other students to know about your experiences with undergraduate research?
- 14) What advice do you have for undergraduate students who want to engage in extracurricular research?

Thank you for your time today. Would you be willing to look over the material I get from this interview, to make sure that I accurately portray your perceptions and experiences?

Thank you very much.